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MINERALS YEARBOOK

U.S.
DEPARTMENT
OF THE
INTERIOR

BUREAU
OF
MINES

1992

UNITED STATES DEPARTMENT OF THE INTERIOR • Bruce Babbitt, Secretary

BUREAU OF MINES

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural resources. This includes fostering the sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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Foreword

This edition of the Minerals Yearbook discusses the performance of the worldwide minerals and materials industry during 1992 and provides background information to assist in interpreting that performance. Content of the individual Yearbook volumes follows:

Volume I, Metals and Minerals, contains chapters on virtually all metallic and industrial mineral commodities important to the U.S. economy. Chapters on advanced materials, nonrenewable organic materials, and nonferrous metals recycling also were added to the Minerals Yearbook series beginning with the 1989, 1990, and 1991 volumes, respectively. A new chapter on materials recycling has been initiated in this 1992 volume. In addition, a chapter on survey methods used in data collection with a statistical summary of nonfuel minerals and a chapter on trends in mining and quarrying in the metals and industrial mineral industries are included.

Volume II, Area Reports: Domestic, contains chapters on the minerals industry of each of the 50 States, Puerto Rico, Northern Marianas, Island Possessions, and Trust Territory. This volume also has a chapter on survey methods used in data collection, including a statistical summary of domestic nonfuel minerals.

Volume III, Mineral Yearbook—International Review: International, contains the latest available mineral data on more than 150 foreign countries and discusses the importance of minerals to the economies of these nations. Beginning with the 1989 the international review is presented as six reports: Mineral Industries of the Middle East, Mineral Industries of Africa, Mineral Industries of Asia and the Pacific, Mineral Industries of Latin America and Canada, Mineral Industries of Europe and Central Eurasia, and Minerals in the World Economy. The reports incorporate location maps, industry structure tables, and an outlook section previously incorporated in our Mineral Perspectives Series quinquennial regional books, which are being discontinued.

The U.S. Bureau of Mines continually strives to improve the value of its publications to users. Therefore, constructive comments and suggestions by readers of the Yearbook will be welcomed.

Acknowledgments

The chapters of this volume were written by the State Mineral Officers of the Bureau of Mines, located throughout the country. Preparation of the chapters was coordinated by the Branch of Mineral Land Assessment, Division of Resource Evaluation.

The Survey Methods and Statistical Summary of Nonfuel Minerals chapter and the tabular material covering total State mineral production and mineral production by county were prepared in the Division of Statistics and Information Services.

Compilations contained in this volume were based largely on statistics and other data provided by the minerals industries. The Bureau gratefully acknowledges the willing contribution on these essential data by both companies and individuals.

In the collection of statistical and other mineral-industry information, the Bureau of Mines was also assisted by various State agencies through cooperative agreements. Many of the chapters in Volume II were reviewed by staff members of these agencies; in some instances, the staff members collaborated in preparing the chapters and are shown as coauthors. Our sincere appreciation for this assistance is extended to the following cooperating organizations:

Alabama: Geological Survey of Alabama.
Alaska: Division of Geological and Geophysical Surveys, Alaska Department of Natural Resources.
Arizona: Arizona Department of Mines and Mineral Resources.
Arkansas: Arkansas Geological Commission.
California: California Department of Conservation, Division of Mines and Geology.
Colorado: Colorado Geological Survey.
Connecticut: State Geological and Natural History Survey of Connecticut, Department of Environmental Protection.
Delaware: Delaware Geological Survey.
Florida: Florida Geological Survey.
Georgia: Georgia Geologic Survey, Environmental Protection Division, Georgia Department of Natural Resources.
Hawaii: Department of Land and Natural Resources of the State of Hawaii.
Idaho: Idaho Geological Survey.
Illinois: State Geological Survey, Illinois Department of Energy and Natural Resources.
Indiana: Geological Survey, Indiana Department of Natural Resources.
Iowa: Geological Survey Bureau, Division of Energy and Geological Resources, Iowa Department of Natural Resources.
Kansas: Kansas Geological Survey.
Kentucky: Kentucky Geological Survey.
Louisiana: Louisiana Geological Survey.
Maine: Maine Geological Survey.
Maryland: Maryland Geological Survey.
Massachusetts: Commonwealth of Massachusetts, Executive Office of Environmental Affairs.
Michigan: Geological Survey Division, Michigan Department of Natural Resources.

Minnesota: Minnesota Geological and Natural History Survey.
Mississippi: Office of Geology, Mississippi Department of Environmental Quality.
Missouri: Missouri Department of Natural Resources, Division of Geology and Land Survey.
Montana: Montana Bureau of Mines and Geology.
Nebraska: University of Nebraska-Lincoln, Nebraska Geological Survey.
Nevada: Nevada Bureau of Mines and Geology.
New Hampshire: New Hampshire Department of Environmental Services.
New Jersey: New Jersey Geological Survey, New Jersey Department of Environmental Protection and Energy, Division of Science and Research.
New Mexico: New Mexico Bureau of Mines and Mineral Resources.
New York: New York State Education Department, New York Geological Survey.
North Carolina: Division of Land Resources, North Carolina Department of Environment, Health, and Natural Resources.
North Dakota: North Dakota Geological Survey.
Oklahoma: Oklahoma Geological Survey.
Pennsylvania: Pennsylvania Bureau of Topographic and Geologic Survey, Department of Environmental Resources.
Puerto Rico: Department of Natural Resources, Commonwealth of Puerto Rico.
Rhode Island: Rhode Island Department of Environmental Management.
South Carolina: South Carolina Geological Survey.
South Dakota: South Dakota Geological Survey.
Tennessee: Tennessee Division of Geology.
Texas: Bureau of Economic Geology, The University of Texas at Austin.
Utah: Utah Geological Survey.
Vermont: Agency of Natural Resources, Division of Geology and Mineral Resources.
Virginia: Virginia Division of Mineral Resources.
Washington: Washington Division of Geology and Earth Resources.
West Virginia: West Virginia Geological and Economic Survey.
Wisconsin: Wisconsin Geological and Natural History Survey.
Wyoming: Geological Survey of Wyoming.

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SURVEY METHODS AND STATISTICAL SUMMARY OF NONFUEL MINERALS

By Jacqueline A. McClaskey and Stephen D. Smith

Ms. McClaskey, an operations research analyst with 7 years of Government experience, has been with the U.S. Bureau of Mines Branch of Statistics and Methods Development since 1990.

Mr. Smith, industry data analyst in the Section of Industry Data Analysis and Coordination, was assisted in the preparation of the Statistical Summary by Imogene P. Bynum, Chief, Section of Metals Data; Rosa McGee, Chief, Section of Industrial Minerals Data; Ivette E. Torres, Chief, Section of International Data; and Jim F. Lemons, Jr., Chief, Branch of Materials.

SURVEY METHODS

The U.S. Bureau of Mines (USBM) Information and Analysis Directorate collects worldwide data on virtually every commercially important nonfuel mineral commodity. These data form the base for tracking and assessing the health of the minerals sector of the U.S. economy.

The USBM's data collection activity was instituted by the 47th Congress in an appropriations act of August 7, 1882 (22 Stat. 329), which placed the collection of mineral statistics on an annual basis. The most recent authority for the USBM survey activity is the National Materials and Minerals Policy, Research and Development Act of 1980 (Public Law 96-479, 96th Congress). This act strengthens protection for proprietary data provided to the U.S. Department of the Interior by persons or firms engaged in any phase of mineral or mineral-material production or consumption.

Data Collection Surveys

The USBM begins the collection of domestic nonfuel minerals and materials statistics by appraising the information requirements of Government and private organizations of the United States. Requirements that can be met by collecting data from minerals establishments are posed as questions on USBM surveys. Figure 1 shows a typical survey form.

Specific questions about the production, consumption, shipments, etc., of mineral commodities are structured in the survey forms to provide meaningful aggregated data. Thus, the entire mineral economic cycle from production through consumption is covered by 161 monthly, quarterly, semiannual, annual, and biennial surveys.

After the survey form has been designed, a list of the appropriate establishments to be canvassed is developed. Many sources are used to determine which companies, mines, plants, and other operations should be included on the survey mailing list. USBM State Mineral Officers, State geologists, Federal organizations (e.g., Mine Safety and Health Administration), trade associations, industry representatives, and trade publications and directories are some of the sources that are used to develop and update survey listings. With few exceptions, a complete canvass of the list of establishments is employed rather than a sample survey. The iron and steel scrap industry is one of the exceptions where a sample survey is conducted.

The Paperwork Reduction Act requires that any Government agency wishing to collect information from 10 or more individuals or establishments first obtain approval from the Office of Management and Budget (OMB). OMB approves the need to collect the data and protects industry from unwarranted Government paperwork.

Survey Processing

The USBM surveys approximately 25,500 establishments. Each year the USBM mails about 45,000 forms that gather information for 161 different surveys. Each completed survey form returned to the USBM undergoes extensive scrutiny to ensure the highest possible accuracy of the mineral data. The statistical staff monitors all surveys to ensure that errors are not created by reporting in physical units different from the units requested on the form. Relationships between related measures, such as produced crude ore and marketable crude ore, are analyzed for consistency. Engineering relationships, such as recovery factors from ores and concentrates, are also employed. The totals for each form are verified, and currently reported data are checked against prior reports to detect possible errors or omissions.

For the majority of the surveys, which are automated, the forms are reviewed to ensure that data are complete and correct before entering into the computer. The computer is programmed to conduct a series of automated checks to verify mathematical consistency and to identify discrepancies between the data reported and logically acceptable responses.

The USBM is modernizing and automating all of its survey processing and data dissemination functions.

Automated commodity data system functions include computerized preparation of statistical tables; the use of desktop publishing to integrate text and tables; and the implementation of a microcomputer bulletin board, known as MINES-DATA, for electronic dissemination of minerals data. Also, information on minerals and mineral-related publications is now available through an easy-to-use automated facsimile (fax) response system known as MINES FaxBack.

Survey Responses.—To enable the reader to better understand the basis on which the statistics are calculated, each commodity annual report includes a section entitled "Domestic Data Coverage." This section briefly describes the data sources, the number of establishments surveyed, the response percentage, and the method of estimating the production or consumption for nonrespondents.

To produce reliable aggregated data, the USBM employs efficient procedures for handling instances of nonresponse. Failure to return the initial survey form results in a second mailing of the form. If the second form is not returned, telephone calls are made to the nonrespondents. The followup calls provide the necessary data to complete the survey forms and/or verify questionable data entries. Periodic visits to important minerals establishments are also made by USBM commodity specialists or State Mineral Officers to gather missing data and to explain the importance of the establishment's reporting. By describing the use of the published statistics and showing the impact of nonresponse, the USBM strives to encourage respondents to give a complete and accurate reply.

The OMB "Guidelines for Reducing Reporting Burden" stipulates that the minimum acceptable response rate shall be 75% of the panel surveyed. In addition, the USBM strives for a minimum reporting level of 75% of the quantity produced or consumed (depending on the survey) for certain key statistics. Response rates are periodically reviewed. For those surveys not meeting the minimum reporting level, procedures are developed and implemented to improve response rates.

Estimation for Nonresponse.—When efforts to obtain a response to a survey fail, it becomes necessary to employ estimation or imputation techniques to account for missing data. These techniques are most effective when the response rate is relatively high. Some of the estimation methods depend on knowledge of prior establishment reporting, while other techniques rely on external information to estimate the missing data. When survey forms are received after the current publication has been completed, the forms are edited, necessary imputations are made for missing data, and the survey data base is updated. The revised data are reported in later publications.

Protection of Proprietary Data.—The USBM relies on the cooperation of the U.S. minerals industry to provide the mineral data that are presented in this and other USBM publications. Without a strong response to survey requests, the USBM would not be able to present reliable statistics. The USBM in turn respects the proprietary nature of the data received from the individual companies and establishments. To ensure that proprietary rights will not be violated, the USBM analyzes each of the aggregated statistics to determine if the data reported by an individual establishment can be deduced from the aggregated statistics. If, for example, there are only two significant producers of a commodity in a given State, the USBM will not publish the State total because either producer could readily estimate the production of the other. It is this obligation to protect proprietary information that results in the "Withheld" or "W" entries in the published tables. However, if a company gives permission in writing, the USBM will publish the data as long as the data from other respondents are protected from disclosure.

International Data

International data are collected by country specialists in the USBM Division of International Minerals with assistance from the Section of International Data. The data are gathered from various sources, including published reports of foreign Government mineral and statistical agencies, international organizations, the U.S. Department of State, the United Nations, the Organization of Petroleum Exporting Countries, and personal contact by specialists traveling abroad. Each February an annual "Minerals Questionnaire" is sent through the Department of State to more than 130 U.S. Embassies asking them to provide estimates of mineral production for the host country for the preceding year. Missing data are estimated by USBM country specialists based on historical trends and specialists' knowledge of current production capabilities in each country.

Publications

The USBM disseminates current and historical minerals information through a broad range of printed publications.

The Minerals Yearbook summarizes annually, on a calendar-year basis, the significant economic and technical developments in the mineral industries. Three separate volumes are issued each year: Volume I, Metals and Minerals; Volume II, Area Reports, Domestic; and Volume III, Area Reports, International. Chapters in these volumes are issued separately as annual reports before the bound volumes are available. (Volume III country reports appear in bound volume only.)

Volume I of the Minerals Yearbook presents, by mineral commodity, salient statistics on production, trade, consumption, reserves, and other measures of economic activity.

Volume II of the Minerals Yearbook reviews the U.S. minerals industry by State and island possessions.

Volume III of the Minerals Yearbook contains the latest available mineral data

for the year of review on more than 170 foreign countries and discusses the importance of minerals to the economies of these nations. Volume III is presented as five area reports and one world overview: Mineral Industries of Africa, Mineral Industries of Asia and the Pacific, Mineral Industries of Latin America and Canada, Mineral Industries of Europe and Central Eurasia, Mineral Industries of the Middle East, and Minerals in the World Economy.

Mineral Industry Surveys contain timely statistical and economic data on minerals. The surveys are designed to keep Government agencies and the public, particularly the mineral industry and the business community, informed of trends in the production, distribution, inventories, and consumption of minerals. Frequency of issue depends on the demand for current data. Mineral Industry Surveys are released monthly, quarterly, semiannually, or annually.

Mineral Commodity Summaries, an up-to-date summary of about 90 nonfuel mineral commodities, is the earliest Government publication to furnish estimates covering the previous year's nonfuel mineral industry data. It contains information on the domestic industry structure, Government programs, tariffs, 5-year salient statistics, and a summary of international mining news.

State Mineral Summaries provide estimated data and summaries of mineral activities at the State level for the previous year. These summaries have been prepared in cooperation with State geological surveys or related agencies.

Minerals Today, published bimonthly, provides readers with the latest information about developments, trends, and issues concerning the mining, processing, and use of minerals and materials.

Metal Industry Indicators, published monthly, contains indexes that measure the current and future performance of four U.S. minerals industries. For each of the four industries, a composite coincident index and a composite leading index have been developed based on procedures and data similar to those used to construct the U.S. Department of Commerce's coincident and leading cyclical indicators for the national economy.

Information Circulars are primarily concerned with USBM economic reviews and interpretative analyses. The series also includes surveys of mining and operating activities, guides to marketing of mineral commodities, and compilations of historical information and statistical and economic data on minerals.

Order free copies of the Mineral Industry Surveys or the Metal Industry Indicators from Publication Distribution, U.S. Bureau of Mines, Cochrans Mill Road, P.O. Box 18070, Pittsburgh, PA 15236, (412) 8992-4338.

To purchase Minerals Today, Annual Commodity Reports, Minerals Yearbook, Mineral Commodity Summaries, and State Mineral Summaries, order from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, (202) 783-3238.

Information Circulars, Mineral Commodity Summaries, and State Mineral Summaries also may be purchased from the National Technical Information Service, Springfield, VA 22161, 1-800-553 NTIS (in Virginia and foreign countries: 1-703-487-4650).

Electronic Data Dissemination

In addition to the USBM's printed publications, current Mineral Industry Surveys for all commodities and 85 annual reports from the Minerals Yearbook are now available through the USBM's MINES-DATA computer bulletin board. Using this system, the public may obtain information up to 4 weeks before published copies of the reports would arrive in the mail. The MINES-DATA system may be accessed by calling (202) 501-0373 using a modem set to 1200 or 2400 baud, 8 data bits, no parity, and 1 stop bit. Further information on how to use the MINES-DATA system may be obtained from the system operator by calling (202) 501-0406.

Also, current information on minerals and mineral-related publications from the USBM is now available through an easy-to-use automated fax response system. The MINES FaxBack service allows callers to retrieve information and order some publications for delivery to their fax machines in minutes, 24 hours per day, 7 days per week. MINES FaxBack makes monthly and quarterly Mineral Industry Surveys publications available to the public at the same time they are forwarded to the printer.

MINES FaxBack works from any Group III-compatible fax machine equipped with a touch-tone telephone (either a built-in handset with touch-tone capability or a separate touch-tone telephone plugged into the fax machine's phone jack). After calling MINES FaxBack, the requestor is guided by a series of voice messages that assist the caller in ordering the desired documents. The caller pays for the phone call that also includes the time needed to deliver the requested document to the caller's fax machine.

To access the MINES FaxBack System, use a touch-tone handset attached to a fax machine or connect a touch-tone telephone to the fax machine's telephone jack and dial (412) 892-4088. Listen to the menu options and select an option using the touch-tone telephone. After completing a selection, press the start button on the fax machine.

STATISTICAL SUMMARY

This annual report summarizes data on crude nonfuel mineral production for the United States, its island possessions, and the Commonwealth of Puerto Rico. Also included are tables that show the principal nonfuel mineral commodities exported from and imported into the United States and that compare world and U.S. mineral production. The detailed data from which these tables were derived are contained in the individual annual reports of Volume I and in the State reports of Volume II of this edition of the Minerals Yearbook.

Although crude mineral production may be measured at any of several stages of extraction and processing, the stage of measurement used in this annual report is what is termed "mine output." It usually

refers to minerals or ores in the form in which they are first extracted from the ground, but customarily includes the output from auxiliary processing at or near the mines.

Because of inadequacies in the statistics available, some series deviate from the foregoing definition. For copper, gold, lead, silver, tin, and zinc, the quantities are recorded on a mine basis (as the recoverable content of ore sold or treated). However, the values assigned to these quantities are based on the average selling price of refined metal, not the mine value. Mercury is measured as recovered metal and valued at the average New York price for the metal.

The weight or volume units shown are those customarily used in the particular industries producing the commodities. Values shown are in current dollars, with no adjustments made to compensate for changes in the purchasing power of the dollar.

TABLE 1

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS							
Beryllium concentrates	metric tons	4,548	W $5	4,339	$5	4,826	$5
Copper[2]	do.	1,587,742	4,311,204	1,631,078	3,931,305	1,765,102	4,180,245
Gold[2]	kilograms	294,527	3,649,914	r295,957	r3,456,786	329,124	3,650,325
Iron ore (includes byproduct material)	thousand metric tons	57,010	1,740,925	56,775	1,674,100	55,569	1,732,416
Iron oxide pigments (crude)	metric tons	37,071	4,615	40,220	4,485	39,272	4,669
Lead[2]	do.	483,704	490,771	465,931	343,948	397,923	307,922
Magnesium metal	do.	139,333	433,119	131,288	336,577	136,947	359,534
Mercury	do.	W	W	58	206	64	376
Molybdenum[3]	do.	61,580	348,256	53,607	249,909	49,554	208,657
Nickel ore[4]	do.	330	NA	5,523	NA	6,671	W
Palladium metal	kilograms	5,930	21,735	6,050	16,923	6,470	18,097
Platinum metal	do.	1,810	27,176	1,730	20,635	1,840	21,060
Silver[2]	metric tons	2,125	329,329	r1,855	r240,908	1,804	228,563
Zinc[2]	do.	515,355	847,485	517,804	602,426	523,430	673,686
Combined value of antimony, bauxite, manganiferous ore (5% to 35%), mercury, rare-earth metal concentrates, tin, titanium concentrates (ilmenite and rutile), tungsten, vanadium, zircon concentrates, and values indicated by symbol W		XX	237,468	XX	143,298	XX	151,091
Total metals[5]		XX	12,442,000	XX	r11,022,000	XX	11,537,000
INDUSTRIAL MINERALS (EXCLUDING FUELS)							
Abrasives[6]	metric tons	3,734	231	2,205	161	1,732	239
Asbestos	do.	W	W	W	W	15,573	6,138
Barite	do.	430,000	16,000	448,000	21,310	325,743	19,633
Boron minerals (B_2O_3)	do.	1,093,919	436,176	1,240,158	442,531	1,008,889	338,700
Bromine[e]	thousand kilograms	177,000	r173,000	170,000	167,000	171,000	170,000
Cement:							
Masonry	thousand short tons	3,274	225,404	r2,637	r187,679	2,930	195,000
Portland	do.	75,596	3,683,400	r68,722	r3,343,223	72,817	3,500,150
Clays	metric tons	42,904,437	1,619,826	44,091,697	1,505,088	40,712,064	1,481,893
Diatomite	do.	631,062	137,982	609,652	139,857	595,122	119,697
Feldspar	do.	630,000	28,471	580,000	26,000	r726,000	r28,500
Fluorspar	do.	r63,500	W	W	W	W	W
Garnet (abrasive)	do.	47,009	6,937	50,860	7,534	54,139	4,842
Gemstones		NA	52,867	NA	84,386	NA	66,195
Gypsum (crude)	thousand short tons	16,406	99,567	15,456	94,199	16,269	100,583
Helium (Grade-A)	million cubic meters	87	113,183	88	174,706	94	187,179
Iodine	thousand kilograms	1,973	30,486	1,999	31,389	1,995	20,877
Lime	thousand short tons	17,452	901,549	17,270	890,482	17,857	949,674
Mica (scrap)	thousand metric tons	109	5,841	103	5,542	85	4,638
Peat	thousand short tons	795	19,200	777	17,887	719	16,747

See footnotes at end of table.

TABLE 1—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
INDUSTRIAL MINERALS (EXCLUDING FUELS)—Continued							
Perlite	metric tons	717,172	17,443	514,047	15,086	541,164	16,368
Phosphate rock	thousand metric tons	46,343	1,075,093	48,096	1,030,913	46,965	1,058,393
Potash (K_2O equivalent)	do.	1,716	303,337	1,709	304,500	1,767	334,407
Pumice	metric tons	442,848	10,687	401,376	9,190	480,855	14,903
Salt	thousand metric tons	36,916	826,659	35,902	801,507	34,784	802,563
Sand and gravel:							
Construction	thousand short tons	910,600	3,249,400	r e913,500	r e3,267,500	919,300	3,341,300
Industrial	do.	28,406	436,200	25,600	390,477	26,967	424,968
Sodium compounds:							
Soda ash	thousand metric tons	9,156	836,188	9,005	835,577	9,379	836,431
Sodium sulfate (natural)	metric tons	349,000	33,748	354,000	30,903	336,829	26,262
Stone:[8]							
Crushed	thousand short tons	e1,222,000	e5,591,300	1,102,878	5,186,821	e1,161,500	e5,593,700
Dimension	short tons	r e1,229,211	r e231,040	r1,270,241	r209,611	e1,080,931	e180,942
Sulfur (Frasch)	thousand metric tons	3,676	335,189	3,119	271,598	2,600	158,727
Tripoli	metric tons	94,389	3,188	88,642	3,271	84,924	3,256
Vermiculite	do.	208,275	19,075	167,923	13,410	190,052	15,062
Combined value of aplite, brucite, calcium chloride (natural), emery, helium (crude), kyanite, lithium minerals, magnesite, magnesium compounds, marl (greensand), olivine, pyrites, staurolite, wollastonite, and values indicated by symbol W		XX	473,453	XX	506,275	XX	456,896
Total industrial minerals[5]		XX	r20,992,000	XX	r20,016,000	XX	20,475,000
Grand total[5]		XX	r33,434,000	XX	r31,038,000	XX	32,012,000

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Recoverable content of ores, etc.

[3]Content of ore and concentrate.

[4]The Riddle nickel smelter uses lateritic ore mined on Nickel Mountain, lateritic ore imported from New Caledonia, and small tonnages of recycled Ni-bearing catalysts. In 1989, the Glenbrook Nickel Co. purchased the idled mining and smelting complex and restarted the operation. Since then, production of ferronickel on a contained Ni basis has been as follows: 1990—3,701 metric tons (mt) valued at $32.8 million; 1991—7,065 mt valued at $57.6 million; and 1992—8,962 mt valued at $62.7 million.

[5]Rounded.

[6]Grindstones, pulpstones, and sharpening stones; excludes mill liners and grinding pebbles.

[7]Beginning in 1992; aplite is combined with feldspar.

[8]Excludes abrasive stone and bituminous limestone and sandstone; all included elsewhere in table.

TABLE 2

TOTAL U.S. NONRENEWABLE ORGANIC MATERIALS PRODUCTION, BY QUANTITY AND VALUE[1]

(Million metric tons and million dollars)

Category	1990		1991		1992[p]	
	Quantity	Value	Quantity	Value[r]	Quantity	Value
Asphalt and road oil	25.02	3,480	[r]25.85	2,979	25.25	2,794
Lubricants, waxes, and miscellaneous products	12.51	1,863	12.10	1,540	11.05	1,335
Petrochemical industries	57.75	7,759	[r]67.79	7,889	65.91	7,467
Petroleum coke and coal	13.05	1,291	[r]12.93	1,071	13.83	1,102
Total	108.33	[2]14,394	[r]118.67	13,479	116.04	12,698

[p]Preliminary. [r]Revised.

[1]Quantities valued at the fossil fuel prices given in the Department of Energy, Energy Information Administration, Annual Energy Review 1992, June 1993, p. 71.

[2]Data do not add to total shown because of independent rounding.

NOTE.— Nonrenewable organic materials represent all nonfuel uses in physical structure applications. The petrochemical industries category includes feedstocks for the production of plastics, synthetic rubber, synthetic fibers, pesticides, coatings, solvents, fertilizers, and other petrochemicals.

TABLE 3

NONFUEL MINERALS PRODUCED IN THE UNITED STATES AND PRINCIPAL PRODUCING STATES IN 1992

Mineral	Principal producing States, in order of quantity	Other producing States
Abrasives[1]	AR, WI, OH	
Antimony[2]	ID	
Aplite	(3)	
Asbestos	CA and VT	
Barite	NV, GA, MO, MT	IL.
Bauxite	AL and GA	
Beryllium concentrate	UT	
Boron minerals	CA	
Bromine[e]	AR	
Brucite	NV	
Calcium chloride (natural)	MI and CA	
Cement:		
Masonry	IN, FL, PA, MI	All other States except AK, CT, DE, LA, MA, MN, NV, NH, NJ, NC, ND, RI, VT, WI.
Portland	CA, TX, PA, MI	All other States except AK, CT, DE, LA, MA, MN, NH, NJ, NC, ND, RI, VT, WI.
Clays	GA, WY, AL, TX	All other States except AK, DE, HI, RI, VT, WI.
Copper[2]	AZ, UT, NM, MT	CO, ID, IL, MI, MO, NV, OR, TN.
Diatomite	CA, NV, WA, OR	
Emery	OR	
Feldspar[3]	NC, VA, OK, CA	GA, ID, SD.
Fluorspar	IL	
Garnet (abrasive)	ID and NY	
Gemstones (natural)[4]	TN, CA, AZ, LA	All other States.
Gold[2]	NV, CA, UT, SD	AK, AZ, CO, ID, MT, NM, OR, SC, WA.
Graphite (natural)	(5)	
Greensand marl	NJ	
Gypsum (crude)	OK, IA, TX, MI	AR, AZ, CA, CO, IN, KS, LA, NM, NV, NY, OH, SD, UT, VA, WY.
Helium (crude and Grade-A)	KS, WY, TX, CO	
Iodine	OK	
Iron ore (usable)[6]	MN, MI, UT, CA	MO, MT, SD, TX.
Iron oxide pigments (crude)	MI, MO, GA, VA	AZ.
Kyanite	VA	
Lead[2]	MO, AK, ID, MT	AZ, CO, IL, NM, NY, TN, WA.
Lime	MO, OH, PA, AL	All other States except AK, CT, DE, FL, GA, HI, KS, ME, MD, MS, NH, NJ, NM, NY, NC, RI, SC, VT.
Lithium minerals	NC and NV	
Magnesite	NV	
Magnesium compounds	MI, CA, UT, FL	DE and TX.
Magnesium metal	TX, UT, WA	
Manganiferous ore	SC	
Mercury	NV, UT, CA	
Mica (scrap)	NC, NM, GA, SD	SC.
Molybdenum	CO, AZ, UT, ID	CA, MT, NM.
Nickel ore	OR	
Olivine	WA and NC	
Palladium metal	MT	

See footnotes at end of table.

TABLE 3—Continued

NONFUEL MINERALS PRODUCED IN THE UNITED STATES AND PRINCIPAL PRODUCING STATES IN 1992

Mineral	Principal producing States, in order of quantity	Other producing States
Peat	FL, MI, WI, MN	CO, IA, IL, IN, MA, ME, MT, NC, ND, NJ, NY, OH, PA, SC, WA, WV.
Perlite	NM, AZ, CA, NV	CO and ID.
Phosphate rock	FL, NC, ID, UT	MT.
Platinum metal	MT	
Potash	NM, UT, CA, MI	
Pumice	OR, NM, ID, CA	AZ and KS.
Pyrites (ore and concentrate)	AZ	
Rare-earth metal concentrates	CA and FL	
Salt	LA, TX, NY, OH	AL, AZ, CA, KS, MI, NM, NV, OK, UT, WV.
Sand and gravel:		
Construction	CA, OH, TX, MI	All other States.
Industrial	IL, CA, MI, NJ	All other States except AK, DE, HI, KY, ME, NH, NM, OR, SD, UT, VT, WY.
Silver[2]	NV, AK, ID, MT	AZ, CA, CO, IL, MI, MO, MN, NY, OR, SC, SD, TN, UT, WA.
Sodium compounds:		
Soda ash	WY and CA	
Sodium sulfate (natural)	CA, TX, UT	
Staurolite	FL	
Stone:		
Crushed	IL, PA, TX, FL	All other States except DE.
Dimension	IN, GA, VT, MA	All other States except AK, DE, FL, HI, KY, LA, MS, NE, NV, NJ, ND, OR, RI, UT, WV, WY.
Sulfur (Frasch)	TX and LA	
Talc and pyrophyllite	MT, TX, VT, NY	CA, NC, OR, VA.
Tin	AZ	
Titanium concentrates	FL, CA, NJ	
Tripoli	IL, OK, AR, PA	
Tungsten[2]	CA	
Vanadium[2]	ID	
Vermiculite (crude)	SC, VA, MT	
Wollastonite	NY	
Zeolites	TX, NM, OR, NV	AZ, IA, ID, WY.
Zinc[2]	AK, TN, NY, MO	CO, ID, IL, MT, WA.
Zircon concentrates	FL and NJ	

[e]Estimated.
[1]Grindstones, pulpstones, and sharpening stones; excludes mill liners and grinding pebbles.
[2]Content of ores, etc.
[3]Beginning in 1992; aplite is combined with feldspar.
[4]Principal and other producing States based on value.
[5]No production reported.
[6]Includes byproduct material.

TABLE 4

VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 1992

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$542,714	19	1.70	Cement (portland), stone (crushed), lime, sand and gravel (construction).
Alaska	526,112	21	1.64	Zinc, gold, lead, sand and gravel (construction).
Arizona	3,165,938	1	9.89	Copper, sand and gravel (construction), gold, cement (portland).
Arkansas	403,822	26	1.26	Bromine, stone (crushed), sand and gravel (construction), cement (portland).
California	2,345,838	3	7.33	Sand and gravel (construction), cement (portland), gold, boron.
Colorado	384,778	29	1.20	Sand and gravel (construction), cement (portland), molybdenum, stone (crushed).
Connecticut	97,192	44	.30	Stone (crushed), sand and gravel (construction), stone (dimension), sand and gravel (industrial).
Delaware[1]	8,575	50	.03	Sand and gravel (construction), magnesium compounds, gemstones.
Florida	1,439,760	5	4.50	Phosphate rock, stone (crushed), cement (portland), sand and gravel (construction).
Georgia	1,346,254	8	4.21	Clays, stone (crushed), cement (portland), sand and gravel (construction).
Hawaii[1]	148,857	39	.47	Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry).
Idaho	306,061	33	.96	Phosphate rock, sand and gravel (construction), gold, silver.
Illinois	733,572	16	2.29	Stone (crushed), sand and gravel (construction), cement (portland), sand and gravel (industrial).
Indiana	476,886	22	1.49	Stone (crushed), cement (portland), sand and gravel (construction), stone (dimension).
Iowa	391,163	28	1.22	Stone (crushed), cement (portland), sand and gravel (construction), gypsum (crude).
Kansas	405,082	25	1.27	Salt, helium (Grade-A), cement (portland), stone (crushed).
Kentucky	400,574	27	1.25	Stone (crushed), lime, cement (portland), sand and gravel (construction).
Louisiana	309,280	32	.97	Salt, sulfur (Frasch), sand and gravel (construction), stone (crushed).
Maine	55,919	46	.17	Sand and gravel (construction), cement (portland), stone (crushed), cement (masonry).
Maryland	339,366	31	1.06	Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry).
Massachusetts	147,401	40	.46	Stone (crushed), sand and gravel (construction), lime, stone (dimension).
Michigan	1,586,977	4	4.96	Iron ore (usable), cement (portland), sand and gravel (construction), stone (crushed).
Minnesota	1,363,939	6	4.26	Iron ore (usable), sand and gravel (construction), stone (crushed), sand and gravel (industrial).
Mississippi	119,964	41	.37	Sand and gravel (construction), clays, cement (portland), stone (crushed).
Missouri	897,189	11	2.80	Lead, cement (portland), stone (crushed), lime.
Montana	539,154	20	1.68	Gold, copper, cement (portland), sand and gravel (construction).
Nebraska	114,790	42	.36	Cement (portland), sand and gravel (construction), stone (crushed), lime.
Nevada	2,588,251	2	8.09	Gold, sand and gravel (construction), silver, diatomite.
New Hampshire[1]	42,034	47	.13	Sand and gravel (construction), stone (crushed and dimension), clays.
New Jersey	240,439	36	.75	Stone (crushed), sand and gravel (construction and industrial), stone (dimension).
New Mexico	871,279	13	2.72	Copper, potash, sand and gravel (construction), stone (crushed).
New York	765,747	14	2.39	Stone (crushed), salt, sand and gravel (construction), cement (portland).
North Carolina	595,648	17	1.86	Stone (crushed), phosphate rock, lithium minerals, sand and gravel (construction).
North Dakota	25,750	48	.08	Sand and gravel (construction), lime, gemstones, sand and gravel (industrial).
Ohio	741,903	15	2.32	Stone (crushed), sand and gravel (construction), salt, lime.
Oklahoma	252,596	35	.79	Stone (crushed), cement (portland), sand and gravel (construction), iodine (crude).
Oregon	214,170	38	.67	Stone (crushed), sand and gravel (construction), cement (portland), lime.
Pennsylvania	879,380	12	2.75	Stone (crushed), cement (portland), sand and gravel (construction), lime.
Rhode Island[1]	21,465	49	.07	Sand and gravel (construction), stone (crushed), sand and gravel (industrial), gemstones.
South Carolina	346,896	30	1.08	Cement (portland), stone (crushed), gold, clays.
South Dakota	300,670	34	.94	Gold, cement (portland), sand and gravel (construction), stone (crushed).
Tennessee	575,804	18	1.80	Stone (crushed), zinc, cement (portland), sand and gravel (construction).
Texas	1,303,378	9	4.07	Cement (portland), stone (crushed), magnesium metal, sand and gravel (construction).
Utah	1,347,663	7	4.21	Copper, gold, magnesium metal, cement (portland).

See footnotes at end of table.

TABLE 4—Continued

VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 1992

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Vermont[1]	$59,817	45	0.19	Stone (dimension and crushed), sand and gravel (construction), talc and pyrophyllite.
Virginia	461,863	24	1.44	Stone (crushed), cement (portland), lime, sand and gravel (construction).
Washington	469,039	23	1.47	Sand and gravel (construction), gold, magnesium metal, stone (crushed).
West Virginia	111,598	43	.35	Stone (crushed), cement (portland), sand and gravel (construction), lime.
Wisconsin[1]	222,369	37	.69	Stone (crushed), sand and gravel (construction), lime, sand and gravel (industrial).
Wyoming	950,757	10	2.97	Soda ash, clays, helium (Grade-A), cement (portland).
Undistributed	25,757	—	—	
Total[2]	32,011,000	XX	100.00	

XX Not applicable.
[1]Partial total, excludes values that must be concealed to avoid disclosing company proprietary data. Concealed values included with "Undistributed" figure.
[2]Rounded.

TABLE 5

VALUE OF NONFUEL MINERAL PRODUCTION PER CAPITA AND PER SQUARE MILE IN 1992, BY STATE

State	Area (square miles)	Population (thousands)	Total value (thousands)	Per square mile		Per capita	
				Dollars	Rank	Dollars	Rank
Alabama	51,705	4,136	$542,714	10,496	25	131	17
Alaska	591,004	587	526,112	890	49	896	3
Arizona	114,000	3,832	3,165,938	27,771	3	826	4
Arkansas	53,187	2,399	403,822	7,592	28	168	13
California	158,706	30,867	2,345,838	14,781	17	76	29
Colorado	104,091	3,470	384,778	3,697	41	111	20
Connecticut	5,018	3,281	97,192	19,369	10	30	47
Delaware	2,044	689	[1]8,575	4,195	38	12	50
Florida	58,664	13,488	1,439,760	24,542	5	107	21
Georgia	58,910	6,751	1,346,254	22,853	8	199	11
Hawaii	6,471	1,160	[1]148,857	23,004	7	128	18
Idaho	83,564	1,067	306,061	3,663	43	287	10
Illinois	56,345	11,631	733,572	13,019	20	63	38
Indiana	36,185	5,662	476,886	13,179	19	84	27
Iowa	56,275	2,812	391,163	6,951	30	139	16
Kansas	82,277	2,523	405,082	4,923	34	161	15
Kentucky	40,409	3,755	400,574	9,913	26	107	22
Louisiana	47,751	4,267	309,280	6,477	32	72	32
Maine	33,265	1,235	55,919	1,681	47	45	41
Maryland	10,460	4,908	339,366	32,444	1	69	36
Massachusetts	8,284	5,998	147,401	17,793	12	25	48
Michigan	58,527	9,437	1,586,977	27,115	4	168	14
Minnesota	84,402	4,480	1,363,939	16,160	14	304	9
Mississippi	47,689	2,614	119,964	2,516	45	46	40
Missouri	69,697	5,193	897,189	12,873	21	173	12
Montana	147,046	824	539,154	3,667	42	654	6

See footnotes at end of table.

TABLE 5—Continued

VALUE OF NONFUEL MINERAL PRODUCTION PER CAPITA AND PER SQUARE MILE IN 1992, BY STATE

State	Area (square miles)	Population (thousands)	Total value (thousands)	Per square mile		Per capita	
				Dollars	Rank	Dollars	Rank
Nebraska	77,355	1,606	$114,790	1,484	48	71	35
Nevada	110,561	1,327	2,588,251	23,410	6	1,950	2
New Hampshire	9,279	1,111	[1]42,034	4,530	37	38	45
New Jersey	7,787	7,789	240,439	30,877	2	31	46
New Mexico	121,593	1,581	871,279	7,166	29	551	7
New York	49,107	18,119	765,747	15,593	16	42	43
North Carolina	52,669	6,843	595,648	11,309	23	87	26
North Dakota	70,703	636	25,750	364	50	40	44
Ohio	41,330	11,016	741,903	17,951	11	67	37
Oklahoma	69,956	3,212	252,596	3,611	44	79	28
Oregon	97,073	2,977	214,170	2,206	46	72	34
Pennsylvania	45,308	12,009	879,380	19,409	9	73	31
Rhode Island	1,212	1,005	[1]21,465	17,710	13	21	49
South Carolina	31,113	3,603	346,896	11,150	24	96	24
South Dakota	77,116	711	300,670	3,899	40	423	8
Tennessee	42,144	5,024	575,804	13,663	18	115	19
Texas	266,807	17,656	1,303,378	4,885	35	74	30
Utah	84,899	1,813	1,347,663	15,874	15	743	5
Vermont	9,614	570	[1]59,817	6,222	33	105	23
Virginia	40,767	6,377	461,863	11,329	22	72	33
Washington	68,138	5,136	469,039	6,884	31	91	25
West Virginia	24,231	1,812	111,598	4,606	36	62	39
Wisconsin	56,153	5,007	[1]222,369	3,960	39	44	42
Wyoming	97,809	466	950,757	9,721	27	2,040	1
Undistributed	XX	XX	25,757	XX	XX	XX	XX
Total[2] or average	3,618,700	254,472	[3]32,011,000	8,846	XX	126	XX

XX Not applicable.

[1]Partial total, excludes values that must be concealed to avoid disclosing company proprietary data. Concealed values included with "Undistributed" figure.

[2]Excludes Washington, DC (which has no mineral production), with an area of 69 square miles and a population of 589,000.

[3]Rounded.

Sources: U.S. Bureau of Mines and Bureau of the Census.

TABLE 6

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ALABAMA							
Cement:							
Masonry	thousand short tons	262	$15,462	e238	e$14,042	213	$11,105
Portland	do.	3,585	165,344	e3,937	e181,102	4,102	180,763
Clays[2]	metric tons	2,049,776	27,747	2,124,380	22,103	2,380,981	20,914
Lime	thousand short tons	1,526	70,816	1,510	75,506	1,603	82,619
Sand and gravel:							
Construction	do.	r13,886	r49,842	e12,700	e45,700	12,294	42,038
Industrial	do.	878	9,075	531	6,133	667	6,768
Stone:							
Crushed[3]	do.	e36,100	e202,400	27,145	161,843	e28,600	e175,600
Dimension	short tons	W	W	9,552	2,449	W	W
Combined value of bauxite, clays (bentonite, kaolin), gemstones, salt, stone [crushed dolomite and granite (1991-92), crushed granite (1990)], talc and pyrophyllite (1990-91), and values indicated by symbol W		XX	r18,742	XX	31,037	XX	22,907
Total		XX	r559,428	XX	539,915	XX	542,714
ALASKA							
Gemstones		NA	W	NA	5	NA	10
Gold[4]	kilograms	3,232	40,200	r3,200	r37,376	5,003	55,492
Sand and gravel (construction)	thousand short tons	15,100	41,800	e14,000	e39,200	15,006	43,335
Stone (crushed)	do.	e2,700	e19,800	e1,085	e4,688	e3,000	e13,400
Combined value of cement [portland (1990-91)], lead, silver, stone [crushed sandstone (1991-92)], tin (1990-91), zinc, and value indicated by symbol W		XX	474,781	XX	412,840	XX	413,875
Total		XX	576,581	XX	r494,109	XX	526,112
ARIZONA							
Clays	metric tons	140,162	2,318	228,411	3,830	e102,337	e463
Copper[4]	do.	978,767	2,657,649	1,024,066	2,468,255	1,153,225	2,731,152
Gemstones		NA	2,098	NA	3,173	NA	5,416
Gold[4]	kilograms	5,000	62,191	r6,195	r72,362	6,656	73,818
Iron oxide pigments (crude)	metric tons	W	W	18	22	77	62
Sand and gravel (construction)	thousand short tons	r31,590	r112,785	e22,500	e79,400	33,842	123,517
Silver[4]	metric tons	r149	r19,346	148	19,212	165	20,873
Stone (crushed)	thousand short tons	e5,300	e13,500	7,060	32,842	e5,500	e26,300
Combined value of cement, clays, [bentonite (1992)], diatomite (1990), gypsum (crude), iron ore [usable (1991)], lead (1991-92), lime, molybdenum, perlite, pumice, pyrites, salt, sand and gravel (industrial), stone (dimension), tin (1992), and values indicated by symbol W		XX	207,591	XX	198,230	XX	184,337
Total		XX	r3,077,478	XX	r2,877,326	XX	3,165,938

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ARKANSAS							
Abrasives[5]	metric tons	W	W	W	154	W	W
Bromine[e]	thousand kilograms	177,000	r$173,000	170,000	$167,000	171,000	$170,000
Clays	metric tons	989,383	21,578	2856,582	28,048	2837,427	22,972
Gemstones		NA	1,503	NA	1,846	NA	1,493
Sand and gravel:							
Construction	thousand short tons	r10,411	r37,371	e8,300	e31,100	10,908	39,627
Industrial	do.	742	7,209	746	7,738	868	10,458
Stone (crushed)[3]	do.	e17,800	e76,900	22,140	101,427	e25,200	e118,900
Combined value of bauxite (1990), cement, clays [fire (1991-92), kaolin (1992)], gypsum (crude), lime, stone [crushed dolomite and traprock (1991-92), crushed slate and dolomite (1990), dimension], talc and pyrophyllite (1990), tripoli, vanadium (1990), and values indicated by symbol W		XX	r63,357	XX	r43,677	XX	60,372
Total		XX	r380,918	XX	r360,990	XX	403,822
CALIFORNIA							
Asbestos	metric tons	W	W	W	W	10,998	4,452
Boron minerals	do.	1,093,919	436,176	1,240,158	442,531	1,008,889	338,700
Cement (portland)	thousand short tons	10,032	604,080	e8,702	e522,120	8,035	428,016
Clays[2]	metric tons	2,163,515	40,217	2,074,707	27,464	1,905,710	26,173
Gemstones		NA	1,501	NA	10,450	NA	9,916
Gold[4]	kilograms	29,607	368,300	r30,404	r355,125	33,335	369,723
Lime	thousand short tons	345	19,425	307	20,389	280	18,072
Mercury	metric tons	(6)	(6)	(6)	1	(6)	(6)
Pumice	do.	71,739	5,088	61,237	4,372	W	W
Rare-earth metal concentrates	do.	W	W	16,465	W	20,699	W
Sand and gravel:							
Construction	thousand short tons	r130,491	r617,984	e101,900	e489,100	112,888	522,108
Industrial	do.	2,452	48,055	2,104	41,690	2,096	42,396
Silver[4]	metric tons	21	3,209	W	W	18	2,259
Stone:							
Crushed	thousand short tons	e42,500	e200,600	45,816	216,156	e40,800	e198,300
Dimension	short tons	r e45,547	r e4,946	44,757	5,254	e23,292	e4,148
Combined value of barite (1990), calcium chloride (natural), cement (masonry), clays (fuller's earth), copper (1990-91), diatomite, feldspar, gypsum (crude), iron ore (usable), magnesium compounds, mica [crude (1991)], molybdenum, perlite, potash, salt, soda ash, sodium sulfate (natural), talc and pyrophyllite, titanium concentrates (ilmenite), tungsten, and values indicated by symbol W		XX	421,820	XX	r403,592	XX	381,575
Total		XX	r2,771,401	XX	r2,538,244	XX	2,345,838

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
COLORADO							
Clays	metric tons	262,292	[2]$1,864	[2]263,866	[2]$1,964	[2]242,310	[2]$1,796
Gemstones		NA	66	NA	287	NA	225
Gold[4]	kilograms	2,357	29,176	3,181	37,154	3,763	41,741
Peat	thousand short tons	W	W	W	396	W	333
Sand and gravel (construction)	do.	r23,051	r77,761	e26,400	e88,200	29,455	105,281
Silver[4]	metric tons	23	3,557	20	2,565	W	W
Stone:							
Crushed	thousand short tons	e 37,600	e 36,100	8,401	41,022	e12,000	e60,400
Dimension	short tons	r e5,483	e(7)	W	W	e6,454	e252
Combined value of cement, clays, [bentonite (1990-91), fire (1992)], copper, gypsum (crude), helium (Grade-A), lead, lime, molybdenum, perlite, sand and gravel (industrial), stone [crushed traprock (1990)], vanadium (1990), zinc, and values indicated by symbol W		XX	r228,181	XX	166,817	XX	174,750
Total		XX	r376,705	XX	338,405	XX	384,778
CONNECTICUT							
Gemstones		NA	2	NA	62	NA	5
Sand and gravel (construction)	thousand short tons	r8,416	r37,387	e5,400	e24,800	6,025	30,107
Stone:							
Crushed[3]	do.	e10,200	e70,600	5,873	52,701	e5,900	e54,500
Dimension	short tons	e14,156	e7,113	r16,545	1,739	W	W
Combined value of clays (common), feldspar (1990-91), mica [scrap (1990-91)], sand and gravel (industrial), stone [crushed dolomite and other (1991-92), crushed granite (1990)], and value indicated by symbol W		XX	r7,165	XX	11,531	XX	12,580
Total		XX	r122,267	XX	90,833	XX	97,192
DELAWARE							
Gemstones		NA	1	NA	1	NA	1
Sand and gravel (construction)	thousand short tons	r2,953	r9,831	e1,600	e5,100	2,488	8,574
Total[8]		XX	r9,832	XX	5,101	XX	8,575
FLORIDA							
Cement:							
Masonry	thousand short tons	442	27,777	e214	e13,482	342	22,424
Portland	do.	3,954	186,404	e3,023	e142,081	3,195	161,969
Clays[2]	metric tons	391,334	39,625	363,253	39,150	367,133	37,201
Gemstones		NA	W	NA	6	NA	1
Peat	thousand short tons	252	4,381	244	3,991	211	3,158
Sand and gravel:							
Construction	do.	r20,680	r66,401	e16,000	e51,400	23,266	66,141
Industrial	do.	520	7,024	551	5,989	477	5,167

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
FLORIDA—Continued							
Stone (crushed)	thousand short tons	e74,000	e$317,400	359,132	3$260,901	e 359,300	e 3$266,900
Combined value of clays (common), magnesium compounds, phosphate rock, rare-earth metal concentrates, staurolite, stone [crushed marl (1991-92)], titanium concentrates (ilmenite and rutile), zircon concentrates, and value indicated by symbol W		XX	924,788	XX	879,164	XX	876,799
Total		XX	r1,573,800	XX	1,396,164	XX	1,439,760
GEORGIA							
Clays	metric tons	9,855,248	1,060,539	9,518,026	949,737	28,962,374	2970,905
Gemstones		NA	20	NA	10	NA	645
Sand and gravel:							
Construction	thousand short tons	r4,827	r15,577	e4,700	e14,500	4,860	15,581
Industrial	do.	W	W	W	W	588	8,783
Stone:							
Crushed	do.	e53,000	e317,300	341,339	3222,900	e 344,000	e 3244,200
Dimension[3]	short tons	r e200,531	r e20,451	r216,938	r21,282	e159,093	e13,138
Combined value of barite, bauxite (1991-92), cement, clays [fire (1992)], feldspar, iron oxide pigments (crude), mica (scrap), peat (1990), stone [crushed marl, marble and other (1991-92)], dimension marble), talc and pyrophyllite (1990), and values indicated by symbol W		XX	r90,164	XX	97,307	XX	93,002
Total		XX	r1,504,051	XX	r1,305,736	XX	1,346,254
HAWAII							
Cement:							
Masonry	thousand short tons	12	1,870	e10	e600	8	1,421
Portland	do.	532	46,311	e547	e47,589	573	53,936
Gemstones		NA	55	NA	60	NA	W
Sand and gravel (construction)	thousand short tons	438	2,459	e400	e2,300	W	W
Stone (crushed)	do.	e7,000	e55,400	310,486	390,563	e 310,500	e 393,500
Total[8]		XX	106,095	XX	141,112	XX	148,857
IDAHO							
Clays	metric tons	W	W	2967	W	W	W
Gemstones		NA	320	NA	426	NA	390
Gold[4]	kilograms	W	W	3,348	39,107	3,177	35,241
Lime	thousand short tons	W	W	150	9,124	W	W
Phosphate rock	thousand metric tons	4,380	67,978	5,921	86,328	5,208	84,000
Pumice	metric tons	31,333	220	36,868	267	55,525	401
Sand and gravel:							
Construction	thousand short tons	r8,563	r22,842	e11,600	e31,300	14,906	40,728
Industrial	do.	552	6,234	W	W	802	9,214
Silver[4]	metric tons	442	68,418	337	43,807	254	32,131
Stone:							
Crushed	thousand short tons	e4,300	e12,900	3,230	15,057	e4,000	e19,200

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
IDAHO—Continued							
Stone—Continued:							
Dimension	short tons	e7,121	e$749	r10,883	r$970	W	W
Combined value of antimony, cement, clays, [common, kaolin (1990-91)], copper, feldspar, garnet (abrasive), lead, molybdenum, perlite,vanadium ore, zinc, and values indicated by symbol W		XX	r195,657	XX	r71,147	XX	$84,756
Total		XX	r375,318	XX	r297,533	XX	306,061
ILLINOIS							
Cement (portland)	thousand short tons	2,842	116,781	e2,654	e108,814	2,860	118,982
Clays	metric tons	2598,479	2,516	935,154	38,877	2535,282	2,362
Gemstones		NA	W	NA	547	NA	715
Sand and gravel:							
Construction	thousand short tons	r33,118	r107,013	e26,300	e90,400	35,695	123,720
Industrial	do.	4,486	62,531	4,146	57,210	4,410	56,741
Stone (crushed)[3]	do.	e62,700	e283,100	68,586	295,362	e72,700	e322,800
Combined value of barite, cement (masonry), clays [fuller's earth (1990, 1992)], copper (1990, 1992), fluorspar, lead (1990, 1992), lime, peat, silver (1990, 1992), stone [crushed sandstone (1990), crushed sandstone and limestone (1991-92), dimension], tripoli, zinc, and value indicated by symbol W		XX	95,478	XX	82,081	XX	108,252
Total		XX	r667,419	XX	673,291	XX	733,572
INDIANA							
Cement:							
Masonry	thousand short tons	368	27,813	e317	e24,092	371	24,822
Portland	do.	2,417	114,414	e2,252	e105,844	2,466	110,737
Clays[2]	metric tons	1,051,703	3,273	929,964	3,516	841,723	3,016
Gemstones		NA	W	NA	561	NA	720
Peat	thousand short tons	37	W	26	W	27	512
Sand and gravel:							
Construction	do.	r23,489	r74,373	e18,100	e60,400	28,862	95,889
Industrial	do.	W	W	W	W	118	1,278
Stone:							
Crushed	do.	e r3 36,700	e r3 147,700	37,924	152,489	e43,000	e178,000
Dimension	short tons	e r3 198,242	e r3 28,565	r3 189,010	r3 27,596	e190,412	e26,767
Combined value of clays (ball), gypsum (crude), lime, stone [crushed marl and miscellaneous stones (1990), dimension limestone and sandstone (1990-91), dimension sandstone (1990)], and values indicated by symbol W		XX	r32,281	XX	r28,797	XX	35,145
Total		XX	r428,419	XX	403,295	XX	476,886
IOWA							
Cement:							
Masonry	thousand short tons	53	5,054	e34	e3,264	50	4,120
Portland	do.	2,525	122,466	e2,301	e112,749	2,824	116,477
Clays	metric tons	423,227	1,376	530,477	2,226	389,008	1,612

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
IOWA—Continued							
Gemstones		NA	$14	NA	$8	NA	$1,606
Gypsum (crude)	thousand short tons	2,192	14,243	2,162	12,285	2,193	11,626
Sand and gravel (construction)	do.	r12,125	r39,488	p17,400	p55,800	16,825	58,382
Stone (crushed)	do.	p29,000	p118,600	331,057	3147,815	p 338,000	p 3186,200
Combined value of lime, peat, sand and gravel [industrial (1992)], and stone [crushed dolomite and sandstone (1991-92), dimension]		XX	r8,888	XX	r10,045	XX	11,140
Total		XX	r310,129	XX	r344,192	XX	391,163
KANSAS							
Cement:							
Masonry	thousand short tons	39	2,011	p30	p1,530	34	1,914
Portland	do.	1,707	76,564	p1,466	p65,970	1,710	79,464
Clays	metric tons	625,969	4,056	607,419	2,828	544,052	3,921
Gemstones		NA	W	NA	527	NA	W
Helium (Grade-A)	million cubic meters	W	W	39	76,540	W	W
Salt[9]	thousand metric tons	2,168	92,119	2,101	97,713	1,852	98,620
Sand and gravel (construction)	thousand short tons	r10,737	r23,771	p9,600	p22,100	11,979	27,289
Stone:							
Crushed[3]	do.	p20,800	p79,200	16,802	67,249	p16,900	p69,600
Dimension	short tons	p 330,315	p 33,142	r 330,807	r 33,128	W	W
Combined value of gypsum (crude), helium (crude), pumice, salt (brine), sand and gravel (industrial), stone [crushed quartzite (1991-92), crushed sandstone and quartzite (1990)], dimension sandstone (1990-91), and values indicated by symbol W		XX	r67,875	XX	r29,156	XX	124,274
Total		XX	r348,738	XX	r366,741	XX	405,082
KENTUCKY							
Clays[2]	metric tons	826,205	8,282	707,587	2,942	760,310	3,777
Gemstones		NA	W	NA	548	NA	W
Sand and gravel (construction)	thousand short tons	8,802	29,581	p7,700	p27,200	7,396	24,412
Stone (crushed)	do.	p 350,100	p 3182,900	46,266	191,893	p58,800	p251,100
Combined value of cement, clays (ball), lead (1990), lime, sand and gravel [industrial (1990-91)], silver (1990), stone [crushed dolomite (1990)], zinc (1990), and values indicated by symbol W		XX	138,101	XX	120,541	XX	121,285
Total		XX	358,864	XX	343,124	XX	400,574
LOUISIANA							
Clays	metric tons	368,322	1,066	360,154	3,646	384,123	3,589
Gemstones		NA	7	NA	27	NA	3,960
Salt	thousand metric tons	13,016	120,827	13,240	130,587	12,054	112,334
Sand and gravel:							
Construction	thousand short tons	r14,588	r56,375	p13,300	p48,900	12,664	48,698
Industrial	do.	559	10,003	W	W	519	9,267

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
LOUISIANA—Continued							
Stone (crushed)	thousand short tons	e2,100	e$16,800	W	W	W	W
Sulfur (Frasch)	thousand metric tons	1,337	W	1,063	W	1,105	W
Combined value of gypsum (crude), lime, stone [crushed miscellaneous (1991), crushed miscellaneous and shell (1992)], and values indicated by symbol W		XX	163,313	XX	$168,642	XX	$131,432
Total		XX	r368,391	XX	351,802	XX	309,280
MAINE							
Gemstones		NA	W	NA	174	NA	108
Sand and gravel (construction)	thousand short tons	7,865	29,349	e3,900	e14,800	6,703	26,932
Stone:							
Crushed	do.	e1,700	e8,700	1,706	9,899	e1,900	e11,400
Dimension	short tons	W	W	73	88	W	W
Combined value of cement, clays (common), peat, and values indicated by symbol W		XX	r17,235	XX	16,343	XX	17,479
Total		XX	r55,284	XX	41,304	XX	55,919
MARYLAND							
Cement (portland)	thousand short tons	1,798	91,172	e1,580	e80,580	1,669	84,191
Clays	metric tons	338,775	1,712	e258,760	e1,141	227,013	980
Gemstones		NA	3	NA	3	NA	1
Peat	do.	3	W	—	—	—	—
Sand and gravel (construction)	do.	18,271	104,023	e13,000	e72,800	11,988	69,297
Stone:							
Crushed	do.	e30,500	e163,900	25,545	188,001	e23,800	e180,400
Dimension	short tons	r e12,479	r e1,079	r12,355	r1,067	e11,365	e1,024
Combined value of other industrial minerals and value indicated by symbol W		XX	6,053	XX	4,720	XX	3,473
Total		XX	r367,942	XX	r348,312	XX	339,366
MASSACHUSETTS							
Gemstones		NA	1	NA	1	NA	1
Sand and gravel:							
Construction	thousand short tons	r13,143	r53,461	e10,100	e39,400	12,033	48,671
Industrial	do.	30	401	30	401	9	151
Stone:							
Crushed	do.	e9,200	e54,500	7,131	51,362	e10,400	e77,200
Dimension	short tons	r e54,566	r e9,684	69,332	11,646	e65,836	e9,292
Combined value of clays (common), lime, and peat		XX	10,138	XX	8,787	XX	12,086
Total		XX	r128,185	XX	111,597	XX	147,401
MICHIGAN							
Cement:							
Masonry	thousand short tons	272	23,880	e225	e22,440	234	20,381
Portland	do.	5,906	263,607	e4,935	e222,075	5,509	262,063
Clays	metric tons	1,201,542	4,094	2,061,861	8,770	1,264,692	4,345
Gemstones		NA	11	NA	10	NA	1
Gypsum (crude)	thousand short tons	2,000	11,511	1,721	13,052	1,770	13,889

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MICHIGAN—Continued							
Iron ore (usable)	thousand metric tons	10,034	W	°12,662	W	12,881	W
Lime	thousand short tons	622	$30,898	613	$30,959	636	$31,253
Peat	do.	280	6,264	249	6,442	199	5,894
Sand and gravel:							
Construction	do.	r51,761	r155,559	°44,800	°132,200	47,994	143,107
Industrial	do.	2,310	19,285	2,093	18,464	1,897	19,506
Stone (crushed)	do.	°43,100	°129,000	40,989	129,490	°38,600	°125,500
Combined value of calcium chloride (natural), copper, iron oxide pigments (crude), magnesium compounds, potash, salt, silver, stone (dimension), and values indicated by symbol W		XX	r796,354	XX	919,366	XX	961,038
Total		XX	r1,440,463	XX	1,503,268	XX	1,586,977
MINNESOTA							
Gemstones		NA	46	NA	62	NA	686
Iron ore (usable)	thousand metric tons	45,139	1,308,920	42,966	°1,157,920	42,348	1,180,563
Peat	thousand short tons	48	2,972	35	1,910	40	2,764
Sand and gravel (construction)	do.	r39,616	r91,363	°24,500	°58,800	37,604	98,673
Stone:							
Crushed	do.	°9,100	°31,900	8,378	30,624	°10,500	°39,500
Dimension	short tons	r °54,705	r °19,487	45,795	13,962	°36,192	°11,436
Combined value of clays (common, kaolin), lime, sand and gravel (industrial), and value indicated by symbol W		XX	27,746	XX	25,607	XX	30,317
Total		XX	r1,482,434	XX	1,288,885	XX	1,363,939
MISSISSIPPI							
Clays[2]	short tons	817,828	16,196	1,172,213	34,382	1,119,568	38,090
Gemstones		NA	1	NA	1	NA	1
Sand and gravel (construction)	thousand short tons	r12,839	r44,682	°9,900	°33,000	11,467	44,124
Stone (crushed)	do.	°1,400	°5,500	1,632	6,603	°2,500	°10,400
Combined value of cement, clays (ball, fuller's earth [1990], kaolin [1990]), and sand and gravel (industrial)		XX	44,799	XX	27,873	XX	27,349
Total		XX	r111,178	XX	101,859	XX	119,964
MISSOURI							
Cement (portland)	thousand short tons	4,481	180,090	°4,276	°171,040	4,725	196,073
Clays[2]	metric tons	1,347,558	12,864	2,001,537	11,060	1,195,412	8,327
Copper[4]	do.	W	W	W	W	10,766	25,497
Gemstones		NA	W	NA	W	NA	862
Iron ore (usable)	thousand metric tons	1,002	W	°224	W	19	W
Lead[4]	metric tons	380,781	386,345	351,995	259,841	300,589	232,602
Sand and gravel:							
Construction	thousand short tons	9,243	25,097	°7,400	°20,100	9,024	26,457
Industrial	do.	W	W	W	W	710	10,931
Silver[4]	metric tons	42	6,434	35	4,483	32	4,084
Stone (crushed)	thousand short tons	°53,100	°190,900	47,938	167,233	°52,200	°187,400
Zinc[4]	metric tons	48,864	80,355	42,506	49,453	44,031	56,670

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
MISSOURI—Continued							
Combined value of barite, cement (masonry), clays (fuller's earth), iron oxide pigments (crude), lime, sand and gravel (industrial), stone (dimension), and values indicated by symbol W		XX	r$223,034	XX	r$197,141	XX	$148,286
Total		XX	r1,105,119	XX	r880,351	XX	897,189
MONTANA							
Clays	metric tons	2 29,741	2 193	362,635	11,332	2 35,368	2 101
Gemstones		NA	3,692	NA	2,796	NA	674
Gold[4]	kilograms	13,012	161,861	r13,715	r160,197	13,994	155,210
Palladium metal	do.	5,930	21,735	6,050	16,923	6,470	18,097
Platinum metal	do.	1,810	27,176	1,730	20,635	1,840	21,060
Sand and gravel (construction)	thousand short tons	5,114	14,319	e4,800	e13,700	11,109	31,375
Silver[4]	metric tons	220	r34,114	222	r28,893	197	24,990
Stone (crushed)	thousand short tons	e4,000	e15,300	2,107	5,725	e2,200	e6,200
Talc and pyrophyllite	metric tons	430,125	18,883	W	W	407,657	16,162
Zinc[4]	do.	W	W	W	W	20,588	26,498
Combined value of barite, cement, clays (bentonite [1990, 1992]), copper, iron ore (usable), lead, lime, molybdenum, peat, phosphate rock, sand and gravel (industrial), stone (dimension), vermiculite, and values indicated by symbol W		XX	r276,021	XX	274,082	XX	238,787
Total		XX	r573,294	XX	r534,283	XX	539,154
NEBRASKA							
Clays	metric tons	227,292	1,685	198,319	909	182,873	879
Gemstones		NA	7	NA	1	NA	645
Lime	thousand short tons	W	W	W	W	29	1,741
Sand and gravel (construction)	thousand short tons	11,453	30,056	e10,100	e27,300	13,206	38,108
Stone (crushed)	do.	e4,000	e21,200	4,861	23,328	e5,900	e29,100
Combined value of cement, sand and gravel (industrial), and values indicated by symbol W		XX	37,381	XX	37,854	XX	44,317
Total		XX	90,329	XX	89,392	XX	114,790
NEVADA							
Barite	metric tons	337,000	5,884	374,000	11,933	W	W
Clays[2]	do.	34,625	4,098	15,553	3,204	50,517	7,722
Gemstones		NA	407	NA	958	NA	661
Gold[4]	kilograms	179,078	2,216,233	r180,382	r2,106,866	203,165	2,253,305
Lead[4]	metric tons	830	842	W	W	—	—
Mercury	do.	W	W	57	202	64	373
Sand and gravel:							
Construction	thousand short tons	18,377	59,008	e20,300	e69,000	24,273	93,585
Industrial	do.	607	W	546	W	531	W
Silver[4]	metric tons	r583	r75,783	578	75,050	614	77,724
Stone (crushed)	thousand short tons	e1,600	e5,000	1,199	6,527	e1,200	e6,700
Zinc[4]	metric tons	7,889	12,973	W	W	—	—

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
NEVADA—Continued							
Combined value of brucite, cement (portland), clays [fuller's earth (1990-91), kaolin], copper, diatomite, fluorspar (1990) , gypsum (crude), lime, lithium minerals, magnesite, molybdenum (1990-91), perlite, salt, and values indicated by symbol W		XX	$216,820	XX	$155,018	XX	$148,181
Total		XX	r2,597,048	XX	r2,428,758	XX	2,588,251
NEW HAMPSHIRE							
Gemstones		NA	38	NA	31	NA	4
Sand and gravel (construction)	thousand short tons	7,901	26,599	e4,700	e16,200	6,436	25,570
Stone:							
Crushed	do.	e600	e2,500	1,542	9,148	e1,700	e11,000
Dimension	short tons	r e16,559	r e6,910	34,803	5,013	e37,647	e5,460
Total[8]		XX	r36,047	XX	30,392	XX	42,034
NEW JERSEY							
Gemstones		NA	3	NA	3	NA	1
Peat	thousand short tons	W	527	W	541	W	W
Sand and gravel:							
Construction	do.	13,862	64,245	e10,300	e47,900	16,416	79,993
Industrial	do.	1,762	26,190	1,634	23,738	1,518	24,727
Stone (crushed)	do.	e21,200	e131,700	3 16,680	3 119,287	e 3 17,100	e 3 126,000
Combined value of clays (common, fire), greensand marl, stone [crushed sandstone and other (1991-92)], titanium concentrates [ilmenite and rutile (1991-92)], zircon concentrates, and values indicated by symbol W		XX	6,805	XX	13,519	XX	9,718
Total		XX	229,470	XX	204,988	XX	240,439
NEW MEXICO							
Clays[2]	metric tons	27,994	74	27,794	74	32,645	79
Copper[4]	do.	262,815	713,622	252,859	609,454	211,337	500,504
Gemstones		NA	225	NA	100	NA	34
Gold[4]	kilograms	888	11,041	W	W	W	W
Lead[4]	metric tons	W	W	193	142	W	W
Perlite	do.	454,500	13,181	W	W	W	W
Potash	thousand metric tons	1,451	245,571	1,469	250,900	1,436	256,620
Sand and gravel (construction)	thousand short tons	r10,311	r39,631	e9,200	e35,900	11,210	46,176
Silver[4]	metric tons	48	7,431	W	W	W	W
Stone (crushed)	thousand short tons	e2,400	e12,800	2,801	13,089	e3,000	e14,400
Combined value of cement (portland), clays (fire), gypsum (crude), helium [Grade-A (1990-91)], iron ore [includes byproduct material (1990), usable], mica (scrap), molybdenum, pumice, salt, stone (dimension), zinc, and values indicated by symbol W		XX	r59,445	XX	r75,851	XX	53,466
Total		XX	r1,103,021	XX	r985,510	XX	871,279
NEW YORK							
Clays	metric tons	490,552	2,906	421,003	2,417	414,766	2,412

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
NEW YORK—Continued							
Gemstones		NA	$365	NA	$125	NA	$170
Peat	thousand short tons	W	W	1	21	W	W
Salt	thousand metric tons	4,900	162,900	4,534	173,837	4,703	164,729
Sand and gravel (construction)	thousand short tons	r29,912	r121,780	e23,700	e95,500	31,458	130,379
Stone:							
Crushed	do.	e39,900	e207,600	34,871	195,639	e36,800	e212,700
Dimension	short tons	r e20,981	r e3,918	r17,959	r3,162	e18,217	e2,779
Combined value of cement, garnet, (abrasive), gypsum (crude), lead, sand and gravel (industrial), silver, talc and pyrophyllite, wollastonite, zinc, and values indicated by symbol W		XX	273,954	XX	228,142	XX	252,578
Total		XX	r773,423	XX	r698,843	XX	765,747
NORTH CAROLINA							
Clays[2]	metric tons	2,179,428	9,356	2,063,875	9,015	2,119,890	9,775
Feldspar	do.	418,402	14,460	402,448	13,027	438,624	15,498
Gemstones		NA	1,057	NA	785	NA	1,219
Mica (scrap)	thousand metric tons	65	3,796	64	3,747	51	2,967
Peat	thousand short tons	13	W	21	W	W	108
Sand and gravel:							
Construction	do.	r11,289	r42,530	e9,900	e35,000	10,233	42,717
Industrial	do.	1,177	15,338	1,174	15,565	1,199	17,533
Stone:							
Crushed	do.	e52,900	e276,200	3 46,514	3 243,920	e 3 48,600	e 3 262,400
Dimension	short tons	r e36,163	r e9,758	r37,056	r10,568	e25,369	e7,469
Combined value of clays (kaolin), lithium minerals, olivine, phosphate rock, stone [crushed volcanic cinder (1991-92)], talc and pyrophyllite, and values indicated by symbol W		XX	213,112	XX	221,711	XX	235,962
Total		XX	r585,607	XX	r553,338	XX	595,648
NORTH DAKOTA							
Clays	metric tons	50,485	W	27,825	W	W	W
Gemstones		NA	10	NA	6	NA	643
Lime	thousand short tons	82	4,623	98	5,360	111	4,288
Sand and gravel (construction)	do.	r7,046	r16,111	e5,000	e12,000	8,740	20,609
Stone (crushed)	do.	e1,000	e4,600	11	W	11	W
Combined value of other industrial minerals and values indicated by symbol W		XX	116	XX	(10)	XX	210
Total		XX	r25,460	XX	r17,366	XX	25,750
OHIO							
Cement:							
Masonry	thousand short tons	124	10,880	e109	e9,591	113	10,260
Portland	do.	1,426	72,883	e1,356	e69,156	1,455	77,053
Clays	metric tons	2,546,151	13,334	2,204,635	11,015	2,288,245	12,062
Gemstones		NA	W	NA	57	NA	5
Lime	thousand short tons	1,884	92,817	1,783	85,976	1,841	96,739
Peat	do.	12	182	9	222	W	W

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
OHIO—Continued							
Sand and gravel:							
Construction	thousand short tons	r45,717	r$170,319	e42,300	e$160,100	47,260	$177,508
Industrial	do.	1,349	24,205	1,294	23,462	1,406	26,445
Stone:							
Crushed	do.	e48,400	e190,900	347,310	3184,177	e 348,500	e 3194,500
Dimension	short tons	r e 333,976	r e 32,202	r 347,031	r 32,443	e35,059	e2,244
Combined value of abrasives, gypsum (crude), salt, stone [crushed limestone and dolomite (1991-92), dimension limestone (1990-91)], and values indicated by symbol W		XX	r154,938	XX	137,550	XX	145,087
Total		XX	r732,660	XX	r683,749	XX	741,903
OKLAHOMA							
Cement (portland)	thousand short tons	1,544	60,457	e1,620	e63,180	1,026	39,280
Clays	metric tons	631,302	3,156	e824,176	e4,178	621,944	3,296
Gemstones		NA	W	NA	W	NA	1,863
Gypsum (crude)	thousand short tons	2,184	11,154	2,356	12,925	2,603	14,915
Iodine (crude)	thousand kilograms	1,973	30,486	1,999	31,389	1,995	20,877
Sand and gravel:							
Construction	thousand short tons	r9,145	r21,753	e9,000	e22,300	9,904	24,204
Industrial	do.	1,258	22,984	1,241	20,918	1,071	19,011
Stone:							
Crushed[3]	do.	e25,300	e89,500	25,678	95,509	e27,500	e105,300
Dimension	short tons	r e 34,267	r e 3153	r 33,777	3596	e5,182	e706
Tripoli	metric tons	18,801	155	15,885	141	W	W
Combined value of cement (masonry), feldspar, lime, salt, stone [crushed dolomite (1990-91), crushed granite (1992), dimension sandstone (1990-91)], tripoli (1992), and values indicated by symbol W		XX	r19,627	XX	r24,390	XX	23,144
Total		XX	r259,425	XX	r275,526	XX	252,596
OREGON							
Cement (portland)	thousand short tons	W	W	e249	e18,675	W	W
Clays	metric tons	223,452	1,390	213,356	1,086	2202,530	2326
Copper[4]	do.	—	—	W	W	152	2361
Gemstones		NA	1,683	NA	2,758	NA	2,723
Nickel ore[11]	metric tons	330	NA	5,523	NA	6,671	W
Sand and gravel (construction)	thousand short tons	15,785	60,928	e15,600	e62,800	16,488	69,536
Silver[4]	metric tons	W	W	—	—	(6)	1
Stone (crushed)[3]	thousand short tons	e18,000	e86,600	20,608	89,322	e16,800	e74,900
Talc and pyrophyllite	metric tons	105	10	63	67	64	67
Zinc[4]	do.	—	—	751	873	—	—
Combined value of cement (masonry), clays [bentonite (1992)], diatomite, emery, gold (1990, 1992), lime, pumice, silver (1990), stone [crushed dolomite and quartzite (1990), crushed slate (1991-92)], and values indicated by symbol W		XX	53,984	XX	22,347	XX	66,256
Total		XX	204,595	XX	197,928	XX	214,170

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
PENNSYLVANIA							
Cement:							
Masonry	thousand short tons	303	$22,594	e253	e$18,975	326	$21,924
Portland	do.	5,621	286,185	e4,881	e248,931	5,529	258,887
Clays	metric tons	2840,646	2,900	2701,399	2,890	649,257	3,455
Gemstones		NA	5	NA	5	NA	1
Lime	thousand short tons	1,626	92,557	1,695	95,328	1,660	94,543
Peat	do.	18	730	10	207	16	250
Sand and gravel (construction)	do.	r20,795	r97,068	e18,300	e87,800	19,334	94,643
Stone:							
Crushed[3]	do.	e95,800	e502,700	70,334	362,306	71,600	380,200
Dimension	short tons	r e46,788	r e10,894	r41,983	r10,459	41,728	10,822
Combined value of clays [fire (1990), kaolin (1990-91)], mica [scrap (1990-91)], sand and gravel (industrial), stone [crushed granite (1990), crushed limestone, dolomite, and quartzite (1991-92)], and tripoli		XX	15,125	XX	17,482	XX	14,655
Total		XX	r1,030,758	XX	r844,383	XX	879,380
RHODE ISLAND							
Gemstones		NA	2	NA	1	NA	1
Sand and gravel (construction)	thousand short tons	1,969	9,042	e1,300	e6,000	2,455	11,964
Stone (crushed)	do.	e 121,600	e8,800	1,187	7,262	e1,500	e9,500
Total[8]		XX	17,844	XX	13,263	XX	21,465
SOUTH CAROLINA							
Cement (portland)	thousand short tons	2,464	109,644	e2,215	e99,675	2,296	93,385
Clays	metric tons	2,062,824	44,486	1,709,205	25,662	1,608,338	27,694
Gemstones		NA	10	NA	10	NA	641
Gold[4]	kilograms	W	W	W	W	6,747	74,832
Sand and gravel:							
Construction	thousand short tons	r8,664	r24,998		e18,900	6,896	19,923
Industrial	do.	844	15,972	822		849	17,316
Stone:							
Crushed[3]	do.	e26,200	e135,400	18,216	84,260	17,600	e83,800
Dimension	short tons	e8,929	e848	8,829	854	W	
Combined value of cement (masonry), manganiferous ore, mica (scrap), peat, silver, stone [crushed shell (1990), crushed dolomite (1991-92)], vermiculite, and values indicated by symbol W		XX	r118,475	XX	r94,364	XX	29,305
Total		XX	r449,833	XX	r340,073	XX	346,896
SOUTH DAKOTA							
Gemstones		NA	110	NA	W	NA	967
Gold[4]	kilograms	17,870	221,157	16,371	191,217	18,681	207,195
Sand and gravel (construction)	thousand short tons	r9,676	r23,513	e8,700	e20,800	8,279	22,187

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
SOUTH DAKOTA—Continued							
Silver[4]	metric tons	10	$1,566	7	$944	6	$802
Stone (crushed)	thousand short tons	e4,800	e16,800	4,824	19,657	e4,500	e18,900
Combined value of cement, clays (common), feldspar, gypsum (crude), iron ore (usable), lime, mica (scrap), stone (dimension), and values indicated by symbol W		XX	r55,897	XX	57,304	XX	50,619
Total		XX	r319,043	XX	289,922	XX	300,670
TENNESSEE							
Clays[2]	metric tons	1,060,662	25,776	828,635	44,572	574,470	24,097
Gemstones		NA	W	NA	W	NA	23,347
Sand and gravel:							
Construction	thousand short tons	7,619	23,474	e6,700	e21,100	8,478	35,077
Industrial	do.	W	W	W	W	677	10,665
Stone:							
Crushed	do.	e54,600	e268,600	44,088	223,561	e46,700	e243,800
Dimension	short tons	r e3,460	r e292	3,460	260	e3,400	e320
Combined value of cement, clays [bentonite (1992), common (1991-92), fuller's earth (1990, 1992), kaolin (1991)], copper, lead, lime, phosphate rock (1990), silver, zinc, and values indicated by symbol W		XX	344,627	XX	258,294	XX	238,498
Total		XX	r662,769	XX	547,787	XX	575,804
TEXAS							
Cement:							
Masonry	thousand short tons	142	10,106	W	W	W	W
Portland	do.	7,678	296,680	e7,498	e289,341	7,540	308,749
Clays[2]	metric tons	2,162,095	14,652	2,265,746	13,247	2,237,093	12,610
Gemstones		NA	W	NA	W	NA	3,834
Gypsum (crude)	thousand short tons	1,868	10,166	1,609	9,240	1,790	9,920
Lime	do.	1,337	76,181	1,373	69,400	1,474	83,359
Salt	thousand metric tons	7,450	75,149	8,106	73,117	7,985	76,125
Sand and gravel:							
Construction	thousand short tons	46,083	158,080	e38,800	e135,800	45,640	166,362
Industrial	do.	1,849	40,880	1,557	27,002	1,511	26,141
Stone (crushed)	do.	e81,800	e285,700	65,813	226,836	e71,300	e253,100
Sulfur (Frasch)	thousand metric tons	2,340	W	2,056	W	1,495	W
Talc and pyrophyllite	metric tons	227,138	4,844	212,887	4,561	235,919	5,720
Combined value of clays [ball (1991-92), bentonite, fuller's earth, kaolin], helium (crude and Grade-A), iron ore (usable), magnesium compounds, magnesium metal, sodium sulfate (natural), stone (dimension), and values indicated by symbol W		XX	r486,092	XX	r417,067	XX	357,458
Total		XX	r1,458,530	XX	r1,265,611	XX	1,303,378
UTAH							
Beryllium concentrates	metric tons	4,548	5	r4,339	5	4,826	5
Clays[2]	do.	277,795	1,774	210,382	1,028	242,769	2,714
Gemstones		NA	713	NA	489	NA	634

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
UTAH—Continued							
Lime	thousand short tons	354	$18,878	325	$18,634	W	W
Salt	thousand metric tons	1,062	50,436	1,310	29,959	1,367	$44,498
Sand and gravel:							
Construction	thousand short tons	13,601	44,881	e14,400	e48,200	17,678	54,819
Industrial	do.	2	42	—	—	—	—
Silver[4]	metric tons	147	22,750	W	W	W	W
Stone:							
Crushed	thousand short tons	e4,600	e20,200	4,450	18,259	e5,300	e22,400
Dimension	do.	e17,559	e1,109	23,079	1,429	—	—
Combined value of cement, clays [bentonite, fuller's earth (1992)], copper, fluorspar (1990), gold, gypsum (crude), iron ore (usable), magnesium compounds, magnesium metal, mercury (1990, 1992), molybdenum, phosphate rock, potash, sodium sulfate (natural), vanadium ore (1990), and values indicated by symbol W		XX	1,174,213	XX	r1,067,184	XX	1,222,593
Total		XX	r1,335,001	XX	r1,185,187	XX	1,347,663
VERMONT							
Asbestos	metric tons	W	W	W	W	4,575	1,686
Gemstones		NA	10	NA	5	NA	1
Sand and gravel (construction)	thousand short tons	3,675	11,948	e3,000	e9,900	3,474	11,291
Stone:							
Crushed	do.	e3,700	e35,000	2,685	12,666	e2,500	e12,200
Dimension	short tons	r e106,265	r e33,522	r92,658	31,013	e125,000	e34,639
Combined value of other industrial minerals		XX	6,046	XX	6,236	XX	([10])
Total		XX	r86,526	XX	59,820	XX	e59,817
VIRGINIA							
Clays[2]	metric tons	882,383	3,741	723,495	3,248	753,504	3,367
Gemstones		NA	34	NA	70	NA	W
Lime	thousand short tons	846	39,784	825	39,612	842	40,271
Sand and gravel (construction)	do.	13,096	48,950	e9,700	e36,900	9,545	37,336
Stone:							
Crushed	do.	e59,400	e320,000	48,861	260,966	e47,500	e261,300
Dimension	short tons	W	W	11,046	3,061	W	W
Combined value of aplite[3] (1990-91), cement, clays [bentonite (1992), fuller's earth], feldspar,[3] gypsum (crude), iron oxide pigments (crude), kyanite, sand and gravel (industrial), talc and pyrophyllite, vermiculite, and values indicated by symbol W		XX	r94,057	XX	84,188	XX	119,589
Total		XX	r506,566	XX	428,045	XX	461,863
WASHINGTON							
Clays	metric tons	158,257	1,357	263,374	2,633	306,267	e1,889
Gemstones		NA	281	NA	85	NA	379
Gold[4]	kilograms	9,620	119,671	9,954	116,260	8,802	97,619

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
WASHINGTON—Continued							
Sand and gravel (construction)	thousand short tons	r40,032	r$132,921	40,200	$140,700	40,933	$140,994
Stone (crushed)	do.	e12,700	e41,900	13,126	59,588	e13,500	e63,200
Combined value of cement, clays [fire (1992)], diatomite, gypsum [crude (1990-91)], lead (1991-92), lime, magnesium metal, olivine, peat, sand and gravel (industrial), silver, stone (dimension), zinc (1991-92), and values indicated by symbol W		XX	r176,929	XX	r163,395	XX	164,958
Total		XX	r473,059	XX	r482,661	XX	469,039
WEST VIRGINIA							
Clays	metric tons	164,257	384	134,262	322	79,573	221
Gemstones		NA	1	NA	2	NA	1
Sand and gravel (construction)	thousand short tons	r2,456	r12,040	e3,100	e14,300	1,385	5,730
Stone (crushed)	do.	e [2]12,000	e [2]45,200	10,255	50,505	e11,400	e57,800
Combined value of cement, lime, peat, salt, sand and gravel (industrial), stone [crushed granite (1990)], and values indicated by symbol W		XX	75,803	XX	51,802	XX	47,846
Total		XX	r133,428	XX	116,931	XX	111,598
WISCONSIN							
Gemstones		NA	W	NA	542	NA	5
Lime	thousand short tons	461	24,608	536	23,225	521	26,579
Peat	do.	12	256	9	227	62	553
Sand and gravel:							
Construction	do.	r29,553	r73,676	e29,600	e77,500	29,118	77,066
Industrial	do.	W	W	W	W	1,374	24,639
Stone:							
Crushed	do.	e26,600	e91,000	[3]23,676	[3]80,475	e [3]25,500	e [3]89,300
Dimension	short tons	r e [3]57,525	r e [3]7,191	r [3]60,890	r [3]6,221	e36,166	e4,227
Combined value of other industrial minerals and values indicated by symbol W		XX	r18,727	XX	r27,534	XX	([10])
Total		XX	r215,458	XX	r215,724	XX	[8]222,369
WYOMING							
Cement (portland)	thousand short tons	W	W	W	W	483	30,182
Clays[2]	metric tons	2,523,573	76,082	2,496,361	81,573	2,534,550	83,094
Gemstones		NA	151	NA	61	NA	12
Lime	thousand short tons	W	W	37	2,729	W	W
Sand and gravel (construction)	do.	4,329	14,446	e3,500	e11,900	3,147	11,438
Stone (crushed)	do.	e2,200	e14,000	2,946	12,645	e4,500	e19,900
Combined value of cement (masonry), clay (common), gypsum (crude), helium (Grade-A), soda ash, and values indicated by symbol W		XX	806,169	XX	820,268	XX	806,131
Total		XX	910,848	XX	929,176	XX	950,757

See footnotes at end of table.

TABLE 6—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES, BY STATE

Mineral	1990		1991		1992	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
UNDISTRIBUTED						
Delaware, Hawaii, New Hampshire, North Dakota (1991), Rhode Island, Vermont (1991-92), Wisconsin (1991-92), and undistributed (1991)	XX	$5,938	XX	r$13,870	XX	$25,797

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" figure.

[3]Excludes certain stones; kind and value included with "Combined value" figure.

[4]Recoverable content of ores, etc.

[5]Grindstones, pulpstones, and sharpening stones; excludes mill liners and grinding pebbles.

[6]Less than 1/2 unit.

[7]Revised data withheld to avoid disclosing company proprietary data; included with "Combined value" data.

[8]Partial total, excludes values that must be concealed to avoid disclosing company proprietary data. Values excluded from partial total included with "Undistributed States."

[9]Excludes salt in brines; value included with "Combined value" figure.

[10]Value excluded to avoid disclosing company proprietary data.

[11]The Riddle nickel smelter uses lateritic ore mined on Nickel Mountain, lateritic ore imported from New Caledonia, and small tonnages of recycled Ni-bearing catalysts. In 1989, the Glenbrook Nickel Co. purchased the idled mining and smelting complex and restarted the operation. Since then, production of ferronickel on a contained Ni basis has been as follows: 1990—3,701 metric tons (mt) valued at $32.8 million; 1991—7,065 mt valued at $57.6 million; and 1992—8,962 mt valued at $62.7 million.

[12]Excludes traprock.

TABLE 7

NONFUEL MINERAL PRODUCTION[1] IN THE COMMONWEALTH OF PUERTO RICO AND ISLANDS ADMINISTERED BY THE UNITED STATES

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
PUERTO RICO							
Cement (portland)	thousand short tons	1,486	$122,027	e1,382	e$110,560	1,431	$119,643
Clays	metric tons	W	W	145,483	355	W	527
Lime	thousand short tons	29	3,483	30	4,440	30	3,717
Sand and gravel (industrial)	do.	55	825	55	825	W	W
Stone (crushed)	do.	NA	NA	8,828	49,839	NA	NA
Total		XX	[2]126,335	XX	166,019	XX	[2]123,887
ADMINISTERED ISLANDS							
American Samoa: Stone (crushed)	thousand short tons	—	—	69	756	—	—
Guam: Stone (crushed)	do.	—	—	2,201	18,038	—	—
Total		XX	—	XX	18,794	XX	—

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; not included in "Total." XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Total does not include value of items withheld.

TABLE 8

U.S. EXPORTS OF PRINCIPAL MINERALS AND PRODUCTS, EXCLUDING MINERAL FUELS

Mineral		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS					
Aluminum:					
Aluminum oxide (alumina, includes hydroxide [calcined equivalent])	thousand metric tons	1,351	r$412,109	1,143	$306,513
Crude and semicrude	metric tons	1,762,287	3,356,065	1,452,695	2,680,202
Manufactures	do.	r62,181	r201,005	7,475	231,190
Scrap (remelt ingot, used beverage containers, other waste and scrap)	do.	460,820	541,702	295,239	299,598
Speciality compounds (aluminum sulfate, aluminum oxide abrasives, and various fluorine-based compounds)	do.	39,200	45,630	NA	NA
Antimony:					
Metal, alloys, waste and scrap	do.	694	1,138	947	1,619
Oxide (antimony content)	do.	3,752	7,404	4,817	10,443
Arsenic metal	do.	233	528	94	783
Bauxite (dried and calcined)	thousand metric tons	44	9,148	NA	NA
Beryllium (alloys, wrought or unwrought, and waste and scrap)	kilograms	33,122	2,690	41,109	5,277
Bismuth (metal, alloys, waste and scrap)	do.	74,597	641	90,320	577
Cadmium (alloys, dross, flue dust, metal, residues, and scrap)	metric tons	158	218	178	244
Chromium:					
Chemicals	do.	23,237	30,514	22,820	29,325
Chromite ore and concentrate	do.	8,759	2,041	7,042	1,602
Metal and alloys	do.	11,073	16,398	11,122	14,909
Pigments	do.	1,969	7,423	2,554	10,413
Cobalt:					
Metal (unwrought, powders, waste and scrap, and mattes and other intermediate products of metallurgy)	do.	543	13,963	485	20,180
Metal (wrought and cobalt articles)	do.	323	13,400	405	13,200
Ores and concentrates	do.	9	231	6	83
Oxides and hydroxides	do.	1,102	10,623	999	11,797
Other forms (acetates and chlorides)	do.	822	5,866	897	7,729
Columbium:					
Ferrocolumbium	thousand kilograms	741	6,952	902	8,254
Ores and concentrates	do.	8	55	—	—
Copper:					
Scrap (alloyed and unalloyed)	metric tons	306,593	446,363	246,636	281,882
Semimanufactures [bare wire (includes wire rod), bars, cable (stranded), foil, hydroxides, oxides, pipes, plates, sheets, tubing, and wire (stranded)]	do.	77,438	306,873	108,734	400,522
Sulfate	do.	827	2,361	1,049	NA
Unmanufactured (anodes, ash, blister, ore, concentrate, matte, precipitates, and refined)	do.	r548,356	r1,033,971	472,571	791,697
Gold:					
Bullion (refined)	kilograms	174,377	2,038,850	256,845	2,877,377
Doré and precipitates	do.	45,536	486,266	51,008	518,661
Ores and concentrates	do.	10	98	30	221
Waste and scrap	do.	64,204	653,748	60,968	548,873
Indium	do.	NA	NA	NA	NA
Iron ore [usable, agglomerates, byproduct ore, concentrates, and direct-shipping ore, (less than 5% manganese)]	thousand metric tons	4,045	156,242	5,055	186,864

See footnotes at end of table.

TABLE 8—Continued

U.S. EXPORTS OF PRINCIPAL MINERALS AND PRODUCTS, EXCLUDING MINERAL FUELS

Mineral		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued					
Iron and steel:					
Direct-reduced iron	thousand metric tons	22	$33,845	NA	NA
Ferroalloys not elsewhere listed:					
Ferrophosphorous	metric tons	2,872	1,822	2,142	$1,470
Ferrozirconium	do.	95	138	88	130
Ferroalloys (n.e.c.)	do.	2,800	4,112	2,217	3,497
Pig iron	thousand metric tons	15	1,700	NA	NA
Products:					
Cast (granules-shot, grinding balls, grit, fittings, pipe, rolls, and other)	do.	165	338,944	201	403,831
Fabricated	do.	645	1,742,491	609	1,938,148
Steel mill	do.	5,757	3,671,704	3,890	3,032,072
Scrap:					
Borings, bundles, heavy melting, iron, shredded, shovelings, stainless, turnings, and other steel	do.	9,345	1,232,845	9,262	1,099,802
Ships, boats, and other vessels for scrapping	do.	114	8,158	92	7,622
Used rails for rerolling and other uses (contains used plus new rails)	do.	48	12,422	22	5,998
Lead:					
Ash and residues (lead content)	metric tons	11,828	4,106	2,141	1,031
Ore and concentrate (lead content)	do.	87,953	25,159	72,323	22,202
Scrap	do.	93,262	26,574	63,212	15,165
Unwrought metal and alloys (lead content)	do.	94,428	69,982	64,340	44,624
Wrought metal and alloys (lead content)	do.	7,615	20,614	5,251	19,637
Magnesium:					
Alloys	do.	3,233	10,132	1,473	5,365
Metal	do.	42,859	119,848	35,824	96,221
Powder, sheets, tubing, ribbons, wire, and other forms	do.	8,149	18,046	12,158	24,367
Waste and scrap	do.	919	2,304	2,496	5,907
Manganese:					
Ferromanganese (all grades)	do.	14,573	15,414	13,404	12,996
Metal (including alloys, waste, and scrap)	do.	5,272	12,658	5,005	11,946
Ore and concentrates	do.	66,292	8,523	13,086	2,295
Silicomanganese	do.	2,873	2,802	9,171	6,500
Mercury	do.	786	3,144	977	2,760
Molybdenum (molybdenum content):					
Ferromolybdenum	do.	r225	3,058	319	4,403
Ore and concentrates	do.	33,424	r113,714	33,438	125,405
Oxides and hydroxides	do.	1,571	9,678	556	2,889
Molybdates (all)	do.	740	3,965	1,030	4,976
Powder	do.	230	4,907	350	5,811
Unwrought	do.	88	1,204	74	640
Wire	do.	360	r12,057	355	14,972
Wrought	do.	110	5,570	144	5,772
Nickel (nickel content):					
Alloyed [bars, foil, ingot (unwrought), pipes, profiles, rods, sheets, strip, tubes, wire, and other articles]	do.	16,058	227,384	15,184	208,105

See footnotes at end of table.

TABLE 8—Continued

U.S. EXPORTS OF PRINCIPAL MINERALS AND PRODUCTS, EXCLUDING MINERAL FUELS

Mineral		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued					
Nickel (nickel content)—Continued:					
Unwrought:					
Primary [briquets, cathodes, chemicals (catalysts and salts), ferronickel, flakes, oxide (metallurgical grade), pellets, powder, and shot]	metric tons	9,104	$91,359	8,560	$84,175
Secondary [scrap (stainless steel and waste)]	do.	27,798	243,405	25,307	187,797
Wrought (bars, foil, pipes, profiles, rods, sheets, strips, tubes, and wire)	do.	354	5,756	447	7,955
Platinum-group metals (concentrates, iridium, ores, osmium, palladium, platinum, rhodium, ruthenium, and waste and scrap)	kilograms	39,624	461,588	57,829	382,016
Rare-earth metals (rare-earth oxide content):					
Cerium compounds	do.	1,368,535	8,195	1,935,021	10,089
Compounds (inorganic and organic)	do.	1,793,092	20,954	1,306,463	12,771
Ferrocerium and pyrophoric alloys	do.	r2,113,169	9,343	2,737,342	15,842
Metals (includes scandium and yttrium)	do.	59,035	2,683	36,452	1,098
Ores and concentrates	metric tons	459	NA	NA	NA
Selenium (metal, waste and scrap, selenium content)	kilograms	210,495	1,939	174,788	1,658
Silicon:					
Ferrosilicon	metric tons	50,393	43,008	55,996	45,825
Metal	do.	8,246	112,323	8,531	93,813
Silver:					
Bullion (refined)	kilograms	r787,475	115,224	910,587	125,531
Doré and precipitates	do.	r53,127	8,486	88,894	16,104
Ores and concentrates	do.	299	49	8,505	1,503
Waste and scrap	do.	r840,228	124,015	745,221	110,381
Tantalum:					
Ores and concentrates (includes synthetic)	thousand kilograms	11	248	19	50
Unwrought (alloys, metal, powders, and waste and scrap)	do.	208	27,646	131	24,329
Wrought	do.	77	26,580	66	22,668
Thorium:					
Compounds	kilograms	2,649	154	93	12
Ore and monazite concentrate	do.	—	—	5,000	11
Tin:					
Ingots and pigs	metric tons	970	5,455	1,888	8,957
Tin scrap and other tin bearing material (except tinplate scrap, includes bars, rods, profiles, wire, powders, flakes, tubes, and pipes)	do.	121,359	r85,708	127,191	89,298
Tinplate and terneplate	do.	150,187	89,677	272,549	162,302
Titanium:					
Metal:					
Scrap	do.	4,568	10,706	2,770	7,201
Sponge	do.	418	2,604	178	1,102
Other unwrought (billet, blooms and sheet bars, ingots, etc.)	do.	3,845	47,833	2,640	43,372
Wrought (bars, rods, etc.)	do.	3,300	113,060	2,431	111,027
Ores and concentrates	do.	26,912	10,167	34,665	10,566
Pigments (dioxides and oxides)	do.	r211,854	r352,912	270,422	420,372
Tungsten (tungsten content):					
Ammonium paratungstate	do.	770	4,114	470	3,354
Carbide powder	do.	839	18,880	715	18,098
Metal and alloy powder	do.	689	13,947	316	8,380

See footnotes at end of table.

TABLE 8—Continued

U.S. EXPORTS OF PRINCIPAL MINERALS AND PRODUCTS, EXCLUDING MINERAL FUELS

Mineral		1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
METALS—Continued					
Tungsten—Continued:					
Miscellaneous tungsten-bearing materials [(ferrotungsten and ferrosilicon tungsten, unwrought, wire (metal and alloy), wrought, other compounds (other tungstates), and other metal)]	metric tons	822	$40,037	684	$28,332
Ore and concentrate	do.	21	165	38	284
Vanadium:					
Aluminum-vanadium master alloy	kilograms	170,392	4,344	545,198	9,564
Compounds [(pentoxide (anhydride), and other (excludes vanadates), vanadium content)]	do.	1,810,150	10,957	1,138,653	4,921
Ferrovanadium	do.	178,027	2,454	325,656	3,727
Zinc:					
Blocks, pigs, anodes, etc. (unwrought and unwrought alloys)	metric tons	5,477	8,680	NA	NA
Compounds (chloride, lithopone, oxide, sulfate, sulfide, and compounds n.s.p.f.)	do.	16,312	51,102	16,081	59,593
Dust and flakes	do.	5,737	8,247	NA	NA
Ore and concentrates	do.	r381,818	r220,927	387,918	239,343
Waste and scrap (zinc content)	do.	96,314	61,706	NA	NA
Wrought zinc and zinc alloys (angles, bars, pipes, plates, rods, strips, etc.)	do.	16,536	22,466	NA	NA
Zirconium:					
Ore and concentrates	do.	31,333	20,607	27,853	14,323
Unwrought and waste and scrap	do.	238	5,785	389	13,070
Metal totals[1]		XX	r20,095,000	XX	18,797,000
INDUSTRIAL MINERALS					
Abrasive materials (includes reexports):					
Natural		XX	158,518	XX	177,542
Manufactured		XX	161,433	XX	205,732
Asbestos (includes reexports):					
Manufactured		XX	116,015	XX	134,102
Unmanufactured	metric tons	25,636	7,424	24,860	6,724
Barite: Natural barium sulfate	do.	43,296	3,304	12,469	1,806
Boron:					
Boric acid	thousand metric tons	47	35,457	80	53,652
Sodium borates	do.	554	205,722	489	159,492
Bromine:					
Compounds (contained bromine)	thousand kilograms	14,555	21,280	16,946	26,445
Elemental	do.	2,563	7,665	5,320	5,542
Calcium chloride	metric tons	30,568	8,030	38,365	8,808
Cement: Hydraulic and clinker	thousand metric tons	633	r45,774	747	48,720
Clays:					
Ball	do.	58	2,924	49	3,120
Bentonite	do.	660	63,571	591	53,652
Fire	do.	119	19,000	228	23,537
Fuller's earth	do.	27	4,440	27	4,022
Kaolin	do.	2,855	430,287	3,000	490,869
Other (includes chamotte or dinas earth, activated clays and earths, and artificially activated clays)	do.	197	69,952	262	88,278
Diatomite	do.	152	45,187	163	50,704
Feldspar	metric tons	8,425	1,334	17,700	2,212
Fluorspar	do.	73,943	16,424	13,646	1,983

See footnotes at end of table.

TABLE 8—Continued

U.S. EXPORTS OF PRINCIPAL MINERALS AND PRODUCTS, EXCLUDING MINERAL FUELS

Mineral		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)
INDUSTRIAL MINERALS—Continued					
Gemstones (includes reexports):					
Diamonds (excludes industrial diamond)	carats	r3,710,416	r$1,521,600	3,950,390	$1,449,500
Graphite:					
Artifical (includes artifical, and colloidal or semicolloidal)[3]	metric tons	37,662	29,876	34,487	32,689
Natural (amorphous, crystalline flake, lump or chip, and natural n.e.c.)	do.	19,374	11,345	20,217	12,244
Gypsum:					
Boards	thousand short tons	105	36,943	151	39,177
Crude	do.	74	3,720	108	3,946
Plasters	do.	96	19,872	151	22,303
Other	do.	XX	25,077	XX	31,557
Helium (Grade-A)	million cubic meters	27	36,504	31	72,108
Iodine:					
Crude/resublimed	thousand kilograms	r1,213	r15,751	1,625	15,139
Potassium iodide	do.	105	398	182	402
Iron oxide pigments:					
Pigment grade	metric tons	20,606	33,816	21,117	32,173
Other grade	do.	164,084	109,463	172,162	115,935
Lime	short tons	r51,688	r6,058	64,500	7,540
Lithium compounds:					
Carbonate	kilograms	9,564,674	31,273	8,225,957	27,008
Hydroxide	do.	3,078,922	12,998	2,911,116	13,183
Metal	do.	57,373	NA	62,232	NA
Magnesium:					
Calcined dolomite	metric tons	16,702	3,349	19,584	3,314
Caustic-calcined magnesia	do.	3,640	2,289	5,262	2,404
Compounds (chlorides, hydroxide and peroxide, and sulfates)	do.	8,913	8,022	9,586	8,253
Dead-burned and fused magnesia	do.	66,292	25,038	56,758	22,257
Magnesite (crude)	do.	7,961	5,567	5,926	4,214
Other magnesia	do.	25,149	13,985	19,075	11,540
Mica:					
Scrap and flake:					
Powder	do.	3,420	1,717	3,954	2,054
Waste	do.	874	331	475	204
Sheet:					
Unworked	do.	205	309	170	307
Worked	do.	411	7,454	436	7,180
Nitrogen compounds (major):					
Anhydrous ammonia	thousand metric tons	r705	NA	431	NA
Fertilizer materials	do.	13,768	NA	12,205	NA
Industrial chemicals	do.	135	110,131	142	120,731
Peat	thousand short tons	14	NA	24	NA
Perlite (crude)	metric tons	e29,030	e852	e29,000	e825
Phosphorus:					
Diammonium and monoammonium phosphates	thousand metric tons	r10,508	1,847,926	9,161	NA
Elemental phosphorous	metric tons	17,018	30,421	17,880	32,784
Phosphate rock:					
Ground	thousand metric tons	219	13,078	288	NA

See footnotes at end of table.

TABLE 8—Continued

U.S. EXPORTS OF PRINCIPAL MINERALS AND PRODUCTS, EXCLUDING MINERAL FUELS

Mineral		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)
INDUSTRIAL MINERALS—Continued					
Phosphorus—Continued:					
Phosphate rock—Continued:					
Unground	thousand metric tons	5,530	$246,755	3,689	NA
Phosphoric acid	do.	440	76,342	602	NA
Superphosphates	do.	r911	r120,809	1,114	NA
Potash:					
Potassium chloride, all grades	metric tons	730,600	NA	708,500	NA
Potassium magnesium sulfate	do.	306,400	NA	292,600	NA
Potassium nitrate	do.	r16,000	NA	18,600	NA
Potassium sulfate	do.	203,300	NA	309,800	NA
Pumice and pumicite	thousand metric tons	13	290	NA	NA
Quartz crystal:					
Cultured	thousand kilograms	53	2,620	15	$1,278
Natural	do.	NA	NA	NA	NA
Salt	thousand metric tons	1,777	29,875	992	32,193
Sand and gravel:					
Construction:					
Gravel	do.	635	6,043	550	5,364
Sand	do.	398	1,301	870	12,599
Industrial	do.	1,485	106,606	1,337	90,403
Sodium compounds:					
Soda ash	do.	2,734	409,088	2,955	433,606
Sodium sulfate	do.	103	11,495	155	11,403
Stone:					
Crushed	metric tons	2,190,672	33,003	3,656,800	43,400
Dimension	thousand short tons	NA	64,947	NA	54,904
Strontium compounds (precipitated carbonate, oxide, hydroxide, and peroxide)	kilograms	1,800,221	1,765	1,186,259	2,193
Sulfur:					
Elemental	thousand metric tons	1,196	119,713	966	69,662
Sulfuric acid (100% H_2SO_4)	metric tons	148,872	11,806	139,456	11,822
Talc (excludes talcum in packages, face, and compact)	thousand metric tons	178	30,050	175	30,070
Vermiculite	do.	e10	NA	e8	NA
Industrial minerals totals[1]		XX	r6,661,000	XX	4,437,000
Total[1]		XX	r26,756,000	XX	23,234,000

rRevised. NA Not available. XX Not applicable.

[1]Rounded.

[2]Artificial graphite includes large amounts of materials made from petroleum coke.

TABLE 9

U.S. IMPORTS FOR CONSUMPTION OF PRINCIPAL MINERALS AND PRODUCTS, EXCLUDING MINERAL FUELS

Mineral		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS					
Aluminum:					
Aluminum oxide (alumina)	thousand metric tons	4,592	$1,102,008	4,701	$886,613
Crude and semicrude	metric tons	1,489,600	2,268,296	1,724,624	2,462,070
Manufactures	do.	r43,287	r142,973	47,204	147,566
Scrap (remelt ingot, used beverage containers, and other waste and scrap)	do.	208,384	219,558	265,306	267,372
Antimony:					
Metal	do.	13,502	23,841	15,100	26,077
Ore and concentrate (antimony content)	do.	3,381	5,250	1,923	3,710
Oxides (antimony content)	do.	11,950	18,941	14,181	22,619
Arsenic:					
Acid	do.	374	427	40	34
Metal	do.	1,008	2,899	740	2,550
Sulfides	do.	(1)	31	(1)	31
Trioxide	do.	27,142	14,320	30,671	16,342
Bauxite:					
Calcined	thousand metric tons	r298	r21,620	346	23,289
Crude and dried	do.	r11,871	NA	10,939	NA
Beryllium:					
Beryl	metric tons	288	394	61	NA
Metal and compounds	kilograms	118,343	822	108,392	1,237
Bismuth metals and alloys	do.	1,411,394	7,876	1,620,534	7,681
Cadmium metal	metric tons	2,039	7,928	1,958	3,842
Chromium:					
Chemicals	do.	11,987	r21,143	9,948	20,278
Chromite ore	do.	212,139	14,963	219,474	15,299
Ferrochromium (all grades)	do.	400,536	231,659	410,798	235,140
Metals and alloys [metal (waste and scrap and other), and ferrochromium-silicon]	do.	11,066	47,238	14,830	44,027
Pigments and preparations based chromium	do.	4,939	13,453	6,943	15,308
Cobalt:					
Metal (alloys, articles, matte, wrought, and waste and scrap)	do.	574	13,019	805	19,200
Metal (unwrought, excluding alloys and waste and scrap)	do.	6,375	157,711	5,274	246,393
Oxide and hydroxides	do.	583	12,941	431	18,651
Other forms (acetates, carbonates, chlorides, and sulfates)	do.	448	r3,481	629	7,779
Columbium:					
Ferrocolumbium	thousand kilograms	3,282	27,415	3,767	31,075
Ores and concentrates	do.	2,515	8,445	2,428	8,764
Oxide	do.	603	10,210	792	13,473
Unwrought (alloys, metals, and powders)	do.	1	103	1	101
Copper:					
Scrap (alloyed and unalloyed)	metric tons	125,928	216,305	168,750	284,144
Semimanufactures [bare wire (includes wire rod), bars, cable (stranded), foil, hydroxides, oxides, pipes, plates, tubing, sheets, and wire (stranded)]	do.	69,467	294,825	67,507	275,504
Sulfate	do.	10,309	NA	8,290	NA

See footnotes at end of table.

TABLE 9—Continued

U.S. IMPORTS FOR CONSUMPTION OF PRINCIPAL MINERALS AND PRODUCTS, EXCLUDING MINERAL FUELS

Mineral		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued					
Copper—Continued:					
Unmanufactured (anode, ash, blister, concentrates, matte, ore, precipitates, and refined, copper content)	kilograms	413,276	$907,438	457,233	$923,815
Gallium (unwrought, waste and scrap)	do.	11,271	3,829	8,479	3,126
Germanium materials	do.	26,834	11,999	13,229	4,871
Gold:					
Bullion (refined)	do.	147,491	1,721,576	141,251	1,568,186
Doré and precipitates	do.	5,597	66,735	17,092	175,542
Ore and concentrates	do.	992	10,874	351	3,877
Waste and scrap	do.	24,668	126,264	15,649	66,376
Hafnium (unwrought, and waste and scrap)	metric tons	3	489	2	431
Indium (unwrought, and waste and scrap)	kilograms	36,288	7,867	54,417	10,824
Iron ore:					
Pellets	thousand metric tons	9,317	338,493	8,880	314,372
Usable [agglomerates, byproduct ore, concentrates, and direct-shipping ore, (less than 5% manganese)]	do.	13,335	436,777	12,504	395,791
Iron and steel:					
Direct-reduced iron	do.	423	97,897	NA	NA
Ferroalloys not elsewhere listed:					
Ferrophosphorus	metric tons	6,713	1,835	7,492	1,920
Ferrotitanium and ferrosilicon-titanium	do.	1,166	3,819	1,357	3,202
Ferrozirconium	do.	288	483	1	2
Ferroalloys (n.e.c.)	do.	16,485	24,749	16,518	23,830
Pig iron	do.	434,318	75,261	496,547	196,428
Products:					
Cast	thousand metric tons	187	195,644	191	196,428
Fabricated	do.	1,709	2,705,856	1,762	2,887,517
Steel mill	do.	r14,375	9,060,231	15,490	7,892,621
Scrap:					
Iron and steel	do.	1,073	142,552	1,316	147,616
Ships, boats, and other vessels for scrapping	do.	2	60	(1)	31
Used rails for rerolling and other uses	do.	93	16,173	78	15,583
Stainless steel (bars, pipe, plate, semifinished, shapes, sheet, strip, tube, wire and wire rods)	metric tons	340,015	NA	400,077	NA
Lead:					
Base bullion (lead content)	do.	419	283	218	94
Miscellaneous products (lead content)	do.	1,154	4,133	NA	NA
Ore and concentrates (lead content)	do.	12,437	4,466	5,310	3,422
Pigments and compounds	do.	23,946	29,967	30,239	36,197
Pigs and bars (lead content)	do.	116,473	69,351	190,723	106,433
Scrap (reclaimed, includes ash and residues, lead content)	do.	117	28	236	65
Wrought (all forms, including wire and powders, gross weight)	do.	r5,962	8,460	7,094	10,548
Magnesium:					
Alloys (magnesium content)	do.	4,596	15,903	3,839	14,545
Metal	do.	21,758	52,186	4,244	11,030

See footnotes at end of table.

TABLE 9—Continued

U.S. IMPORTS FOR CONSUMPTION OF PRINCIPAL MINERALS AND PRODUCTS, EXCLUDING MINERAL FUELS

Mineral		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued					
Magnesium—Continued:					
Powder, sheets, tubing, ribbons, wire, and other forms (magnesium content)	metric tons	1,359	$4,866	1,336	$4,281
Waste and scrap	do.	4,150	4,653	2,425	2,821
Manganese:					
Chemicals (manganese dioxide and potassium permanganate)	do.	r20,990	30,724	22,193	33,024
Metal	do.	r15,791	24,509	13,952	21,991
Ore and concentrates (manganese content)	do.	r234,511	80,664	240,800	59,934
Ferromanganese (all grades, manganese content)	do.	r500,946	378,324	476,940	333,631
Silicomanganese (manganese content)	do.	r169,784	130,677	169,047	118,464
Mercury (metal, mercury-bearing waste and scrap)	do.	56	301	92	403
Molybdenum (molybdenum content):					
Ferromolybdenum	do.	953	7,304	1,096	6,974
Molybdates (all)	do.	77	772	86	763
Ore and concentrates	do.	161	882	831	4,081
Oxides and hydroxides (gross weight)	do.	948	5,013	1,032	3,928
Powder	do.	r27	r788	52	1,784
Unwrought	do.	45	r1,703	46	1,437
Wire (gross weight)	do.	2	211	1	177
Wrought (gross weight)	do.	53	3,275	46	3,004
Other (inorganic compounds, orange, waste and scrap, and other, gross weight)	do.	1,186	6,237	1,029	4,476
Nickel (nickel content):					
Alloyed (bars, foil, ingot [unwrought], pipes, profiles, rods, sheets, strips, tubes, wires, and other articles)	do.	7,794	119,466	5,944	72,517
Unwrought:					
Primary (briquets, cathodes, chemicals [catalysts and salts], ferronickel, flakes, oxide [metallurgical grade], pellets, powder and shot)	do.	r132,446	1,123,536	118,760	871,086
Secondary (scrap [stainless steel and waste])	do.	r6,212	r58,638	9,506	47,791
Wrought (bars, foil, pipes, profiles, rods, sheets, strips, tubes, and wire)	do.	1,131	16,880	951	15,319
Platinum-group metals (iridium, ores, osmium, palladium, platinum, rhodium, ruthenium, ores, and waste and scrap)	kilograms	125,661	1,742,866	132,006	1,483,680
Rare-earth metals (rare-earth oxide content):					
Cerium compounds (includes chlorides, hydroxides, nitrates, oxides, oxilate, and sulfates)	do.	544,962	4,913	808,688	8,034
Compounds (includes hydroxides, nitrates, oxides, and others, except chlorides)	do.	3,693,163	34,079	4,148,289	34,711
Chloride mixtures (except cerium chloride)	do.	3,377,242	8,890	1,583,402	7,692
Ferrocerium and other pyrophoric alloy	do.	92,997	r1,424	105,630	1,613
Oxide mixtures (except cerium oxides)	do.	892,277	13,138	294,971	14,853
Rare-earth metals (whether intermixed or alloyed)	do.	225,820	3,329	280,593	3,101
Rhenium:					
Ammonium perrhenate	do.	3,513	2,815	5,694	2,833
Metal	do.	10,847	13,316	6,385	7,522
Selenium: (selenium content)					
Selenium dioxide	do.	r10,252	208	9,484	196

See footnotes at end of table.

TABLE 9—Continued

U.S. IMPORTS FOR CONSUMPTION OF PRINCIPAL MINERALS AND PRODUCTS, EXCLUDING MINERAL FUELS

Mineral		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued					
Selenium—Continued: (selenium content)					
Unwrought, and waste and scrap	kilograms	333,289	$7,815	361,043	$6,776
Silicon:					
Ferrosilicon	metric tons	183,214	93,455	247,601	113,911
Metal	do.	43,386	100,373	32,716	92,734
Silver:					
Bullion (refined)	kilograms	r2,525,134	338,514	2,661,622	340,898
Doré and precipitates	do.	151,836	25,740	528,715	102,118
Ore and concentrates	do.	21,422	3,659	25,352	3,885
Waste and scrap	do.	1,452,501	153,299	1,774,085	54,492
Tantalum:					
Ores and concentrates (includes synthetic)	thousand kilograms	1,000	20,609	1,367	35,600
Unwrought (alloys, metal, powders, and waste and scrap)	do.	137	11,462	103	5,757
Wrought	do.	2	765	2	768
Tellurium (unwrought, and waste and scrap)	kilograms	29,255	3,073	48,384	3,700
Thallium (unwrought waste and scrap)	do.	1,013	184	NA	NA
Thorium:					
Compounds	do.	42,609	1,270	13,505	526
Ore metal (excludes monazite)	do.	205,100	31	186,803	36
Tin:					
Compounds	metric tons	r340	r2,698	510	3,883
Concentrates (tin content)	do.	1	6	—	—
Dross, skimmings, residues, scrap, tin alloys, n.s.p.f.	do.	5,855	33,132	NA	NA
Metal (unwrought)	do.	29,102	161,725	27,314	163,023
Miscellaneous tin and tin manufactures (alloys [n.s.p.f.], dross, flitters, foil, metallics, powder, residues, scrap, skimmings, and manufactures [n.s.p.f.])	do.	XX	r35,648	XX	60,208
Tinplate and terneplate	do.	r284,783	195,659	295,321	200,534
Tinplate scrap	do.	10,109	2,240	28,500	7,070
Titanium:					
Concentrates:					
Ilmenite	do.	213,886	24,071	294,585	20,414
Rutile (natural and synthetic)	do.	r240,120	r121,631	317,399	129,758
Titaniferous iron ore	do.	27,012	1,593	32,381	1,564
Titanium slag	do.	408,302	105,792	537,118	155,943
Metal:					
Ingots and billets	do.	24	1,095	241	2,062
Powder	do.	34	697	50	886
Unwrought	do.	612	5,451	684	5,363
Waste and scrap	do.	2,666	8,503	6,257	19,436
Wrought (bars, castings, foil, pipes, plates, profiles, rods, sheet, strip, tubes, wire, and other)	do.	914	24,014	456	12,830
Other (includes bars, blooms, sheet, slabs, and other unwrought)	do.	141	1,561	78	491
Pigments (dioxides and oxides)	do.	166,094	285,290	169,260	284,843
Tungsten (tungsten content):					
Ammonium tungstate	do.	842	6,756	378	2,647

See footnotes at end of table.

TABLE 9—Continued

U.S. IMPORTS FOR CONSUMPTION OF PRINCIPAL MINERALS AND PRODUCTS, EXCLUDING MINERAL FUELS

Mineral		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued					
Tungsten (tungsten content)—Continued:					
Ferrotungsten	metric tons	525	$3,128	414	$2,194
Miscellaneous tungsten-bearing materials [carbide, chlorides, oxides, unwrought, tungstates (calcium and sodium), waste and scrap, wrought, and other tungsten-bearing material]	do.	6,246	71,114	3,375	50,152
Ore and concentrates	do.	7,837	43,269	2,477	16,265
Vanadium:					
Ferrovanadium (vanadium content)	kilograms	419,573	5,367	592,490	7,038
Pentoxide (anhydride, vanadium content)	do.	132,904	943	205,956	1,364
Vanadium-bearing materials [ash, residues, slag, other (includes spent catalyst), pentoxide content]	do.	r1,574,007	r4,853	1,495,199	3,500
Zinc:					
Blocks, pigs, slabs	metric tons	549,137	619,880	NA	NA
Compounds (chloride, lithopone, oxide, sulfate, sulfide, and compounds n.s.p.f.)	do.	r48,106	r53,265	49,072	59,594
Dross, ashes, and fume (zinc content)	do.	6,483	4,658	NA	NA
Dust, powder, flakes	do.	15,424	26,169	NA	NA
Ore and concentrates (zinc content)	do.	45,419	22,110	NA	NA
Sheets, plates, strips, and other forms	do.	539	877	NA	NA
Waste and scrap	do.	31,596	14,185	NA	NA
Oxide	do.	38,215	43,712	NA	NA
Other (anodes, manufactures, and unwrought alloys)	do.	XX	22,765	XX	NA
Zirconium:					
Ore and concentrates	do.	35,706	13,772	37,439	6,906
Unwrought and waste and scrap	do.	197	1,347	115	821
Metal totals[2]		XX	27,605,000	XX	25,273,000
INDUSTRIAL MINERALS					
Abrasive materials (natural and artificial)		XX	r450,880	XX	482,134
Asbestos (unmanufactured)	metric tons	34,765	8,900	31,602	7,210
Barite:					
Barium chemicals	do.	29,382	22,551	32,173	24,322
Crude and ground	do.	887,205	41,304	353,665	17,324
Witherite	do.	18	8	NA	NA
Boron (contained boric oxide):					
Borax	thousand metric tons	10	3,260	16	5,328
Boric acid	do.	5	3,784	6	4,337
Colemanite	do.	18	4,389	30	8,408
Ulexite	do.	16	4,060	42	10,306
Bromine:					
Compounds (contained bromine)	thousand kilograms	r23,727	r41,952	14,646	32,559
Elemental	do.	r142	r91	851	522
Calcium:					
Metal	kilograms	821,457	5,238	815,264	4,452
Chloride (crude)	metric tons	124,094	18,610	128,253	17,653
Other compounds	do.	r84,130	r40,843	69,818	32,825
Cement: Hydraulic and clinker	thousand metric tons	7,893	r402,577	6,168	297,174

See footnotes at end of table.

TABLE 9—Continued

U.S. IMPORTS FOR CONSUMPTION OF PRINCIPAL MINERALS AND PRODUCTS, EXCLUDING MINERAL FUELS

Mineral		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)
INDUSTRIAL MINERALS—Continued					
Clays:					
Kaolin (China clay)	thousand metric tons	3,373	$1,607	4,221	$2,122
Fire	do.	425	80	8,089	937
Fuller's earth and decolorizing earths	do.	82	47	160	31
Bentonite	do.	2,224	1,272	2,527	1,257
Ball and common blue clay	do.	699	230	753	262
Other (chamotte or dina's earth, artifically activated clay and activated earth)	do.	28,467	9,952	25,553	10,926
Diatomite	metric tons	436	162	182	128
Feldspar	do.	17,876	1,124	12,965	923
Fluorspar:					
Aluminum fluoride	do.	33,326	33,424	32,274	29,268
Cryolite	do.	3,359	3,448	4,067	3,897
Fluorspar	do.	r437,081	r53,483	407,169	42,502
Hydrofluoric acid	do.	r82,388	r89,085	67,135	67,051
Gemstones:					
Coral and similar materials (unworked)	thousand carats	r2,554	r6,741	2,787	6,115
Diamonds	do.	8,482	3,992,023	9,352	4,143,629
Emeralds (cut but unset)	do.	3,939	165,508	2,956	213,497
Pearls (natural, cultured, and imitation)		NA	r23,949	NA	25,919
Rubies and sapphires (cut but unset)	thousand carats	5,880	r152,484	7,246	152,886
Other precious or semiprecious stones		NA	r294,297	NA	297,388
Graphite:					
Natural [amorphous, crystalline flake, lump or chippy dust, and other natural (crude and refined)]	metric tons	33,544	21,662	49,744	25,538
Electrodes (electric furnace)	do.	26,871	45,635	27,388	43,740
Gypsum:					
Boards	thousand short tons	88	7,842	106	8,803
Crude	do.	7,633	52,070	7,915	52,972
Plasters	do.	11	258	7	660
Other	do.	XX	27,971	XX	33,600
Iodine:					
Crude	thousand kilograms	3,503	r35,516	3,652	32,911
Potassium iodide	do.	52	502	93	891
Iron oxide pigments:					
Natural	metric tons	3,288	1,624	3,428	1,382
Synthetic	do.	31,437	37,736	41,648	48,487
Kyanite (andalucite)	do.	5,140	933	6,380	1,126
Lime:					
Hydrated	short tons	r52,248	r3,841	45,059	3,661
Quicklime	do.	121,678	7,227	167,461	11,322
Lithium:					
Carbonate	kilograms	r3,109,834	r7,419	4,052,048	10,617
Hydroxide	do.	20,375	128	36,430	294
Magnesium compounds:					
Calcined dolomite	metric tons	27,852	r3,371	23,904	3,244

See footnotes at end of table.

TABLE 9—Continued

U.S. IMPORTS FOR CONSUMPTION OF PRINCIPAL MINERALS AND PRODUCTS, EXCLUDING MINERAL FUELS

Mineral		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)
INDUSTRIAL MINERALS—Continued					
Magnesium compounds—Continued:					
Caustic-calcined magnesia	metric tons	107,848	$15,891	83,051	$12,309
Compounds (chlorides, hydroxide, peroxide, and sulfates)	do.	34,384	9,921	28,475	5,817
Dead-burned and fused magnesia	do.	r146,528	30,209	210,415	37,928
Magnesite (crude)	do.	1,956	r713	3,407	623
Other magnesia	do.	4,109	7,712	3,284	6,160
Mica:					
Scrap and flake:					
Powder	do.	9,725	5,219	11,568	7,479
Waste	do.	3,630	996	3,786	974
Sheet:					
Unworked	do.	1,422	1,608	2,054	2,011
Worked	do.	918	6,835	1,407	9,011
Nepheline syenite (crushed and ground)	do.	289,000	13,069	335,000	14,749
Nitrogen compounds:					
Anhydrous ammonia	thousand metric tons	r3,336	r392,463	3,271	365,826
Fertilizer materials	do.	6,495	822,102	6,505	818,978
Industrial chemicals	do.	58	59,444	49	47,321
Peat moss (poultry and fertilizer grade)	do.	573,200	96,132	638,670	110,749
Perlite (crude)	metric tons	r54,431	r1,597	r65,000	r1,900
Phosphate rock and phosphate materials	thousand metric tons	574	50,620	1,560	74,582
Potash:					
Potassium chloride	metric tons	r6,745,000	528,500	6,836,000	549,100
Potassium nitrate	do.	22,300	6,000	39,100	11,300
Potassium sodium nitrate mixtures	do.	r39,100	5,000	36,900	5,600
Potassium sulfate	do.	r55,700	10,100	67,700	11,800
Pumice:					
Crude or unmanufactured	do.	r115,458	10,047	254,112	10,464
Wholly or partially manufactured	do.	2,850	1,382	2,676	1,605
Quartz crystal (lacas)	thousand kilograms	NA	NA	NA	NA
Salt	thousand metric tons	6,188	87,380	5,394	87,714
Sand and gravel:					
Construction	do.	1,329	16,638	1,311	15,463
Industrial	do.	83	932	164	2,454
Sodium compounds:					
Soda ash	do.	134	21,299	72	12,772
Sodium sulfate	do.	157	13,807	158	13,444
Stone:					
Crushed and calcium carbonate fines	thousand metric tons	r5,200	r38,600	7,000	60,700
Dimension		NA	r474,914	NA	403,922
Strontium:					
Celestite (strontium sulfate)	metric tons	33,204	2,577	44,810	3,026
Compounds (carbonate and nitrate)	kilograms	16,629,319	10,803	22,370,558	13,877

See footnotes at end of table.

TABLE 9—Continued

U.S. IMPORTS FOR CONSUMPTION OF PRINCIPAL MINERALS AND PRODUCTS, EXCLUDING MINERAL FUELS

Mineral		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)
INDUSTRIAL MINERALS—Continued					
Sulfur:					
Elemental	thousand metric tons	3,020	$241,749	2,725	$129,894
Sulfuric acid (100% H_2SO_4)	metric tons	1,845,255	57,727	1,985,414	68,496
Talc (unmanufactured)	do.	66,791	11,925	79,560	12,408
Vermiculite	thousand metric tons	38	NA	e40	NA
Industrial minerals totals[2]		XX	r9,185,000	XX	9,153,000
Total[2]		XX	r36,790,000	XX	34,426,000

rRevised. NA Not available. XX Not applicable.
[1]Less than 1/2 unit.
[2]Rounded.

TABLE 10

COMPARISON OF WORLD AND U.S. PRODUCTION OF SELECTED NONFUEL MINERAL COMMODITIES

(Metric tons unless otherwise specified)

Mineral		1991			1992		
		World production[r,1]	U.S. production	U.S. percent of world production	World production[1]	U.S. production	U.S. percent of world production
METALS, MINE BASIS							
Antimony[2]		80,379	W	NA	75,659	W	NA
Arsenic trioxide		43,638	—	—	47,600	—	—
Bauxite[3]	thousand tons	108,157	W	NA	103,625	W	NA
Beryl		6,611	[4]4,399	67	7,002	[4]4,826	69
Bismuth		3,225	W	NA	2,998	W	NA
Chromite	thousand tons	13,445	—	—	10,896	—	—
Cobalt[2]		26,803	—	—	21,924	—	—
Columbium-tantalum concentrate (gross weight)		38,358	—	—	35,193	—	—
Copper[2]	thousand tons	9,187	1,631	18	9,290	1,761	19
Gold[2]	kilograms	2,148,743	[r]296,805	14	2,247,840	329,124	15
Iron ore (gross weight)	thousand tons	956,224	[r]56,596	6	929,754	55,593	6
Lead[2]	do.	3,276	477	15	3,242	408	13
Manganese ore (gross weight)	do.	21,213	—	—	19,929	—	—
Mercury		3,213	58	2	3,014	64	2
Molybdenum[2]		117,732	53,364	45	111,667	49,725	45
Nickel[2]		948,796	[4]5,523	1	921,929	[4]6,671	1
Platinum-group metals	kilograms	288,338	[r]7,780	3	280,889	[r]8,310	3
Silver[2]		15,692	[r]1,855	12	15,345	1,804	12
Tin[2]		202,723	W	NA	179,466	W	NA
Titanium concentrates (gross weight):							
Ilmenite (including leucoxene)	thousand tons	3,411	W	NA	3,581	W	NA
Rutile	do.	458	W	NA	442	W	NA
Tungsten[2]		41,880	W	NA	30,755	W	NA
Vanadium[2]		28,477	W	NA	19,700	W	NA
Zinc[2]	thousand tons	7,170	547	8	7,137	552	8
METALS, SMELTER BASIS							
Aluminum	do.	19,528	4,121	21	19,219	4,042	21
Cadmium		20,221	1,676	8	18,750	1,620	9
Cobalt		24,243	—	—	19,991	—	—
Copper (primary and secondary)[5]	thousand tons	9,217	1,487	16	9,496	1,742	18
Iron, pig	do.	525,579	44,533	8	518,566	47,767	9
Lead (primary and secondary)[6]	do.	5,480	1,229	22	5,426	1,193	22
Magnesium (primary)		339,596	131,288	39	303,619	136,947	45
Nickel[7]		894,282	7,065	1	852,952	8,962	1
Selenium[8]	kilograms	1,631,118	259,522	16	1,723,854	242,797	14
Steel, raw	thousand tons	736,007	79,738	11	721,315	84,322	12
Tellurium[8]	kilograms	83,582	W	NA	90,800	W	NA
Tin[9]		205,948	W	NA	198,023	W	NA
Zinc (primary and secondary)	thousand tons	7,175	[r]376	5	6,354	400	6
INDUSTRIAL MINERALS							
Asbestos	do.	3,533	[10]20	1	3,121	[10]16	1
Barite	do.	5,685	[10]448	8	5,436	[10]316	6
Boron minerals	do.	2,965	[10]1,240	42	2,608	[10]1,009	39
Bromine		380,023	[10]170,000	45	378,800	[10]171,000	45
Cement, hydraulic[11]	thousand tons	1,190,275	[r]66,753	6	1,231,627	71,426	6

See footnotes at end of table.

TABLE 10—Continued

COMPARISON OF WORLD AND U.S. PRODUCTION OF SELECTED NONFUEL MINERAL COMMODITIES

(Metric tons unless otherwise specified)

Mineral		1991			1992		
		World production[r 1]	U.S. production	U.S. percent of world production	World production[1]	U.S. production	U.S. percent of world production
INDUSTRIAL MINERALS—Continued							
Clays:							
Bentonite[12]	thousand tons	9,008	[e]3,432	38	8,524	3,354	39
Fuller's earth[8]	do.	3,953	[10]2,740	69	3,624	[10]2,413	67
Kaolin[12]	do.	23,891	[10]9,575	40	21,502	[10]8,064	38
Diamond, natural	thousand carats	105,855	—	—	107,771	—	—
Diatomite	thousand tons	1,626	610	38	1,581	595	38
Feldspar	do.	5,544	580	10	5,771	725	13
Fluorspar	do.	4,077	[e 4]58	1	3,846	[e 4]51	1
Graphite, natural		596,036	—	—	567,390	—	—
Gypsum	thousand tons	97,792	[r]14,021	14	97,791	14,759	15
Iodine, crude		17,537	1,999	11	16,930	1,995	12
Lime[11]	thousand tons	132,215	[10]15,694	12	128,730	[10]16,227	13
Magnesite, crude	do.	11,166	W	NA	11,129	W	NA
Mica (including scrap and flake)		210,488	102,830	49	186,046	85,338	46
Nitrogen: N content of ammonia	thousand tons	93,995	[r]12,801	14	92,532	13,404	14
Peat[13]	do.	165,243	[r]632	4	147,950	599	4
Perlite		1,510,784	[10]514,036	34	1,396,665	[10]511,768	37
Phosphate rock (gross weight)	thousand tons	149,665	48,096	32	143,753	46,965	33
Potash (K_2O equivalent)	do.	15,323	1,749	11	22,172	1,705	8
Pumice[8]	do.	11,603	[10]401	3	11,142	[10]481	4
Salt[11]	do.	192,281	[r]35,943	19	184,854	34,829	19
Sand, industrial (silica)	do.	112,102	23,223	21	106,308	24,464	23
Sodium compounds, n.e.s. (natural and manufactured):							
Soda ash	do.	31,053	9,005	29	31,067	9,379	30
Sulfate	do.	4,611	696	15	4,297	609	14
Strontium[8]		193,752	—	—	217,100	—	—
Sulfur, all forms	thousand tons	55,041	[r]10,820	20	52,409	10,663	20
Talc and pyrophyllite[14]	do.	9,001	1,037	12	8,864	997	11
Vermiculite		534,693	[r 10]180,000	34	474,649	[10]190,000	40

[e]Estimated. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data.

[1]The world production totals on commodities for which U.S. data are withheld exclude U.S. production; therefore, percent of world production cannot be reported.

[2]Content of ore and concentrate.

[3]U.S. figures represent dried bauxite equivalent of crude ore; to the extent possible, individual country figures that are included in the world total are also on the dried bauxite basis, but for some countries available data are insufficent to permit this adjustment.

[4]Shipments.

[5]Primary and secondary anode and blister copper, including electrowon refined copper that is not included as blister or anode.

[6]Includes bullion.

[7]Refined nickel plus nickel content of ferronickel, nickel oxide, and other nickel salts.

[8]World total does not include estimates for output in the former U.S.S.R. or China.

[9]Includes tin content of alloys made directly from ore.

[10]Quantity sold or used by producers.

[11]Data for the United States include Puerto Rico.

[12]World total does not include an estimate for output in China.

[13]Data for the United States exclude proprietary amounts of fuel peat.

[14]Data for the United States exclude proprietary pyrophyllite production.

FIGURE 1

A TYPICAL SURVEY FORM

Form 6-1066-M
Fer. (6-91)

A03

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
WASHINGTON, D.C. 20241

IRON ORE (Usable ore)

O.M.B.No. 1032-0006.
Approval Expires: 12/31/93

INDIVIDUAL COMPANY DATA-PROPRIETARY

Unless authorization is granted in the section above the signature, the data furnished in this report will be treated in confidence by the Department of the Interior, except that they may be disclosed to Federal defense agencies, or to the Congress upon official request for appropriate purposes.

FACSIMILE NUMBER
1-800-543-0661

(Please correct if name or address has changed.)

Public reporting burden for this collection of information is estimated to average 30 MINUTES per response, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to: Bureau of Mines, Branch of Statistics and Methods Development, Washington D.C. 20241; and Office of Information and Regulatory Affairs, Office of Management and Budget, Washington D.C. 20503.

Please complete and return this form in the enclosed envelope by the 15th of the month following the report period. Additional forms are available upon request.

In completing this form, reasonable estimates may be used wherever exact figures are not available. Use zero (0) when appropriate. DO NOT REPORT DECIMALS OR FRACTIONS.

"Collection of non-fuel minerals information is authorized by Public Law 96-479 and the Defense Production Act. This information is used to support executive policy decisions pertaining to emergency preparedness and defense and analyses for minerals legislation and industrial trends. The Bureau relies on your voluntary and timely response to assure that its information is complete and accurate."

SECTION 1. Mine or group covered by this report.

Name _____ State _____ County _____

SECTION 2. Stocks, production, and shipments of usable ore for the report month.
Report only ore products as shipped to consumer, such as direct-shipping ore, concentrates, or agglomerates.
Report ores produced in the United States only; do not include imports.

Usable ore (1)	Code	Weight unit Mark (X) one (2) Long tons (4)	Weight unit Mark (X) one (2) Metric tons (6)	Physical inventory Adjustment only (3)	Beginning stocks (4)	Production (5)	Shipments (6)	Ending stocks (7)
Iron ore (Containing less than 5% Mn, natural)	201							

SECTION 3. Please indicate any mines opened or closed by your company during the month. _____

Remarks:

Name of person to be contacted regarding this report	Tel. area code	No.	Ext.

Address No. Street	City	State	Zip

May tabulations be published which could indirectly reveal the data reported above? ☐ (1) Yes ☐ (2) No

Signature	Title	Date

THE MINERAL INDUSTRY OF ALABAMA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Alabama for collecting information on all nonfuel minerals.

By Doss H. White, Jr.,[1] and Lewis S. Dean[2]

Alabama's mineral value increased from the $539.9 million reported in 1991 to $542.7 million in 1992. The higher value was due primarily to a $7.1 million increase in lime sales and a $13.8 million rise in crushed stone production. This $20.9 million increase offset declines in the value of bauxite, cement, clays, salt, and construction sand and gravel. Talc output and value data were not reported to the U.S. Bureau of Mines (USBM) in 1992.

Alabama ranked 19th among the 50 States in mineral value and accounted for 1.7% of the Nation's total mineral sales in 1992. The State ranked fifth in the value of mineral output among the nine southern States.

TRENDS AND DEVELOPMENTS

The State's gross State product (GSP), which fell 0.33% in real output in 1991, rebounded slightly, showing an 0.82% gain in 1992.[3] Despite the modest gain in GSP, during the third quarter Alabama ranked third in economic strength among all southern States. These gains were reflected in a very slight 0.005% increase in mineral sales over the 1991 level.

The two sectors of the State's economy that suffered the most during the 1990-91 recession were construction and manufacturing. The former was a major user of mineral raw materials mined instate, while the latter was a smaller, but important, consumer of raw mineral commodities. In 1992, approximately 80% of Alabama's mineral value was derived from sales of those mineral commodities used by the construction industry: cement, clays, sand and gravel, and crushed stone.

Alabama is an important steel producer, and the Port of Mobile reigned as the leading steel exporter in the United States over the past 4 years. A trend in increased iron ore imports through the Port of Mobile's bulk materials handling

TABLE 1
NONFUEL MINERAL PRODUCTION IN ALABAMA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	262	$15,462	e238	e$14,042	W	W
Portland	do.	3,585	165,344	e3,937	e181,102	4,102	$180,763
Clays[2]	metric tons	2,049,776	27,747	2,124,380	22,103	2,380,981	20,914
Lime	thousand short tons	1,526	70,816	1,510	75,506	1,603	82,619
Sand and gravel:							
Construction	do.	r13,886	r49,842	e12,700	e45,700	12,294	42,038
Industrial	do.	878	9,075	531	6,133	667	6,768
Stone:							
Crushed[3]	do.	e36,100	e202,400	27,145	161,843	e28,600	e175,600
Dimension	short tons	W	W	9,552	2,449	W	W
Combined value of bauxite, clays (bentonite, kaolin), gemstones, salt, stone [crushed dolomite and granite (1991-92), crushed granite (1990)], talc and pyrophyllite (1990-91), and values indicated by symbol W		XX	r18,742	XX	31,037	XX	34,012
Total		XX	r559,428	XX	539,915	XX	542,714

eEstimated. rRevised. W Withheld to avoid disclosing company proprietary data; values included with "Combined value" data. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

[3]Excludes certain stones; kind and value included with "Combined value" data.

plant has developed. Since 1989, fine ore imports have experienced an annual decline from 2 million gross tons to 297,000 gross tons in 1992. Conversely, iron ore pellet imports have increased from 112,000 gross tons in 1989 to 2.2 million gross tons in 1992.

Other mineral cargoes shipped regularly through the bulk plant included coal, coke, copper concentrates, gypsum, ilmenite, manganese, potash, pumice, rutile, and talc.[4] The plant can load/unload vessels up to 63,504 metric tons or 70,000 short tons, unloading them at 907 metric tons (1,000 short tons) per hour.[5]

During 1991, the first full-maintenance dredging of the Mobile ship channel was begun to maintain federally mandated depths. The Federal project depth in the channel is 13.7 meters (45 feet) from the sea buoy to McDuffie Terminal and 12.3 meters (40 feet) in the inner harbor area.[6] The project was completed in 1992.

Capital investments in the mineral and mineral-related field totaled $123.5 million, including both fuel and nonfuel sectors. Included were (1) industrial minerals, $2.6 million; (2) cement/concrete, $12.1 million; (3) oil and gas, $34.5 million; and (4) primary metals, $74.3 million.[7]

Both industrial minerals and metals were in the news during 1992. In the industrial minerals sector, ACME/Borden of Westchester, IL, began operation of a resin-coated sand manufacturing plant in Birmingham. The sand is the primary core-making median in metal casting. Georgia Marble Co. announced plans for the construction of a calcium carbonate bagging plant at its Gantts Quarry complex, and National Cement Co. of Alabama Inc. announced plans to use coke and tire-derived fuel in their cement kiln.

In the metals sector, Birmingham Steel Corp. began operation of its new continuous caster. The caster increased the plant's steelmaking capacity to approximately 362,800 metric tons (400,000 short tons) per year. Tuscaloosa Steel Corp. broke ground for a $7.5 million expansion that will expand the capacity of the existing strip mill plate facility by 33%. The State's only secondary lead smelter terminated operations because of money and environmental problems.

EMPLOYMENT

Mining employment, both nonfuel and fuel, increased from an annual average of 11,100 in 1991 to 12,300 in 1992. The annual average employment in the nonfuel mineral sector in 1991 totaled 4,700; employment increased to 5,100 in 1992. The blast furnace and basic steel products sections of the primary metals sector decreased by about 100 employees from 8,200 in 1991 to 8,100 in 1992.

The State's construction industry continued as a major customer for the State's cement, sand and gravel, and crushed stone producers. Employment in the construction sector increased from 75,500 in 1991 to 78,600 in 1992, reflecting the State's partial recovery from the early 1990's recession.[8]

ENVIRONMENTAL ISSUES

USX Corp. began work on a 1.4-hectare (3.5-acre) artificial wetland project in the Birmingham area of west Jefferson County. The project treated acid drainage from a former coal mine operated by the company and ground water runoff from a raw materials storage site at the USX Fairfield Works. USX flooded the wetlands site and planted a variety of wild grasses, bulrushes, and cattails to serve as filters for chemicals and organic waste and to trap iron minerals. The mine drainage was pumped through a limestone-lined trench into three shallow wetland sites and through another limestone-lined trench before discharging into a creek.[9]

Chemical Waste Management, a subsidiary of Waste Management, operated one of the Nation's largest commercial hazardous waste landfills near Emelle, about 88.5 kilometers (55 miles) southwest of Tuscaloosa. The company offered to handle all solid waste generated in Mississippi for the next 20 years. Mississippi officials were considering the proposal along with plans to build instate incinerators and landfills.[10]

In May, a bentonite producer was fined $7,500 for violating air pollution control rules. The violations occurred at the company's drying and blending facility near Sandy Ridge.

Three Interstate Lead Co. officials were indicted by a Jefferson County grand jury on criminal charges of violating the Hazardous Waste Act. The principal charge was "dumping hazardous waters." The company, which operated in the Birmingham area for about 25 years, closed in March while attempting to reorganize under chapter 11 bankruptcy protection. The U.S. Environmental Protection Agency (EPA) completed a cleanup at the plant site.[11] EPA shipped approximately 4,539 metric tons (5,000 short tons) of lead-contaminated slag from the Leeds site to a hazardous waste landfill at Emelle and continued operations of a wastewater treatment center at the smelter to ensure that runoff was contained on-site.[12] The Alabama Department of Environmental Management estimated that it could cost between $101 and $116 million to bring the plant site into compliance with all environmental regulations and court orders. These figures cover the excavation and transporting of all soil in the plant site to the hazardous waste dump at Emelle; such a drastic task was not deemed necessary.

An attempt by Holnam Inc., a Mobile area cement company, to obtain the necessary permits to burn hazardous waste created an environmental controversy. An environmental group, People Opposing Pollution, was formed to block Holnam's plant south of Mobile from burning industrial waste for fuel in the cement making process. A second cement firm, Lehigh Portland Cement Co., Jefferson County, sought State permission to burn tires to supplement kiln fuel. The Leeds Environmental Advisory Board opposed burning tires for fuel. The company, by burning tires, would cut coal consumption by 20% to 22%.[13]

LEGISLATION AND GOVERNMENT PROGRAMS

In January, the Governors of Alabama, Florida, and Georgia signed an agreement that established a partnership to study interstate water issues. Georgia had earlier announced plans to divert water from the Chattahoochee and Coosa Rivers to serve the burgeoning Atlanta market. This would have affected waterflow in Alabama and Florida. Alabama sued to halt the action, fearing harm to industry and recreation. Reduced waterflow could have affected eastern Alabama's mineral industry.

The Geological Survey of Alabama, Tuscaloosa, continued and completed several studies related to the State's mineral resources. Reports were published on the mineral resources of the Valley and Ridge province that give physical and chemical properties, uses, and mining histories of the various geologic units. Other studies related to the mineral industry included published reports on zeolite minerals in the Eocene Tallahatta Formation, silica resources of quartzites in the Alabama Piedmont, structural analysis and geology (scale 1:24,000) of the Hollins line fault in Cleburne County, and mineral resource reports for Lowndes and Marshall Counties. The proceedings volume of the Second Southeastern Section of the Geological Society of America symposium on industrial minerals of the southeastern United States was published by the Geological Survey of Alabama summarizing industrial programs, exploration, research, mining, production, and economics in 11 States.

The Alabama State Lands Division (SLD), an agency in the Department of Conservation and Natural Resources (DCNR), has the responsibility to manage State-owned lands. This includes overseeing mineral production, oil and gas exploration and development, and sand and gravel and coal mining. The DCNR 1992 fiscal year report noted that during the 1990-91 fiscal year the SLD land management program generated more than $24 million. In addition, the cumulative efforts by the SLD related to offshore natural gas development since 1981 netted the State general fund in excess of $88 million in interest during the 1991-92 fiscal year.[14]

The U.S. Bureau of Mines operated the Tuscaloosa Research Center (TURC) on the University of Alabama campus. Research by Bureau scientists and engineers encompassed the areas of mineral recovery, environmental enhancement, and ceramic materials. Domestic minerals were utilized in innovative techniques to prepare advanced ceramics. Other ceramics were evaluated for structural applications in heat exchanges, molten metal containment, and severe corrosive chemical and minerals processing environments. Mineral recovery studies included the use of advanced computer techniques in simulation, modeling, and control of mineral processing operations. Studies were under way to improve the selectivity of flocculation and flotation reagents for fine slurry minerals. Environmental studies examined the migration of metals and nonmetals through phosphogypsum wastes, evaluated the degradation of cyanide in gold wastes, and developed a technique for the stabilization of concentrated processing wastes. TURC personnel published 48 research papers and presented 50 papers on research results at regional and national scientific and engineering meetings.

The U.S. Department of Energy designated the University of Alabama Metal Casting Technology Center as one of two National Metal Casting Research Institutes. The center will receive approximately $919,000 from a cooperative agreement contract to conduct research with practical applications for the U.S. foundry industry. The University of Northern Iowa was also awarded a research grant.[15]

FUELS

Alabama's coal production fell 6.8% in fiscal year 1992; production totaled 23,225,148 metric tons (25,609,866 short tons), down from the 24,924,678 metric tons (27,480,351 short tons) produced in 1991. Coke output in 1992 increased 5.8% from 2,121,000 metric tons (2,338,000 short tons) in 1991 to 2,245,300 metric tons (2,475,000 short tons) in 1992.[16] The value of coal mined in 1992 was estimated at almost $1.1 billion.[17]

In midyear, Birmingham-based Jim Walter Resources Inc., the State's largest coal company, permanently laid off 720 employees, 25% of its work force. Company officials cited falling coal prices, increased operating costs, and foreign and domestic competition as reasons for the reduction. Jim Walters operates one underground mine in Jefferson County and three in Tuscaloosa County.[18]

Pittsburgh & Midway Coal Mining Co. began feasibility studies for an underground mine to recover its 50-million-metric-ton (55-million-short-ton) reserve on the Yellow Creek reserve block in Tuscaloosa County. The reserves are located 366 to 396 meters (1,200 to 1,300 feet) below the land surface in the Blue Creek and Mary Lee coalbeds.[19]

Drummond Coal Co. Inc.'s reclaimed Morris North and Morris South Mines were recognized by the U.S. Office of Surface Mining Reclamation and Enforcement as 1 of the 10 best land reclamation sites in 1992. As part of the reclamation, the company and Jefferson County successfully experimented with composting municipal sludge to regenerate soil.[20]

Drummond began work on a 3.6-million-metric-ton (4-million-short-ton) Shoal Creek underground mine. The mine will produce from 12,546 hectares (31,000 acres) in Tuscaloosa, Jefferson, and Walker Counties. The Shoal Creek Mine will produce from the low-sulfur Blue Creek and Mary Lee coalbeds and will employ about 400 miners when it reaches full production in 1995.[21]

The State continued as a leader in oil, condensate, and gas production. The value of oil and condensate production, based on the average price per barrel, was, respectively, $186 million and $193 million. Natural gas value, based on the average value per 1,000 cubic feet, was

$348 million.

Monroe County in southwestern Alabama was the site of a new petroleum field. The initial production well in the newly designated Frisco City Field flowed 275 barrels per day and 7.2 million cubic meters (256 million cubic feet) of natural gas.[22]

By the end of the first quarter, Shell Offshore Inc. had five natural gas wells operating in its Fairway Field in Mobile Bay. Two wells began producing in December 1991. When all five were in operation, production was projected at about 5.7 million cubic meters (200 million cubic feet) per day. The project was projected to add almost $50 million per year in royalties and severance taxes to the State treasury.[23]

Gateway Pipeline Co. began transporting natural gas from Mobil's onshore plant near Mobile to United Pipeline's main line 40 kilometers (25 miles) north of Mobile.[24]

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

In 1992, 254 companies were involved in mineral production throughout the State. The following mineral commodities were mined or, in the case of cement, manufactured during the year.

Cement.—For the second consecutive year, cement was the leading mineral commodity produced in Alabama, accounting for 35% of the State's mineral value. Alabama's portland cement industry ranked sixth in both output and value among the 37 portland cement-producing States. In masonry cement production, Alabama ranked sixth in tonnage and seventh in value among the 36 masonry cement-producing States.

The State's portland cement industry reported production at 3.7 million metric tons (4.1 million short tons) valued at $180.7 million. Although production increased 200,000 metric tons (220,460 short tons), value declined $339,000 below the previous year's sales. Masonry cement output and value declined from that reported in 1991.

The Alabama portland cement industry operated five plants using the dry cement manufacturing process in Demopolis, Leeds, Mobile, and Montevallo. Three plants in Greystone, Roberta, and Theodore produced masonry cement.

Two of the State's cement firms were considering alternate fuels to supplement traditional kiln fuel. Lehigh Portland Cement Co., Leeds, sought State and local permits to burn shredded automobile tires, and Holnam Inc., Mobile, was considering the use of liquid industrial waste to supplement coal normally used in clinker manufacture. Both plans met with opposition from local environmental groups. National Cement Co., Ragland, burned tires in a 30-day test. The Air Division of the State Department of Environmental Management did not detect any air pollution problem with the National Cement test burn.

Clays.—Alabama ranked third behind Georgia and Wyoming among the 44 clay-producing States in the tonnage of clays mined. Value-wise, the State ranked 10th. Sixty-four clay companies reported production of common clay and/or shale, bauxite, bentonite, fire clay, and kaolin.

Bauxite.—Bauxitic clay is a high-alumina, high-clay content material. When the aluminum content is sufficiently high and other chemical parameters are within specification, bauxite is mined as an ore of alumina. Low-grade bauxitic clay deposits that are low in iron but contain substantial quantities of clay minerals occur in eastern Alabama and western Georgia. These are mined for sale to the refractory and chemical industries.

Two companies, Harbison-Walker Refractories Co. Inc., Div. of Dresser Industries Inc., and Mullite Co. of America, mined low-grade bauxite deposits in the Eufaula bauxite district of Barbour and Henry Counties in southeastern Alabama. The deposits were mined by standard surface methods, and much of the bauxite was dried, calcined, and sold for use in high-temperature refractories. Other uses included abrasive and chemical manufacture.

The bauxite tonnage mined in 1992 declined 17% from that reported in 1991. Value was down 18%.

A third Eufaula firm, Carbo Ceramics, purchased bauxite for the manufacture of proppants. The exploration sector of the petroleum industry used proppants, small ceramic spheres, to "prop" open rock fractures in the producing horizons of petroleum wells.

Bentonite.—Bentonite, a smectite mineral-bearing clay derived from volcanic ash, is divisible into swelling (Western) and nonswelling (Southern) types.

Nonswelling bentonite was mined by American Colloid Co. at Sandy Ridge in Lowndes County. The clay was mined by surface methods, air dried, sized, and shipped. Principal sales were for foundry sand usage; the material acts as a binder. Other sales were to the brick, roofing tile, refractory, and asphalt emulsion industries.

Alabama ranked fifth in tonnage and sixth in value among the 13 States reporting production of bentonite. Production of 130,000 metric tons (143,300 short tons) was higher than that reported in 1991. However, value declined about 16%. Since the Lowndes County deposits were initially mined in 1964, approximately 4.1 million metric tons (4.5 million short tons) has been mined.

Common Clay and/or Shale.—Common clay, derived from the weathering of shale and other lithic materials, was the principal raw material in the manufacture of brick and tile. Alabama ranked fourth in tonnage and second in value among the 43 States with common clay and/or shale production. The industry consisted of 14 companies operating 22 pits in the northern half of the State. After mining, the clay was dried, crushed, blunged, and extruded into desired shapes. The shapes were then kiln dried, stacked on pallets, and shipped.

TABLE 2
ALABAMA: LIME SOLD OR USED BY PRODUCERS, BY USE

Use	1991		1992	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Paper and pulp	403,571	$19,417	404,509	$21,012
Soil stabilization	25,296	1,379	58,631	3,231
Steel, basic oxygen	446,733	21,488	418,939	21,181
Sugar refining	14,963	768	16,350	872
Water purification	256,334	13,387	275,085	14,054
Other[1]	362,955	19,067	429,590	22,269
Total	1,509,852	75,506	1,603,104	82,619

[1]Includes acid water neutralization (1992), alklies, aluminum and bauxite, basic oxygen steel, citric acid, electric steel (1992), food (animal or human), incinerator gas scrubber, magnesia (1992), mason's lime, oil-well drilling, other chemical and industrial, other construction, petrochemicals, petroleum refining, precipitated calcium carbonate, sewage treatment, and wire drawing (1992).

Production was reported at 2 million metric tons (2.2 million short tons) valued at $15.3 million. Output was the same as in 1991; however, value declined $3.3 million.

Fire Clay.—Fire clay, which commonly occurs under coalbeds, is a material low in iron oxide, lime, magnesia, and alkalies that can withstand temperatures of 1,500° C or higher. Alabama ranked second in tonnage and first in value among the nine States with a fire clay industry. Production was by six companies with mines in Calhoun, Shelby, St. Clair, and Walker Counties and in the Eufaula area. Fire clays in the Eufaula area were associated with bauxite. Fire clay statistics were reported by five of these operations. Processing consisted of crushing, calcining, and blending.

Fuller's Earth.—The term fuller's earth is used for clay that has decolorizing and purifying properties. A clay identified as fuller's earth in the Porters Creek Formation in south Alabama is mined by Big River Industries Inc. at Livingston for the manufacture of lightweight aggregate. Production and value data are included with common clay and/or shale.

Kaolin.—Kaolin, also termed china clay, is a white, clay-like material with a specific gravity of 2.6 and a fusion point of 1.785° C. Harbison-Walker Refractories mined kaolin associated with bauxite deposits in Henry County in the Eufaula bauxite district, and one firm mined kaolin in St. Clair County. Kaolin processing varied, depending on the market. The Eufaula region kaolin was mined for use in refractory grogs, abrasives, and face brick. The St. Clair kaolin was used in cement manufacture.

Production and value of the Eufaula kaolin decreased over that reported in 1991. Since 1971, Eufaula district kaolin output has totaled almost 1.3 million metric tons (1.7 million short tons).

Lime.—The value of lime ranked third among the mineral commodities produced in Alabama in 1992, accounting for almost 9% of the total. Alabama ranked fourth in tonnage and fifth in value among the 32 lime-producing States.

Alabama's lime industry consisted of four companies in Shelby County. The four produced lime from locally mined limestone and dolomite.

In 1992, production and value, 1.4 million metric tons (1.6 million short tons) and $82.6 million, increased 84,000 metric tons (93,000 short tons) and $7.1 million above the 1991 level.

Salt.—Alabama ranked eighth among the 14 salt-producing States; output and value rose slightly from the tonnage and value reported in 1991. The Olin Corp. operated a solution-mining facility and chemical complex at the near-surface McIntosh salt dome in Washington County north of Mobile. Olin pumped water into the dome to dissolve the salt; the brine was then pumped to the surface through recovery wells and used to produce chlorine, caustic soda, compressed hydrogen, and salt. Sales were to the pulp and paper, water purification, and sewage treatment industries.

A mined-out portion of the dome was used for compressed air storage by Alabama Electric Cooperative. The compressed air is used to drive a 110-megawatt turbine and motor generator unit to supply power to customers in southern Alabama and the Florida Panhandle during periods of high demand.

Sand and Gravel.—Construction and industrial sand and gravel combined was the third highest ranked mineral commodity produced in Alabama, accounting for almost 9% of the 1992 mineral value. Production of construction sand and gravel ranked the State 24th among the 49 sand-and-gravel-producing States; value ranked 27th. Production of both types totaled 11.7 million metric tons (12.9 million short tons) valued at $48.8 million.

Construction.—The production of construction sand and gravel is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This report contains estimates for 1991 and actual data for 1990 and 1992.

Construction sand and gravel sales were reported at $42 million, a $3.7 million decline from the $45.7 million estimated in 1991. Output fell from the 11.5 million metric tons (12.7 million short tons) estimated in 1991 to 11.2 million metric tons (12.3 million short tons) reported in 1992. Value ranked third among the 10 major mineral commodities mined or manufactured in Alabama.

Industry production and value reports

TABLE 3
ALABAMA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	4,750	$14,065	$2.96
Plaster and gunite sands	W	W	3.50
Concrete products (blocks, brick, pipe, decorative, etc.)	201	884	4.40
Asphaltic concrete aggregates and other bituminous mixtures	1,120	4,101	3.66
Road base and coverings[1]	871	1,836	2.11
Fill	310	1,008	3.25
Railroad ballast	1	4	4.00
Other miscellaneous uses	141	463	3.28
Unspecified:[2]			
Actual	2,758	13,128	4.76
Estimated	2,143	6,550	3.06
Total[3]	12,294	42,038	3.42
Total[4 5]	11,153	42,038	3.77

W Withheld to avoid disclosing company proprietary data; included in "Other miscellaneous uses."
[1]Includes road and other stabilization (lime).
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data may not add to totals shown because of independent rounding.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

were received from 64 companies operating 86 pits. The five leading counties, Montgomery, Escambia, Franklin, Monroe, and Russell, accounted for 14% of the total tonnage mined.

Industrial.—The State ranked 16th in tonnage and 21st in value among the 38 States with industrial sand and gravel production. Production of 605,000 metric tons (667,000 short tons) increased over the 123,000 metric tons (136,000 short tons) reported in 1991. Sales of $6.8 million increased above the $6.1 million reported in 1991.

Seven firms operating 10 mines in 6 counties comprised the industrial sand and gravel industry. The three leading counties, Bullock, Macon, and Tuscaloosa, accounted for almost 64% of the production. Principal sales were to the foundry and filter industries, with lesser tonnages sold for sandblasting and traction applications.

Stone.—The production of stone is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This report contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—The State ranked 17th in tonnage and 18th in value among the 49 States with crushed stone production. Approximately 32% of the State's mineral value was from the sale of crushed stone, the second leading commodity in terms of value mined in Alabama. Production, excluding dolomite, granite, and sandstone, was estimated at 25.9 million metric tons (28.6 million short tons) with an estimated value of $175.6 million. The 1992 production was 1.3 million metric tons (1.5 million short tons) above the previous year's tonnage; value was $13.8 million above that reported in 1991.

In the last year that the crushed stone industry was canvassed, production was reported by 22 companies operating 45 quarries in 19 counties. In descending order of tonnage, production consisted of limestone, marble, dolomite, granite, and sandstone. Approximately 91% of the stone mined was limestone; marble accounted for about 5%; and dolomite, granite, and sandstone comprised the remainder. North Alabama stone companies and highway departments mined a significant amount of chert, which is not covered on the USBM stone canvass.

Production in excess of 1 million tons was reported by firms with quarries in nine counties. The three leading counties, Jefferson, Madison, and Shelby, accounted for about 60% of the total.

Principal sales identified by the companies, almost 14.6 million metric tons or 60% of the total stone produced instate, included graded road base, lime manufacture, bituminous, and concrete aggregate and fill.

Dimension.—Alabama's dimension stone production in 1992 was by three companies operating quarries in Blount, Franklin, and Talladega Counties. Stone types quarried included limestone, marble, and sandstone. Production and value were withheld to avoid revealing company proprietary information, but both increased slightly over the 8,666 metric tons (9,552 short tons) valued at $2.4 million reported by three companies in 1991.

Sulfur (Recovered).—Four companies recovered sulfur at natural gas or petroleum refineries in Escambia, Mobile, Tuscaloosa, and Washington Counties. Production was reported at 419,000 metric tons (461,900 short tons) valued at $24.3 million.

Talc.—Nine States recorded the production of talc. The only talc mine and mill in the southeast was near Alpine in northeast Alabama. The facility, formerly operated by Cyprus Industrial Minerals Co., was sold to RTZ Corp. PLC of the United Kingdom. Principal talc sales were to the cosmetic and pharmaceutical industries. Production and value were not reported to the USBM.

TABLE 4

ALABAMA:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[2]	807	2,580	609	2,066	3,632	10,643
Asphaltic concrete aggregates and road base materials[3]	482	1,995	281	579	1,582	4,496
Unspecified:[4]						
Actual	—	—	3	24	2,643	12,702
Estimated	14	72	638	1,668	1,491	4,810
Total[5]	1,303	4,648	1,530	4,336	9,348	32,651
Total[6 7]	1,182	4,648	1,388	4,336	8,480	32,651

[1]Excludes 112,000 short tons valued at $402,820, not reported by county.
[2]Includes plaster and gunite sands.
[3]Includes fill, railroad ballast, road and other stabilization (lime), and other miscellaneous uses.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value in thousand metric tons and thousand dollars.

Other Industrial Minerals.—Several unprocessed mineral commodities, in addition to those listed in table 1, were shipped into Alabama for processing into a higher value product or used in a manufacturing process.

Fused aluminum oxide and aluminum-zirconium oxide were produced by the Norton Co. at a plant in Madison County in north Alabama. The Huntsville facility produced an alumina oxide abrasive.

Fluorspar was shipped into the State by International Minerals & Chemicals Corp., Florence, Lauderdale County. The mineral was used in the manufacture of fluosilicic acid.

Two operations in Colbert County produced hydrous ammonia. The Tennessee Valley Authority operated a plant at Muscle Shoals, and USS Agri-Chemicals Inc. operated a plant at Cherokee.

Muscle Shoals Minerals imported magnesium minerals from Mexico, Turkey, and Greece to produce fused magnesium oxides used in heating elements. The plant, in western Colbert County, received raw materials shipped by barge on the Mississippi and Tennessee Rivers.

Mica mined and milled in North Carolina was shipped to Tuscaloosa to Tamko Asphalt Products Inc. for use in roofing products manufacture.

Perlite was expanded by W.R. Grace and Co. and Armstrong World Industries at plants in Irondale, Jefferson County. Crude perlite ore was purchased from mines in the western States.

Slag produced from powerplants in Germany was purchased by Southern Agri-Minerals Corp. as raw material for roofing granule manufacture at its plant in Coaling. Slag produced as a waste product by steel mills in Etowah and Jefferson Counties was used as a natural aggregate substitute.

Vermiculite was expanded by W.R. Grace at its Irondale plant. The crude material was obtained from company-owned mines in South Carolina.

Other industrial minerals shipped into or produced in the State included North Carolina diabase processed into insulation at a Phenix City plant, iodine used by a Mobile firm, synthetic iron oxide pigments and regenerator oxides produced by Gulf States Steel Inc. in Gadsden, and synthetic mullite produced by Harbison-Walker at its Eufaula operation. Tungsten was used in weapons manufacture in Huntsville by Martin Technology, and zeolite catalysts were produced by Union Carbide Corp. at a plant near Mobile.

Metals

Aluminum.—Reynolds Metals Co. at Listerhill in northwest Alabama operated the company's largest aluminum fabricating facility. The plant melted scrap aluminum into 13.6-metric tons (15-short tons), 25-inch thick ingots. The ingots were rolled into coils of sheet for can, siding, and appliance manufacture.

Norandal USA Inc. completed work on a $5 million upgrade of the 1.6-meter (64-inch) aluminum coil-coating line at its Goosepond Island aluminum sheet mill near Scottsboro. The work involved replacement of curing oven sections and installation of a new GFG Corp. coating section. The new section will permit faster color changes.[25]

The Goosepond Island mill has a work force of 500 and one of the widest coating lines in North America. The mill produced reroll stock, welded tube, and cut-to-length and leveled rolled-to-gauge products for the domestic and export markets.

The Aluminum Company of America (ALCOA), Mobile, received a State air permit to construct and operate an alumina unloading, storage, and bagging operation at ALCOA's facility at the Alabama State Docks in Mobile.[26]

Brass.—Lee Brass Co., Anniston, operated the largest brass foundry in the United States. In November, the company filed for chapter 11 bankruptcy. In May, the company closed its plumbing fittings operations in a downsizing program to eliminate unprofitable product lines. This cut the work force by almost one-third, leaving 430 workers after the closure compared with 600 before.[27]

Ferroalloys.—Alabama continued to rank third in tonnage and value among the 15 States with ferroalloy output. This ranking was maintained despite a decline in both output and value. In 1992, reported production totaled 78,325 metric tons (86,338 short tons) valued at $77 million.

In January, Alabama Silicon Inc. stopped ferrosilicon production at its Bessemer facility. The halt, for an indefinite period, was due to low ferrosilicon prices.[28]

Iron and Steel.—Alabama's steel industry consisted of six plants in the central and northern part of the State. These included Birmingham Steel Corp., minimill, Birmingham; Gulf States Steel Co., integrated steel mill, Gadsden; SMI Steel Inc., minimill, Birmingham; and USX Corp., integrated steel mill, Fairfield.

During the year, Birmingham Steel Corp. raised its capacity to approximately 362,900 metric tons (400,000 short tons) per year with the installation and operation of a new continuous caster. The company announced profits of almost $20 million for fiscal year 1992.[29]

U.S. Steel Group's Fairfield Works added six single-stack annealing furnaces, increasing its cold-rolled sheet product capacity by 54,400 metric tons (60,000 short tons) per year. The project cost $1 million. Preliminary plans were under way at the Fairfield Works to upgrade and expand the pipe mill's computer systems and recondition certain production facilities. Work was scheduled to begin in 1993. In the past 10 years, more than $1 billion has been invested in capital improvements at Fairfield Works, the South's largest steel mill. In March, the company set a North American record for producing continuous twin-cast steel slabs. Fairfield Works used 308 heats to produce 58,785 metric tons (64,798 short tons) of steel slabs in 10.9 days.[30]

SMI Steel reported a profitable year with new melting and shipping records. The company completed installation and began operation of a four-strand continuous caster.

In October, Gulf States Steel asked about 185 employees to consider early retirement. This was part of a restructuring plan that could include terminations if implementation of the early retirement plan was unsuccessful.[31]

Lead.—Interstate Lead Co. (ILCO) operated a lead smelter at Leeds until early March when the company closed because of financial problems. ILCO filed a chapter 11 petition for reorganization in July 1991, citing heavy financial costs for environmental rules. The ILCO president stated that the company had exhausted its cash attempting to comply with EPA demands.

Silicon Metal.—Silicon metal was produced by SiMETCO Inc. in the Montgomery area and Globe Metallurgical Inc., Selma. SiMETCO's three electric furnaces had an annual capacity of about 40,000 metric tons. Two furnaces operated during the year; startup of the third was scheduled for December 1992 or January 1993. The furnaces are capable of producing silicon metal and silicon-base ferroalloys. SiMETCO produced approximately one-fifth of the U.S. silicon metal demand.[32] Primary markets were the aluminum and chemical industries; silicon metal is used as an alloying agent in the production of primary and secondary aluminum and in the manufacture of silicones.

Tantalum.—Alabama's only extractive mineral operation, Coosa Mining Ltd., closed following the death of its owner. Coosa Mining, a subsidiary of O'Dell Construction Co., was the Nation's only tantalum ore producer.

Other Metals.—Kerr McGee Chemical Corp. imported ilmenite, a titanium mineral mined in Australia, for feedstock for its synthetic rutile plant near Mobile. Synthetic rutile was shipped to a company plant in Hamilton, MS, for use in the manufacture of titanium dioxide pigments. Prince Manufacturing Co., Phenix City, imported manganese and chromite. They were ground and sold as a coloring agent for brick.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 32 years of mineral-related industry and government experience and has monitored the mineral activities in Alabama since 1989. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

[2]Geologist, Mineral Resources Division, Geological Survey of Alabama.

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ALABAMA

LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Al	Aluminum plant
Bent	Bentonite
Bx	Bauxite
CC	Common Clay
Cem	Cement plant
CS	Crushed Stone
D-L	Dimension Limestone
FA	Ferroalloys plant
FC	Fire Clay
Kao	Kaolin
Lime	Lime plant
Salt	Salt
SG	Sand and Gravel
Steel	Iron and Steel plant
Talc	Talc plant

Principal Mineral-Producing Localities

TABLE 5
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Aluminum (smelters):			
Reynolds Metals Co.	Reynolds Metals Bldg. Richmond, VA 23218	Smelter	Colbert.
Bauxite:			
Harbison-Walker Refractories Co. Inc.,[1] a division of Dresser Industries Inc.	Dale Rd. Route 1, Box 58 Eufaula, AL 36027	Mine and plant	Barbour and Henry.
Mullite Co. of America	901 East 8th Ave. King of Prussia, PA 19406	Mines and plant	Do.
Cement:			
Allied Products Co.[2]	Box 36130 Birmingham, AL 35236	Quarry and plants	Jefferson and Shelby.
Blue Circle Inc.[3]	Box 182 Calera, AL 35040	Quarry and plant	Shelby.
Citadel Cement Corp.	2959 Paces Ferry Rd., Suite 7 Atlanta, GA 30339	do.	Marengo.
Ideal Basic Industries Inc.	950 17th St. Box 8789 Denver, CO 80201	Quarry and plants	Mobile.
Lehigh Portland Cement Co.	Box 1882 718 Hamilton Mall Allentown, PA 18105	Quarry and plant	Jefferson.
National Cement Co. Inc.[4]	Box 7348 Mountain Brook Station Birmingham, AL 35223	do.	St. Clair.
Clays:			
Bickerstaff Clay Products Co. Inc.	Box 1178 Columbus, GA 31902	Mines and plant	Jefferson and Russell.
Blue Circle Inc.	Box 182 Calera, AL 35040	Mine and plant	Shelby.
Jenkins Brick Co.	Box 91 Montgomery, AL 37101	Mines and plant	Elmore and Montgomery.
Livlite Corp.	Drawer V Livingston, AL 35470	Mine and plant	Sumter.
Ferroalloys:			
Interlake Inc., Globe Metallurgical Div.	Box 348 Selma, AL 36701	Electric furnace	Dallas.
International Minerals & Chemicals Corp.	Garner Rd. Bridgeport, AL 35740	do.	Jackson.
Ohio Ferro-Alloys Corp.	Box 68 Montgomery, AL 36057	do.	Montgomery.
Reynolds Metals Co.	Box 191 Sheffield, AL 35660	do.	Colbert.
Lime:			
Allied Products Co.	Box 268 Alabaster, AL 35007	Quarry and plant	Shelby.
Dravo Lime Co.[4]	One Gateway Center Seventh Floor Pittsburgh, PA 15222	do.	Do.
Salt:			
Olin Corp.	Box 28 McIntosh, AL 36553	Brine wells and chemical plant	Washington.

See footnotes at the end of table.

TABLE 5-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Holland & Woodward Co. Inc.	Box 19147 Decatur, AL 35601	Mine and plants	Franklin.
R & S Materials Inc.	Box 3547 Montgomery, AL 36109	do.	Elmore and Montgomery.
S & S Materials	Box 640 Panama City, FL 32401	Mine	Dallas.
Superior Products Inc.	Box 171 Jemison, AL 35085	Mine and plants	Chilton.
Stone:			
Allied Products Co.	Box 628 Alabaster, AL 35007	Quarries and plants	Shelby.
Blue Circle Inc.	Box 182 Calera, AL 35040	Quarry and plant	Do.
Dravo Lime Co.	One Gateway Center Seventh Floor Pittsburgh, PA 15222	do.	Colbert, Lee, Shelby.
National Cement Co. Inc.	Box 7348 Mountain Brook Station Birmingham, AL 35223	do.	St. Clair.
Vulcan Materials Co.	Box 7324-A Birmingham, AL 35253	do.	Calhoun, Colbert, Etowah, Franklin, Jackson, Jefferson, Madison, Morgan, Talladega, Shelby.
Talc:			
Cyprus Industrial Minerals Co.	Alpine, AL 35014	do.	Talladega.

[1]Also kaolin and synthetic mullite.
[2]Also lime and stone.
[3]Also clays and stone.
[4]Also stone and sand and gravel.

THE MINERAL INDUSTRY OF ALASKA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of Interior, and the Division of Geological and Geophysical Surveys, Alaska Department of Natural Resources, for collecting information on all nonfuel minerals.

By James R. Coldwell and Edward C. Gensler[1]

Alaska's nonfuel mineral production reported to the U.S. Bureau of Mines (USBM) in 1992 was $526.1 million; in 1991 the value was $494.1 million. Alaska ranked 21st among the States in 1992, unchanged from 1991. According to USBM data, Alaska ranked first among the States in production of zinc, second in lead, fifth in silver, and eighth in gold. Nationally, Cominco Alaska Inc.'s Red Dog Mine ranked first in zinc production, fourth in lead, and sixth in silver. Kennecott's Greens Creek Mine ranked 2d in silver production, 3d in zinc, and 10th in lead. Gold production in 1992 was 48% above that reported in 1991, according to USBM data. The gold and silver were recovered by 197 placer mines and 2 lode mines. Alaska's two tin producers were idle during the year. Alaska also produced small quantities of gemstones. Construction sand and gravel production was about 10% above 1991 output. The production of crushed and broken stone was estimated to be 180% higher than the amount reported in 1991. Nonfuel mineral exploration expenditures were estimated by the State to be about $30.4 million, down from about $39.9 million in 1991. Almost $25.7 million of this amount was spent on exploration of precious-metal lode and placer deposits. Expenditures on exploration of three lode gold mines were $22.2 million including the Alaska Juneau and Kensington Mines near Juneau and the Fort Knox Mine near Fairbanks. Development expenditures were reported to be about $29.6 million in 1992, up from $25.6 million in 1991.

TRENDS AND DEVELOPMENTS

The value of lead, silver, and zinc production increased about 10% in 1992. Higher lead and zinc prices offset lower lead and zinc production, and higher silver production offset lower silver prices. Published State surveys listed the total production of zinc at 248,978 metric tons, down from 252,346 metric tons in 1991; lead at 62,278 metric tons, down from 63,119 metric tons in 1991; and silver at 283,500 kilograms, up from 281,382 kilograms in 1991.

Gold production reported by the State increased to 8,163 kilograms in 1992 from 7,585 kilograms in 1991. The increase was due chiefly to record production from Cambior Alaska's Valdez Creek Mine, east of Cantwell. The Valdez Creek Mine, Alaska's largest gold mine for 7 of the past 8 years, produced 3,150 kilograms of raw gold, equivalent to an estimated 2,672 kilograms of refined gold.

Tin production was the lowest in more than 10 years because both major producers were idle in 1992. No mercury, platinum, or tungsten production was reported in 1992.

Construction sand and gravel production increased from an estimated

TABLE 1
NONFUEL MINERAL PRODUCTION IN ALASKA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	W	NA	$5	NA	$10
Gold[2]	kilograms	3,232	$40,200	r3,200	r37,376	5,003	55,492
Sand and gravel (construction)	thousand short tons	15,100	41,800	e14,000	e39,200	15,006	43,335
Stone (crushed)	do.	e2,700	e19,800	3,085	3,4,688	e 3,000	e 3,13,400
Combined value of cement [portland (1990-91)], lead, silver, stone [crushed sandstone (1991-92)], tin (1990-91), zinc, and value indicated by symbol W		XX	474,781	XX	412,840	XX	413,875
Total		XX	576,581	XX	r494,109	XX	526,112

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Recoverable content of ores, etc.
[3]Excludes certain stones; kind and value included with "Combined value" data.

12.7 million metric tons to 13.6 million metric tons and crushed and broken stone increased from 4.79 million metric tons to 13.4 million metric tons from 1991 to 1992. The detailed results of State surveys of the mining industry were published in Alaska's Mineral Industry 1992—Special Report 47. The report was published and distributed by the Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys (DGGS) and Division of Mining (DOM), and by the Division of Business Development of the Department of Commerce and Economic Development.

EMPLOYMENT

Nonfuel mineral employment was estimated at 3,377 by the State, a decrease of about 4% from the 3,531 estimated in 1991. Mechanized placer mining employed 1,251 persons; lode gold and silver, 240; base metals, 415; recreational mining, 325; construction sand and gravel, 640; stone, 145; tin, jade, and soapstone, 20; exploration, 137; and development, 164. Most of the employees in base metal, lode gold and silver, and coal mining operations work all year. The other operations are mostly seasonal and work from 3 to 6 months of the year. Exploration and development employees are calculated by the State as working 260 days per year. A few of the larger placer operations are now stripping overburden most of the year and adding stability to the work force. Nonfuel mineral employment has dropped from 4,274 to 3,377 persons since 1988, mostly because of the completion of the development programs at the Greens Creek and the Red Dog Mines.

ENVIRONMENTAL ISSUES

The USBM completed 3 years of studies investigating submarine tailings disposal (STD) and evaluating its application. This work resulted in a series of publications providing an overview and bibliography, two volumes of case studies of STD worldwide, an analysis of implications of current U.S. policy, and a study of the comparative economics of on-land disposal and submarine tailings disposal. The conclusion of this work is that a well-designed STD system in some high-rainfall coastal areas may be an environmentally acceptable alternative to on-land disposal of mill tailings in a tailings impoundment. If the current prohibition against STD were to be lifted, Alaska would benefit because most of the sites where this technology could be applied are in the State.

The Bureau of Land Management (BLM) released the Final Environmental Impact Statement (FEIS) for the A-J Mine Project in May 1992. The BLM did not release a Record of Decision (ROD) because it is in the process of conveying project-related landholdings to the State of Alaska and therefore will no longer be a part of the permitting process for the project. The U.S. Forest Service released the FEIS and ROD for the Kensington Gold Project in February 1992. The Forest Service selected a modification of the applicant's alternative that included dechlorinating the mill effluent; enhancing the settling of suspended solids in the tailings impoundment through flocculation, water management, and baffling of the pond; and moving the marine outfall to a point south of Point Sherman. Concerns over the Lynn Canal fishery located immediately offshore of the mine site prompted the additional restrictions. The City and Borough of Juneau (CBJ) Planning Commission approved the conditional use permit in October, and the joint venture currently plans to continue the permitting process.

At the Red Dog Mine in the northern region, Cominco Alaska Inc. completed a comprehensive dust control program to reduce heavy-metal contamination from ore conveyor belts, ore stockpiles, and truck loading stations. A mine drainage diversion ditch also was constructed that kept metal levels and pH in Red Dog Creek to a standard better than before mining started. During 1992, Dolly Varden char were found in portions of the creek that historically had no fish populations owing to natural heavy-metal toxicity.

In the eastern interior region, Fairbanks Gold Ltd. received from CH2M Hill a two volume-environmental assessment report containing baseline data collected from 1989 to 1992, an air quality monitoring program summary, and an outline for the life of mine water quality monitoring program. In addition, the company has developed a long-range permanent closure and reclamation plan to mitigate potential degradation of land and water resources and to return the land to a condition suitable for wildlife and recreation uses.

Planning for the $200 million high-technology Healy Clean Coal Project that incorporates new coal burning technology using new types of combustion systems as well as a spray dryer absorber system continued during 1992. Emissions will be reduced by controlling combustion and improving sulfur dioxide absorption following combustion. The project was selected by the U.S. Department of Energy for matching funding under the Clean Coal Technology program. The proposed 50-megawatt powerplant will be owned by the Alaska Industrial Development and Export Authority (AIDEA). Golden Valley Electric Association (GVEA) would operate the plant after construction is complete. The new plant will be adjacent to GVEA's existing 25-megawatt powerplant and the Usibelli Coal Mine. Site construction could begin as early as mid-1994 with test operations starting in early 1997 and full-scale operation commencing in early 1998.

The Alaska Department of Environmental Conservation (ADEC) began the triennial revision of the state water quality standards and regulations required by the Clean Water Act. Reasonable standards and regulations are crucial to the mining industry because of their affect on compliance and associated costs. Excessively stringent standards on mixing zones may prevent mining in many areas of the State.

The Alaska Science and Technology Foundation (ASTF) was formed to assist the economy of the State by providing matching funds for viable projects. Under terms of an ASTF grant,

Goldstream Exploration Inc. of Fairbanks completed a successful demonstration plant for a placer mining system that processed about 30.6 cubic meters per hour of feed in 1990. Work continues on a larger plant designed to process about 153 cubic meters per hour. The larger unit is expected to be completed about mid-1994. The technology also is being considered for use in environmental cleanup work involving heavy-metals soil contamination. Goldstream has built lab-size and pilot-scale units for use in projects in the lower-48.

In the Circle mining district, an ADEC approved method for on-site waste oil recycling was developed by Paul and Co., the largest placer mine in the district.

Higher ferrous scrap prices resulted in an overall 16% increase in the total value of recycled metals, for a 1992 total of $3.05 million. Low base metal prices reduced the amount being shipped from collection centers in the State.

EXPLORATION ACTIVITIES

Exploration expenditures reported by State surveys were estimated at $30.2 million, down almost 24% from expenditures of $39.9 million in 1991 and lowest in the past 5 years. Total drilling in Alaska in 1992 was 135,502 meters, down almost 14% from drilling of 156,910 meters in 1991 and lowest in the past 5 years. Expenditures by commodity groupings in 1992 were as follows: precious metals, $25.1 million (83.0%); base metals, $1.1 million (3.7%); polymetallic, $3.6 million (11.8%); and industrial minerals, $25,000 (0.08%). About one-half of the exploration expenditures were in southeastern Alaska, one-quarter in the eastern interior, and lesser and decreasing amounts in southwestern, western, south-central, northern, and Alaska Peninsula.

Most of the exploration effort was on old mines and prospects. Exploration provided employment for 36,277 workdays, the equivalent of 140 work years of 260 days each. This was an increase of almost 5% above the employment in 1991. State surveys in 1992 showed that there were 2,501 new State claims and 679 new Federal claims located, compared with 3,391 State claims and 1,299 Federal claims in 1991. There were 50,049 active State and Federal claims in 1992, about 13% lower than in 1991 and lowest in the past 5 years.

More than one-half of the exploration expenditures were spent on three advanced precious-metal projects: the Alaska Juneau Mine and the Kensington Mine, both near Juneau, and the Fort Knox project near Fairbanks.

American Copper and Nickel Co. completed an aerial geophysical survey, mapped, and sampled its Hetta Inlet prospects on Prince of Wales Island.

In the eastern interior, Fairbanks Gold Ltd. moved into the development phase for its Fort Knox project. The 1992 program, the largest in the State, included resource, geotechnical, and hydrological drilling, and substantial baseline data collection. Additional drilling increased proven and probable reserves from 110 million metric tons grading 0.89 grams per metric tons to 158 million metric tons grading 0.82 grams per metric ton gold. Operating year-round, the proposed mine is expected to recover 9,330 kilograms of gold annually. Ore production of 31,750 to 45,350 metric tons per day will create 200 to 250 jobs for 16 to 20 years.

LaTeko Resources Ltd. announced the results of an independent ore-resource study on the Ryan Lode system by Mine Development Associates of Reno, NV. Reserves were estimated at 7.5 million metric tons averaging 2.64 grams per metric ton gold. Drilling performed in the past 2 years totaling 38,415 meters of reverse circulation holes and 2,896 meters of core on 30.5 meters centers or less defined the new system. Optimism is running high that additional reserves will be located in the future.

American Copper and Nickel Co. continued its systematic exploration of the remainder of the 36 square kilometers of Ester Dome. The company completed several line kilometers of ground geophysical surveys complementing earlier airborne surveys, 430 meters of reverse circulation drilling, and 3,391 meters of diamond drilling. At the Eagle Creek prospect, it completed geophysical, geochemical, and geological surveys, and 833 meters of diamond drilling.

AMAX Gold Exploration drilled 1,626 meters of reverse circulation drilling at the old Hindenberg prospect. AMAX also completed 1,782 meters of reverse circulation drilling at the NERCO-owned Liberty Bell property west of Healy in the Bonnifield mining district.

Freegold Recovery Inc. completed 521 meters of reverse circulation drilling and 3,963 meters of trenching on the Too Much Gold Prospect. Sampling, mapping, geophysical, trenching, and reverse circulation drilling was completed on the Golden Summit joint venture. An additional 15,250 line meters of geochemical sampling and trenching was completed by Carlin Gold Co., Freegold's joint-venture partner, at the western end of the Golden Summit project.

Noranda Exploration Inc. conducted a 460-line-kilometers airborne magnetic-electromagnetic-radiometric and VLF-EM geophysical surveys on the Taurus property.

In the southwestern region, Cominco Alaska Exploration, Inc. completed an additional 2,014 meters of diamond drilling on its Pebble Copper deposit west of Newhalen and north of Lake Iliamna. An overall probable resource of 420 million metric tons grading 0.4% copper and 0.4 grams per metric ton gold has been identified.

Calista Native Corp. reported limited exploration in the Aniak area and at Stuyahok in the Marshall district. Placer Dome continued exploration trenching at the Golden Horn prospect at Flat in the Iditarod district.

In the western region, North Pacific Mining Co. (NPMC), a subsidiary of Cook Inlet Regional Corp., operated a large exploration program at the Illinois Creek deposit. Trenching totaling 1,530 meters and diamond drilling totaling 1,529 meters were completed in 1992. Near-surface geologic reserves at Illinois Creek were reported to be 3.7 million metric ton at 2.4 grams per metric ton gold and 50 grams per metric ton silver.

Late in 1992, Echo Bay Alaska and NPMC formed a joint venture for 1993 exploration.

In the south-central region, Hunt, Ware & Proffett diamond drilled an additional 2,652 meters on the Johnson River polymetallic deposit west of Anchorage in the southern Alaska Range. Geological reserves are estimated at 738,000 metric tons grading 9.75 grams per metric ton gold, 0.97% copper and 9.18% zinc. North Pacific Mining Co. continued its exploration of the Toklat polymetallic prospect in the Talkeetna Mountains. Ahtna Inc. explored for precious metals in the Wrangell Mountains and in the Cantwell area. Cambior Alaska Inc. continued its minor exploration program on Valdez Creek. Rowallen Mine Partnership collected bulk samples from Caprock Corp.'s holdings near the confluence of White and Valdez Creeks upstream from the Valdez Creek Mine.

In the northern region, the only reported base metal activity was at the Lik prospect. GCO Minerals Co. managed the program and drilling assessment work. Several small placer gold exploration programs were reported from the Koyukuk district.

In the Alaska Peninsula region, exploration expenditures dropped to a fraction of 1991 levels owing to Battle Mountain Exploration Co.'s decision to leave the State at the end of 1991. American Copper and Nickel Co. ran a small exploration program near Kamishak. Alaska Apollo Resources Inc. maintained its Shumagin Project on Unga Island.

LEGISLATION AND GOVERNMENT PROGRAMS

Eleven bills passed during the 1992 Alaska legislative session that were of particular interest to the mining industry. Of these 11, the industry supported 8 and opposed 3. Two important bills that passed and were supported by industry included a permanent taxation exemption for in-place natural resources and a bill enabling establishment of port authorities that are vital for development of some projects. Of the bills opposed, one bill included the "instream flow" concept that had been stopped in each of the past 8 years. Industry also felt legislation was needed to act on the modifications to the Mental Health Trust lands and a reasonable bill to implement the Federal Clean Air Act Amendments. Legislation failed to pass in both cases.

The Mental Health Land Trust predicament was not solved during 1992, but an escrow mechanism was created so that projects on affected lands would not be encumbered. Under court order from the Alaska Supreme Court, advocates for the Mental Health Trust Lands Trust and the State are trying to reconstitute a new trust equivalent to the 404,700-hectare territorial land grant set up in 1956 by the U.S. Congress and subsequently dissolved by the State legislature in 1978. The trust could not be restored because the State had sold or transferred 55% of the land to new owners since 1978. The Mental Health Lands issue is important to the mining industry because several mineral-rich areas are on State lands affected by the lawsuit.

The University of Alaska Fairbanks received an allotment grant of $16,000 from the USBM. The school has received a total of $2.96 million since inception of the Mineral Institute Program in 1978. The School of Mineral Engineering at the University of Alaska Fairbanks celebrated its 75th anniversary in 1992.

The State Land Selection Committee submitted land selections of the remaining statehood land entitlement of about 8.1 million hectares. When finally transferred, the State will have about 42.1 million hectares, an area slightly larger than the State of California. The Alaska Division of Geological and Geophysical Surveys used information generated from the USBM's Minerals Availability System (MAS) and Mining Claims Information System (MCIS) data bases to assist in identifying areas of high mineral and energy potential for selection.

By the year 2000, when all land selections have been adjudicated, Alaska Natives will have about 16.8 million hectares, an area slightly smaller than the State of Washington; all other privately owned land in Alaska will amount to about 0.7 million hectares, an area slightly smaller than the combined area of Delaware and Rhode Island. The Federal Government will retain ownership of about 87.6 million hectares, an area slightly smaller than the combined areas of Arizona, Nevada, and New Mexico. The land transfers are expected to increase the availability of land for new mineral entry and development over the next 8 years as all selections are adjudicated.

On October 5, 1992, the U.S. Department of Interior Appropriation Act of 1993 was signed into law. The new law mandates a new rental fee of $100 for each Federal mining claim. The law is expected to reduce the number of unpatented claims held by claimholders. The fee will force claimholders to evaluate their claims and decide which ones should be retained.

Arctic Slope Regional Corp. continued testing the feasibility of reducing demand for expensive petroleum-based products in remote areas by substituting coal mined at the Deadfall syncline area of northwest Alaska. In 1991, the Alaska Legislature awarded $2 million to the company to continue the project's exploration and feasibility studies.

FUELS

Usibelli Coal Mine Inc. operated the only commercial-scale coal mine in Alaska. Usibelli produced about 1,389,340 metric tons of subbituminous-C coal worth an estimated $38.3 million, about the same as that in 1991. The mine supplied eight customers. About one-half of its production was exported to the Korean Electric Power Co. (KEPCO) in Honam, Republic of Korea. Usibelli absorbed most of a $5.24 per metric ton price reduction resulting from contract negotiations between KEPCO, the Suneel Shipping Co., Usibelli, and the Alaska Railroad. Suneel and the Alaska Railroad absorbed a smaller portion of the price reduction, and the State of Alaska agreed to a $0.28 per metric ton royalty

reduction on coal exported to Korea. Domestic customers immediately sought similar royalty reductions from the State as well. More price reductions are expected in 1993; maintaining the export agreement will be even more difficult for all parties concerned.

Idemitsu Alaska Inc. has acquired all permits and approvals for mine startup for its Wishbone Hill Mine Project near Palmer. To date, the company has spent about $10 million on the project. Negotiations for transportation of coal from mine site to port continued. Additional development drilling was completed in 1992. Approximately 250 drill holes have defined a reserve of about 13.6 million metric tons of high-quality steam coal.

The Diamond Alaska Coal Co. continued control of its five State coal leases in the Beluga coalfield about 85 kilometers west of Anchorage. Estimated reserves are 1,200 million metric tons of subbituminous coal. Plans for a 33,000-metric tons per day (11 million metric tons per year) surface mine are on hold until market conditions improve.

The State survey reported that the Arctic Slope Consulting Group (ASCG) mined approximately 726 metric tons of bituminous coal in the Deadfall Syncline. The company estimates the deposit contains 54.5 million metric tons of coal minable by opencut and shallow underground methods. The coal was burned in nearly a dozen North Slope villages for home-heating tests. The company has applied for a 1993 Federal matching grant from the USBM to support additional work on the project. Doyon Ltd. extracted a bulk sample from its Little Tonzona holdings 136 kilometers southeast of McGrath. Doyon also sampled coals on Washington Creek 64 kilometers west of Eagle.

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Gold.—Gold production reported to the USBM in 1992 was 5,003 kilograms valued at $55.5 million, reported by 2 lode and 11 placer operators. This reported production was about 61% of the amount estimated by the State. The average price of gold in 1992 was $11.09 per gram compared with $11.68 per gram in 1991.

State production estimates for 1992 "are based on data compiled from 160 DGGS questionnaires returned by companies, individuals, and phone responses by another 20 sand, gravel and stone quarry operators; summaries supplied by the Alaska Department of Transportation and Public Facilities (ADOTPF), U.S. Bureau of Land Management, and the U.S. Forest Service (USFS); and bullion sale volume from Alaskan precious metal refiners." Unless otherwise stated, the following production estimates were taken from the State published survey results. The State estimated 1992 gold production at 8,163 kilograms valued at $88.5 million, an increase of 8% from that of 1991. About 87% of the estimated gold was produced by 197 placer mines, and the balance of 13% was recovered by 2 lode mines. In 1992, the 10 largest producers in Alaska recovered 60% of the State's production, 4,880 kilograns of gold. These producers, listed in alphabetical order, were Alaska Placer Development, Alaska Gold Co., Cambior Mines Inc., Cooks Mining, Kennecott Greens Creek Mining Co., NYAC Mining, Paul and Co., Polar Mining Inc., Sphinx Mining, and Taiga Mining. Cambior's Valdez Creek Mine was the largest gold producer in 1992 and has been for 7 of the past 8 years. Many seasonal placer miners lost upward of 25% of production due to a late spring thaw coupled with an extremely early freeze-up throughout the interior of Alaska.

In 1992 the northern region produced 140 kilograms of gold from 12 placer operations that employed 50 people. Production in 1991 was 183 kilograms of gold from 13 operations that employed 55 people. Early snowfalls and cold weather, which shortened the mining season by 1 month, caused most of the reduction in gold recovered. Activities were reported in the Chandalar, Shungnak, and Wiseman districts in the central and southern parts of the Brooks Range. The biggest producer was Chandalar Mines Inc. that mined ground on Little Squaw Creek in the Chandalar district.

The western region produced an estimated 1,633 kilograms of gold from 33 placer mines, about 12% less gold than that in 1991. Alaska Gold Co. operated two bucketline stacker dredges near Nome, Dredge No. 5 and Dredge No. 6. These dredges operated 160 days, from May to early November, employing 95 workers. The State reported production of 560 kilograms of gold from all Alaska Gold Co. dredges in the western region.

Many small mining firms were active on the Seward Peninsula. Sphinx Mining Co. worked on Monument Creek in the Ruby district. Even with a reduced work force due to lower gold prices, it was still the largest placer mine on Monument Creek. On Colorado Creek in the Tolstoi area Rosander Mining Co. bypassed the deeply buried payzones mined in previous years in favor of mining a shallow upper payzone.

The eastern interior region produced an estimated 2,255 kilograms gold from 106 mines in 1992 and employed 498 people. Production was about 1.5% less than that in 1991. The Fairbanks district was again the largest producer of gold in the region and was second statewide. Estimated production from the district's 23 mines was 1,135 kilograms of gold. Polar Mining Co. operated a large placer pit on lower Goldstream Creek, north of Ester Dome between Sheep and Nugget Creeks, and another placer pit on Fish Creek. Roberts Mining continued its underground drift placer operation on Dome Creek. The State survey said Roberts Mining produced about 11,470 cubic meters of pay gravel during the winter, to be processed during the summer, by utilizing low profile, mechanized mine equipment.

The Circle mining district activity was about the same as that in 1991, according to the State survey. About 25 companies produced 295 kilograms of gold utilizing 90 employees. This was a reduction in production of 20% from that of 1991.

Some of the larger mines in the district were Paul and Co. on Porcupine Creek and Greenhorn Mining Co. (Stan Gelvin) and Magic Circle on Ketchem Creek.

The Eureka-Tofty and Rampart districts supported 10 placer mines in 1992 producing 218 kilograms of gold. The Fortymile district had 30 placer mines in 1992, two less than in 1991, producing about 159 kilograms of gold. According to Mike Buzby and Alice Bayless of Bayless Mining, overall the Fortymile had a bad year due to fluctuations in the water levels within the Fortymile River system. Mining activity in the Bonnifield and Richardson districts in 1992 was essentially unchanged from that of 1991.

The south-central region produced a record 2,888 kilograms of gold in 1992, up from 1,172 kilograms estimated production in 1991, according to the State survey. Employment rose from 265 to 305 employees. Cambior Alaska Inc., the operator of the Valdez Creek placer mine, is solely responsible for this 69% increase in production and is currently the largest producer of placer gold in North America. Cambior recovered about 2,676 kilograms of refined gold in 1992 and estimates minable reserves to be 8,014 kilograms of gold.

Alaska Hardrock Mining Co. got the old Enserch mill back into operation and with eight workers processed several thousand metric tons of stockpiled ore and continued mining and exploring the Independence mine and other close properties.

Southwestern region's estimated production was about 451 kilograms of gold, down 7% from that of 1991. The 24 mines employed 103 people, down from 25 mines and 105 employees in 1991. The largest placer mine in the region continued to be NYAC Mining Co., with 15 employees, at the head of Bear Creek, about 55 kilometers south of Aniak.

Activity in the southeastern region was mostly hard-rock underground mining and exploration for base and precious metals, the exploration and development of old gold and silver mines, and a very small amount of placer mining for gold. Of the 1,015 kilograms of gold produced in the region, 1,008 kilograms was produced by Kennecott's underground Greens Creek Mine from 331,055 metric tons of massive sulfide ore, according to the State survey. The gold was recovered by smelting the lead, zinc, and mixed lead-zinc concentrates from the flotation concentrator. In 1992 Greens Creek was the second largest producer of gold in Alaska. Starting in 1988, a new ore body called the West Deposit was explored and found to contain 10 million metric tons of ore bearing 4.49 grams per metric ton of gold along with lead, silver, and zinc. Despite the richness of the ore, size of the deposit, and high production rate, the mine reported substantial financial losses for 1992, primarily owing to depressed metal prices.

Silver.—Silver production reported to the State in 1992 was 283,532 kilograms, valued at an estimated $34,913,341. The State reported silver production in 1990 and 1991 at 315,234 kilograms and 282,322 kilograms, respectively, valued at $50,675,000 and $39,114,490. Alaska ranked second among the States in production of silver, up from third in 1991. The Greens Creek Mine, in its fourth year, produced 220,835 kilograms of silver from 331,055 metric tons of ore.

Greens Creek was the State's leading silver-producing mine, but slipped into second place nationwide from first place in 1991. The milling rate averaged 907 metric tons per day. The silver was contained in the gravity and flotation concentrates from the mill and recovered by smelting and refining.

The Red Dog Mine was the other major silver source in Alaska in 1992. An average of about 3,932 metric tons per day was milled by selective flotation, producing lead, zinc, and bulk zinc-lead concentrates. Silver was recovered from each of the concentrates by smelting and refining. The ore milled in 1992 was reported to have averaged about 19.9% zinc and 6.0% lead, from a published reserve of 72.1 million metric tons averaging 16.8% zinc, 4.9% lead, and 74 grams per metric tons silver. Efforts continued to improve zinc recovery from Red Dog's complex ores and metal recovery from the various ore types. Difficult ore mineralogy continued to adversely affect metal recovery, and the quality of the lead and bulk zinc-lead concentrates continued to be unsatisfactory. According to company officials, the overall performance of the mine was disappointing, mainly because of poor metal prices and lower sales volumes.

Placer gold recovered in 1992 contained an unspecified amount of silver. Refined gold yields the silver as metal but the placer gold used as nugget specimens and for nugget jewelry retains the silver in the original alloy. Exploration for primary silver and silver-bearing base metal deposits did not attract much interest or monetary expenditure because of the relatively low metal prices.

Tin.—The State survey reported 680 kilograms of tin, valued at about $5,910, was produced in Alaska in 1992, the lowest value in more than 10 years. Both major tin producers were reported as idle during the year. The reported tin output in 1991 was 3,084 kilograms valued at $22,100. The reported tin output in 1990 was 25,855 kilograms valued at $200,000. There was little exploration effort and expenditure on tin in 1992 other than that necessary to hold several promising prospects justified by previous work.

Zinc and Lead.—The State survey reported 1992 zinc production at 248,978 metric tons valued at $301,957,700 and lead production at 62,278 metric tons valued at $31,585,440. This amount was about the same as last year's production at 252,346 metric tons of zinc and 63,119 metric tons of lead valued at $278,221,000 and $33,403,680, respectively, in 1991. According to USBM data, Alaska ranked first among the States in production of zinc, second in lead, and fifth in silver.

The Greens Creek Mine operated full time during its fourth year. The mine is in a nonwilderness area east of Hawk Inlet, on Admiralty Island, about 29 kilometers southwest of Juneau. The

underground mine supplied an average of 907 metric tons per day of ore to the selective flotation mill, for a total of 331,055 metric tons. The State survey lists 1992 production at 220,810 kilograms of silver, 1,008 kilograms of gold, 14,966 metric tons of lead, and 36,734 metric tons of zinc in concentrates. Lead, zinc, and a bulk lead-zinc concentrate were shipped to foreign smelters from the company's Hawk Inlet storage and loading dock.

The Red Dog Mine is about 140 kilometers north of Kotzebue and 83 kilometers inland, northeasterly, from the Chukchi Sea. The mine produced 1,435,190 metric tons of zinc-lead-silver ore during 1992, according to the State survey. About 430,800 metric tons of lead, zinc, and bulk (ISF) lead-zinc concentrates was shipped during the short open water season of about 100 days. The concentrates went to the Cominco smelter at Trail, British Columbia, Canada, and to smelters in Europe and the Far East. GCO Minerals Co. did several hundred meters of drilling assessment work on the Lik zinc-lead-silver property about 19 kilometers west of the Red Dog Mine. The State survey reports the Lik deposit has preliminary reserves of about 21.77 million metric tons averaging 9.0% zinc, 3.1% lead, and 48 grams per metric ton silver.

Other Metals.—Several placer operators recovered small amounts of platinum and platinum-group metals as a byproduct with their gold production. There was some active exploration of low-grade copper deposits that carried recoverable gold and silver values. Interest in molybdenum deposits has disappeared. Only necessary assessment work was carried out on some of the more interesting nickel-copper claims. The previous interest in uranium and rare earths has about disappeared.

Industrial Minerals

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991. Production of construction sand and gravel reported to the USBM in 1992 was 13.6 million metric tons valued at $43.3 million, about 7% above estimated output in 1991. The estimated production in 1991 was 12.7 million metric tons valued at $39.2 million. The State survey reported the 1992 production of 13.2 million metric tons valued at $42.2 million, produced by 640 employees. The largest percentage increase in sand, gravel, and stone use in the State was in the southeastern region and most of the increase is related to infrastructure development associated with logging on Tongass National Forest and other lands. The largest percentage decrease has been in the northern region and is associated with decreased North Slope oilfield use. The USBM and the State of Alaska production quantities of sand and gravel are fairly similar so most of the amount and value distribution information is taken from the State figures.

The northern region used about 711,000 metric tons of sand and gravel. The Red Dog Mine project used sand and gravel, riprap, and shotrock for road maintenance and construction. About 235,820 metric tons of gravel was used by Alyeska Pipeline Service north of Atigun Canyon. B.P. Exploration used sand and gravel for construction, maintenance, and repair projects in the Kuparuk Deadarm Mine area and the Duck Island unit. Work was completed on airports at Kiana and Selawik, according to ADOTPF records.

The western region reported about 570,000 metric tons total usage, an increase of 47% from that of 1991. All of the increase was for road repairs and construction on the Seward Peninsula and to improve and upgrade the White Mountain and Nome airports. ADOTPF took care of the road work. Tidemark Corp. provided the gravel for the federally sponsored road and airport construction. The estimated unit value of sand and gravel in the northern and western regions was $4.63 per metric ton and $3.04 per metric ton, respectively. State surveys reported industry employment was 80 people in the northern region and 55 people in the western region.

The eastern interior region consumed about 3.72 million metric tons of sand and gravel, valued at more than $12.9 million, an average of $3.83 per metric ton. The State listed industry employment at 165 people. ADOTPF-administered projects used 2,704,675 metric tons on such improvement projects as Geist Road, Peger Road, Airport Road, Dalton Highway bridge, Farmers Loop Road west, Ballaine Road, Fort Yukon Runway, and Elliott Highway. Fairbanks Sand and Gravel Inc. (FSG) was purchased from Sealaska Corp. by Aggregate Products Inc. Owing to the sale of the company and the need for repair on mine and equipment, production was far below that for previous years. FSG recovered about 55,327 metric tons of sand and gravel, using its barge-mounted clam shell dredge and 20 employees. Other sand and gravel users in the region include Earthmovers, H & H Contractors, ACE General Contractors, and Rolling Stone Inc.

The south-central region producers reported mining about 4.47 million metric tons of sand and gravel worth about $14.8 million and employing 170 people. Federal and State funded highway projects in the Anchorage area used about 2.7 million metric tons according to ADOTPF records. Rebuilding of the Glenn Highway from Palmer to Peters Creek was the largest single construction project. In the Valdez-Glennallen area the ADOTPF administered work on the Chitina airport, Gulkana Runway, Glenn Highway, Richardson Highway, and the Copper Highway bridge. Road repair in south Anchorage and port improvements called for 1.9 million metric tons of pit-run aggregates shipped by Alaska Railroad.

In the southwestern region the State survey reported use of 18,140 metric tons of industrial minerals by Calista Corp.

Southeastern regional sand and gravel production was 3.32 million metric tons valued at about $9 million by the 12

TABLE 2
ALASKA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	260	$1,432	$5.51
Asphaltic concrete aggregates and other bituminous mixtures	W	W	2.91
Road base and coverings	12,589	35,560	2.82
Fill	1,646	4,678	2.84
Snow and ice control	W	W	4.82
Other miscellaneous uses	205	698	3.40
Unspecified:[1]			
Estimated	306	968	3.16
Total	15,006	[2]43,335	2.89
Total[3 4]	13,613	43,335	3.18

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[2]Data do not add to total shown because of independent rounding.
[3]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[4]Total quantity and total value in thousand metric tons and thousand dollars.

companies reporting to the State survey. The industry employed 158 people, almost double the employment level of 1990. The principal uses were maintenance of roads in the Juneau, Ketchikan, and other urban areas and the construction and maintenance of logging access roads on Tongass National Forest, Native Corp., and private lands. Production in the Juneau area was reported as 27,210 metric tons worth $106,500 from the Acme Pit by Hildre Sand and Gravel Co. and 45,350 metric tons from the Lemon Creek pit by Red Samm Construction, Inc. About 22,675 metric tons of river gravel was used by the city of Skagway for road maintenance and port facility work.

The Alaska Peninsula region reported the production of about 437,900 metric tons of sand and gravel valued at $397,890 produced by eight people. About one-third of the material mined was for logging roads on Kodiak and Afognak islands. Most of the rest of the material mined was used by ADOTPF and the city of Kodiak for maintenance and repair of the island's road system and within the city limits of Kodiak.

Stone (Crushed).—Crushed stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991. No production of dimension stone was reported in Alaska in 1992.

The USBM estimated production of crushed and broken stone in 1992 was 2.7 million metric tons valued at $13.4 million. Production in 1991 was reported to have been 0.98 million metric tons valued at $4.79 million. Surveys by the State show 1992 stone production of 2.6 million metric tons valued at $23.0 million and in 1991 2.7 million metric tons valued at $22.5 million. The demand for stone was generally weak after 1990, with a slow decline through 1991 and 1992. Employment in 1992 was 145, down from 165 in 1991.

Some crushed stone was used in the form of shotrock and riprap for dam construction and road maintenance at the Red Dog Mine project in the northern region.

The use of crushed stone in the western region was for road resurfacing and construction, airport improvements and expansion, and for State road and infrastructure needs near Nome.

In the Alaska Peninsula region Koniag Inc. quarried graywacke to be crushed rock for road construction on Afognak Island and Kodiak Island. Most of the material was for logging road construction. ADOTPF and the city of Kodiak also used crushed bedrock on the island's road system and within the city.

About 1.1 million metric tons of stone was reportedly quarried in the southeastern region. Principal uses were for construction and maintenance of Tongass Forest and private and State logging access roads. An unnamed construction company mined about 5,900 metric tons of shotrock from a quarry leased from the village of Thorne Bay for use in the city. In the Juneau area, Red Samm Construction quarried 45,350 metric tons of shotrock worth $465,000.

Other Industrial Minerals.—Alaska Basic Industries manufactured gray portland cement at its plant in Anchorage using domestic clinker and gypsum received at the Port of Anchorage by marine transportation. This is the only cement plant in Alaska so the amount and value of the cement produced is withheld to avoid disclosing company proprietary data.

The State survey listed peat production in 1992 at about 54,000 cubic meters valued at about $400,000. That was a decrease from the 57,000 cubic meters valued at $450,000 estimated in 1991. Employment in 1992 was 40, down from 45 employees reported in 1991. Most of the peat was mined just north of Fairbanks on land owned by the University of Alaska. Much of the peat was consumed in agricultural uses.

Jade was mined at its Ambler River deposits by NANA Regional Corp. and processed for marketing at its plant in Kotzebue. The source of the nephrite jade was NANA's Empire Mine in the Jade Mountains and its Stewart Mine in the Cosmos Hills. These deposits are up the Kobuk River east of Kotzebue, near Kiana and Shungnak. The jade varies in quality and is used for a variety of fine carved personal ornamental items to cut and polished tiles and large slabs for table

tops and facings. Soapstone for carving and other uses was mined north of Anchorage. The USBM has withheld the quantities and values of jade and soapstone production for several years to avoid disclosing company proprietary data. The State survey listed the value of these materials produced in 1992 at $30,000 up from $12,000 reported in 1991.

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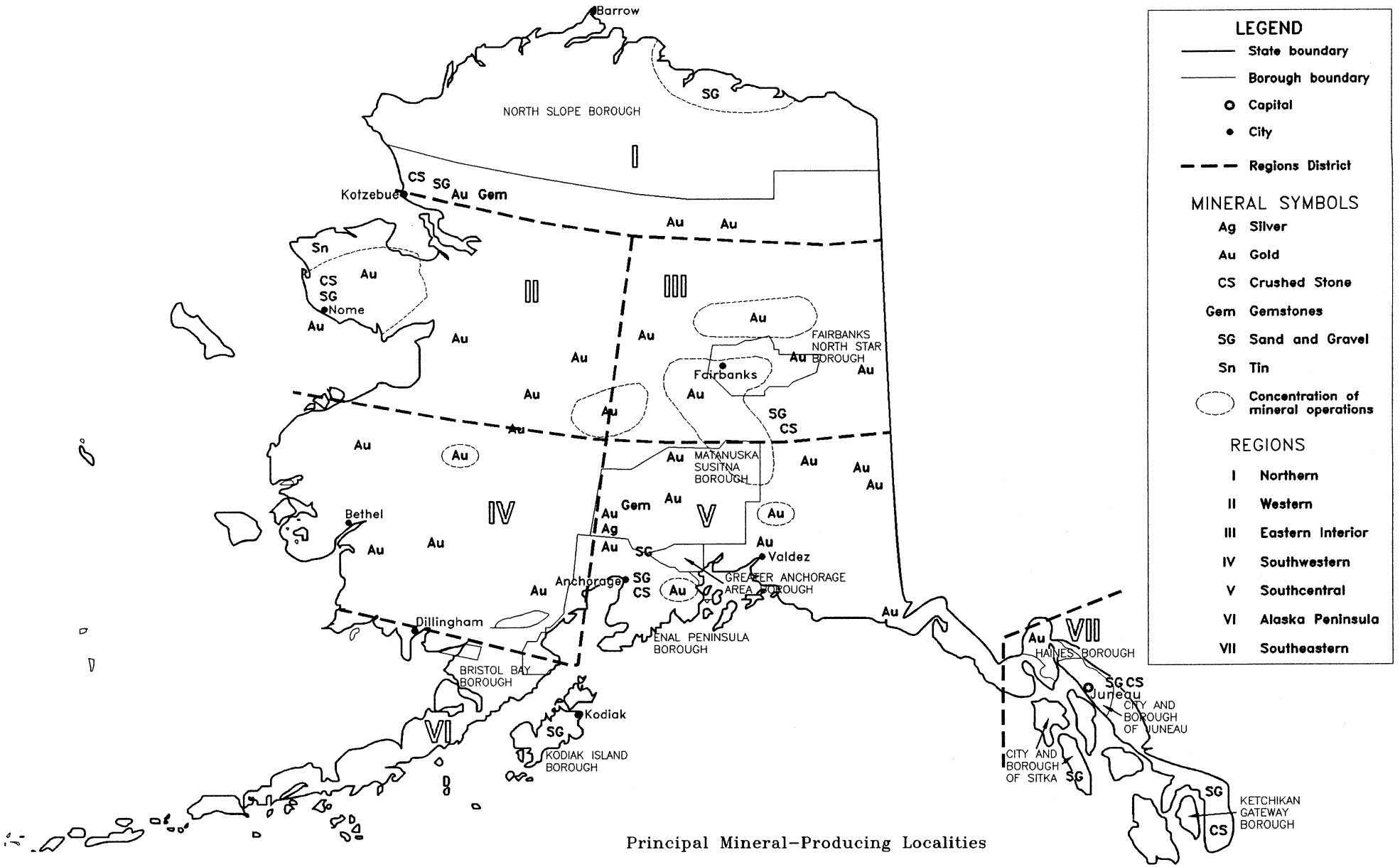
[1]Mining engineers, U.S. Bureau of Mines, Juneau, AK. They have covered the mineral activities in Alaska since 1993.

[2]Swainbank, R. C., T. K. Bundtzen, A. H. Clough, E. W. Hansen, and M. G. Nelson. Alaska's Mineral Industry 1992. Div. of Geol. and Geophys. Surv. Spec. Rep. 47, 1993, 90 pp.

ALASKA



Principal Mineral-Producing Localities

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	Region
Cement:			
Alaska Basic Industries	1040 O'Malley St. Anchorage, AK 99501	Grind and blend	Cook Inlet-Susitna.
Gold:			
Alaska Gold Co.	Box 640 Nome, AK 99762	Placer-dredge	Seward Peninsula.
Cambior Alaska Inc.	Box 110 Cantwell, AK 99729	Placer	South-central.
Kennecott Greens Creek Mining Co.	300 Vintage Blvd. Suite 200 Juneau, AK 99801	Lode-underground mine	Southeastern.
Polar Mining Co.	4545 Woodriver Dr. Fairbanks, AK 99709	Placer	Yukon River.
Gemstone (jade):			
NANA Regional Corp.	Box 49 Kotzebue, AK 99752	Quarry	Northern.
Stone:			
Aleutian Construction Co.	3909 Arctic Blvd. Anchorage, AK 99501	do.	Aleutian Islands.
KRM Inc.	Box 8100 Ketchikan, AK 99901	do.	Southeastern.
City of Petersburg	Box 329 Petersburg, AK 99833	do.	Do.
South Coast Inc.	Box 8620 Ketchikan, AK 99901	Quarries	Seward Peninsula.
U.S. Bureau of Indian Affairs	Box 3-8000 Juneau, AK 99801	do.	Southeastern.
Tin:			
Shoreham Resources Ltd.	Box 10499 Fairbanks, AK 99710	Placer	Eastern Interior.
Zinc, silver, lead:			
Kennecott Greens Creek Mining Co.	3000 Vintage Blvd. Suite 200 Juneau, AK 99801	Lode-underground mine	Southeastern.
Cominco Alaska Inc.	Box 1230 Kotzebue, AK 99752	Lode-open pit	Northern.

THE MINERAL INDUSTRY OF ARIZONA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Arizona Department of Mines and Mineral Resources for collecting information on all nonfuel minerals.

By Jean A. Dupree[1] and H. Mason Coggin[2]

Arizona remained the national leader in 1992 in nonfuel mineral production value, a lead it has held for 4 years. Total value for the State was $3.17 billion, an increase of about 10% over the revised 1991 total of $2.88 billion and equating to nearly 10% of U.S. total nonfuel mineral value. In addition, Arizona supplied 65% of the 1992 U.S. total copper value and continued to lead the United States in copper production. Arizona's 1992 copper production was 1.15 million metric tons valued at $2.73 billion, and copper still provided the lion's share (86%) of the State's total nonfuel mineral value. Construction sand and gravel, gold, and portland cement continued to be lesser, but significant, players in the State's mineral picture. In 1992, the State remained an important gold producer and was nationally significant in terms of output of several byproducts of copper production—lead, molybdenum, rhenium, silver, and sulfuric acid.

TRENDS AND DEVELOPMENTS

The year 1992 was the last full year of gold production at Cyprus Mineral's Copperstone Mine in western Arizona. Mining ended in December when ore reserves were depleted. In its 1992 annual report, Cyprus projected that heap-leach production from low-grade stockpiles would continue through April 1993. The company first poured gold at Copperstone in November 1987.

By nearly an order of magnitude, Arizona continued to lead all other States in copper production. Arizona's 1992 copper output grew 12.6%, and the State supplied 65% of total U.S. copper value. A study prepared by the Western Economic Analysis Center showed that the Arizona copper industry contributed $6.56 billion as a combined direct and indirect impact to the 1992 State economy, up sharply from its $5.65 billion impact in 1991. The combined

TABLE 1
NONFUEL MINERAL PRODUCTION IN ARIZONA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	140,162	$2,318	228,411	$3,830	[2]102,337	[2]$463
Copper[3]	do.	978,767	2,657,649	1,024,066	2,468,255	1,153,225	2,731,152
Gemstones		NA	2,098	NA	3,173	NA	5,416
Gold[3]	kilograms	5,000	62,191	r6,195	r72,362	6,656	73,818
Iron oxide pigments (crude)	metric tons	W	W	18	22	77	62
Sand and gravel (construction)	thousand short tons	r31,590	r112,785	e22,500	e79,400	33,842	123,517
Silver[3]	metric tons	r149	r19,346	148	19,212	165	20,873
Stone (crushed)	thousand short tons	e5,300	e13,500	7,060	32,842	e5,500	e26,300
Combined value of cement (portland), clays [bentonite (1992)], diatomite (1990), gypsum (crude), iron ore (usable, 1991), lead (1991-92), lime, molybdenum, perlite, pumice, pyrites, salt, sand and gravel (industrial), stone (dimension), tin (1992), and values indicated by symbol W		XX	207,591	XX	198,230	XX	181,915
Total		XX	r3,077,478	XX	r2,877,326	XX	3,165,938

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" data.
[3]Recoverable content of ores, etc.

economic impact reflected both the industry's direct payments to its employees, businesses, and State and local governments in addition to money recirculated through the Arizona economy to create a multiplier effect. Taxes directly paid by the copper industry to State and local governments were $117 million, an increase of 16% from those paid in 1991. Indirect and direct 1992 revenues (taxes paid by the copper companies and their employees, and by suppliers and their employees and suppliers) received by the Federal Government were $3.5 billion, more than $20,000 per acre of Federal lands used for metal mining in Arizona. Federal taxes alone paid by the State copper industry totaled $88 million, a return of more than $500 per acre. Additionally, the Arizona copper industry had an important impact on lowering the 1992 U.S. trade deficit in that the State's copper producers sold copper and copper concentrates valued at nearly 454 million to customers overseas.[3]

Among construction trends, single family housing sales increased in the State's two largest metropolitan areas during the year. In the Phoenix metropolitan area, they grew 33% with about 18,500 units permitted. In the Tucson area, such permits rose an impressive 39% to reach 3,900 units. Such increases had a positive effect on State sand and gravel, cement, crushed stone, gypsum, and other industrial mineral producers.

EMPLOYMENT

According to Arizona Department of Economic Security employment figures, 1.605 million people were employed during 1992 in the nonagricultural sector. An average of 12,600 people were employed in mining during 1992, compared with 14,900 so employed in 1991. Of this number, 10,100 held jobs in the copper mining sector, compared with 12,300 in 1991. Average unemployment statewide was 7.5%. According to a study by the Arizona Mining Association, about 69,400 State residents held jobs during 1992 as a result of the combined direct and indirect contributions of the copper industry to personal, business, and government income.[4]

ASARCO Inc. and unions reached a tentative agreement in July on a new 3-year contract that affected Arizona employees at the Hayden copper smelter and at the company's Silver Bell and Mission Mines.

During February, a representation election was held at Cyprus' Miami operation to decide whether Cyprus employees wanted to be represented by a union coalition of the United Steelworkers of America, the International Association of Machinists, and the International Brotherhood of Boilermakers. Election results were delayed for 8 months while Cyprus appealed the holding of the election because it had wanted the entire Miami operation to be considered one bargaining unit while the unions had wanted the election for only smelter and rod plant employees. In September, the National Labor Relations Board decided against Cyprus' interpretation, and election results were released: employees had voted 206 to 84 against union representation. Also during 1992, Cyprus Minerals Co. relocated its Cyprus Copper Co. from Denver to Tempe. In a major cost reduction manuever at yearend, Cyprus Copper Co. announced the layoff of 184 Arizona employees from its Tempe office and at its Sierrita-Twin Buttes, Miami, Bagdad, and Casa Grande operations.

Magma Copper Co. awarded its teams at the San Manuel smelter and refinery their first bonus checks based on the company's gainsharing plan that went into effect in 1991. Magma continued to experiment with its new workplace climate that involved increased cooperation and communication between management and labor: a company that apparently has effected the simple realization that these two groups are in the same business. By 1992, Magma's new team-based organizational structure had generated measurable changes in mining costs, work efficiency, and improved safety.

About 30 State high school teachers took advantage of two summer courses, each a week long, concerning minerals and mining. Sponsored by the Arizona Mining Association, teachers received college credit for the program through the University of Arizona. The teachers learned about the mineral extraction process, uses of minerals, meeting environmental standards, and other aspects of the mining industry. Representatives from all the State's copper mining operations spoke to the teachers. Tucson teachers toured Magma Copper Co.'s San Manuel operations; those in Tempe visited Magma's Pinto Valley operation and Cyprus Minerals Co.'s Miami operation.

ENVIRONMENTAL ISSUES

Asarco finalized transfer of 157,000 contiguous acres (245 square miles) of the Cienega Watershed to the Bureau of Land Management (BLM) in exchange for 3,500 acres of BLM land near Silver Bell. According to one Pima County official, 6 years of cooperative effort among the county, BLM, Arizona State Land Department, and Asarco ended in conservation, water resource protection, flood and erosion control, open space preservation, habitat protection, and new recreational opportunities for the area. The head of Asarco's Southwestern Mining Div. pointed out that the land exchange completed a corridor of public lands extending south from Colossal Cave almost to the United States-Mexico border.

In past years, Cyprus had spent hundreds of thousands of dollars to reclaim tailings piles at its Miami operation using topsoiling, seeding, and watering methods that would not yield grass cover after the first growing season. During 1992, Cyprus Minerals Co. completed its successful $70,000, 3-year experiment with Longhorn cattle and special grass seedings to control dust and reclaim tailings. The cattle trample seed and mulch into the tailings in a fenced area, add their own special fertilizer, and are then moved to another plot. In this holistic system, interaction of the cattle with grass germination increased seed

germination and created a dense protective grass cover, which curtailed wind erosion. According to the school of thought for this experiment, grasses and rangelands require interaction with cattle (as they did with the buffalo) to function properly as an ecosystem, and rangeland destruction is brought about not so much by overgrazing as by destroying that interaction between the grass growth cycle and grazing animals. The method produced dense grass growth not just on the top of the tailings, but also on the slopes.

DMI Aviation of Tucson was fined $1.6 million and ordered by the State and Federal agencies to clean up 450 metric tons (500 short tons) of aluminum dross on its property. The dross, generated between 1976 and 1982, was a byproduct of a process in which aircraft parts were recycled to recover aluminum.

EXPLORATION ACTIVITIES[5]

Companies continued to explore for copper in Arizona, in particular, for leachable properties. Magma Copper Co. acquired from Conoco Inc. the Poston Butte copper deposit 3 miles northwest of Florence in Pinal County, future production from which could replace the nearly depleted San Manuel open pit. Preliminary estimates indicated the deposit had reserves of 270 million metric tons (300 million short tons) of oxide ore containing 0.37% copper and 470 million metric tons (500 million short tons) of sulfide ore containing 0.39% copper. Magma indicated that, pending successful feasibility studies and permitting, plant construction could begin as early as 1995. The mine would employ about 300 people. Magma continued evaluation of the Lower Kalamazoo deposit at San Manuel. According to the State Department of Mines and Mineral Resources, other companies acquired properties for exploratory copper projects in Cochise, Pinal, and Santa Cruz Counties.

Arimetco International Inc. entered into a lease-option agreement with Zonia Co. under which Arimetco could explore and mine 1,200 acres east of Kirkland Junction (Yavapai County). McAlester Fuel Co., the former owner, operated a copper precipitation operation on the property between 1966 and 1975. In its annual report, Arimetco announced a minable reserve of 27 million metric tons (30 million short tons) grading 0.38% copper. Inherited from previous mining operations were an additional 6 million metric tons (7 million short tons) on heap-leach piles grading 0.24% copper.

Arimetco continued development of its Van Dyke property that, according to the company, contained a reserve of more than 100 million short tons of 0.51% copper. Arimetco planned to utilize the existing Van Dyke shaft as part of the in situ leach extraction system. The company began repairs to the shaft and constructed a tool shop, hoist building, and installed a rebuilt hoist. By yearend, 400 feet of the 1,100-foot shaft had been renovated and readied for use.

According to the Arizona Department of Mines and Mineral Resources, Phelps Dodge Corp. rehabilitated the Hopewell tunnel and other underground workings in the Jerome area. The work was conducted to sample and evaluate this classic U.S. massive sulfide deposit for base and precious metal resources.

Cyprus Minerals Co. conducted heap-leach tests at the old Lakeshore Mine near Casa Grande to evaluate the property as an open pit operation.

Victoria Resources Corp. and Bema Gold Corp. jointly announced that Victoria had signed a letter of intent to acquire the entirety of the West Hills copper property from private vendors. Bema was the largest shareholder of Victoria and announced plans to further explore the property. The area is near Gleason, about 30 miles south of Willcox (Cochise County). Phelps Dodge staked an adjacent area west of the property.

Toltec Resources drilled and dropped the Middlemarch copper property in the Dragoon Mountains (Cochise County).

A number of companies reported they were pursuing gold exploration targets in the State. Western States Minerals Corp. withdrew from a joint-venture partnership with DRX Inc. at the Commonwealth property (Cochise County). Reasons cited for terminating the arrangement included declining gold prices and investment requirements needed to acquire a 60% interest in the property. Addwest Minerals reopened Line Road tunnel and No. 1 shaft at the Gold Road Mine near Oatman (Mohave County). Cambior acquired the Cyclopic Mine (Mohave County) and other areas in the Gold Basin district. VLS Minerals drove a decline at the Wilson placer in the La Cholla placer district near Quartzsite (La Paz County).

Cyprus returned the BVO property (Yuma County) to its owners after drilling the property for precious metals. Verdstone Gold Corp. acquired BVO and began developing a small, open pit mine and established an arrangement with Cyprus to truck ore to the Copperstone mill (La Paz County).

Royal Gold Inc. signed a 2-year option agreement with Southwest Exploration Inc. to conduct exploration on the Treasure King property (Yavapai County). Equinox Resources Ltd. entered into an agreement to acquire a 100% interest in the Oro Blanco gold property near Nogales (Pima County) from NCA Minerals. Manhattan Minerals Corp. signed a letter of intent to acquire an 80% interest in the Harquahala gold property (La Paz County). Oneida Resources Inc. and Placer Dome terminated their joint-venture exploration agreement on the Mexican Hat project (Cochise County). Placer Dome had earned 80% interest in the property, which Oneida repurchased.

Silverspar Minerals Inc. completed drilling on its silver-fluorite property about 50 miles north of Yuma. All deposits were reputed to be of acid-grade, a type suitable for the manufacture of hydrofluoric acid and fluorocarbons. According to the company, phaseout of chlorofluorocarbons and increased demand for hydrofluorocarbons had enhanced the market for acidspar.

LEGISLATION AND GOVERNMENT PROGRAMS

The second regular session of the 40th Arizona Legislature and five specially

called sessions (fifth through ninth) convened during 1992. A total of 1,142 bills and 84 memorials and resolutions were introduced into the second regular session, of which 260 bills were enacted into law. Additionally, 3 joint resolutions were signed by the Governor and 14 memorials and resolutions were transmitted to the Secretary of State.

One bill that could eventually have dramatic impacts to State sand and gravel dredging, House bill 2594, established administrative procedures for determining the State's claim to ownership of the beds of watercourses. The enactment establishes the five-member Arizona Navigable Stream Adjudication Commission to determine navigability of State watercourses and any associated public trust values. "Navigable" is defined as a watercourse that was in existence at the time of statehood and was used for commerce. The goal of the new legal exercise is to determine the State's claim to ownership of the beds of Arizona watercourses. Beginning in 1993, the State Land Department is to begin evaluating the navigability of each watercourse, its present uses, and its public trust values. Results of its determination will be forwarded to the Arizona Navigable Stream Adjucation Commission, which will consist of five gubernatorial appointees. The State will relinquish its claim to the streambed if the watercourse is determined to be nonnavigable. Land relinquished will be appraised at fair market value; the amount would be credited to the present lessee or owner at the time of public sale. If the current owner were not the successful bidder, they are to be reimbursed by the bidder for the appraisal value.

A bill that would have imposed a $1 fee on all mining claims to fund location and closing of abandoned mines by the State Mine Inspector's Office died in the House. The bill, Senate bill 1336, would have raised an estimated $100,000 to $200,000 annually.

The State legislature and the Governor also enacted several environmental bills. Senate bill 1430, the Air Quality Act, was enacted, thereby conforming Arizona's air pollution laws to the 1990 Clean Air Act, clarify State and county roles in air quality enforcement, and reduce permitting steps.

The Stream and Riparian Resources Act, House bill 2404, died in the House. The bill would have extended legal recognition to riparian ecosystems and established a ladder for preference water use: municipal needs first, followed by irrigation and stock watering, power, mining, groundwater recharge, and, finally, riparian protection. Senate bill 298 was enacted, however, to collect scientific and economic data and develop analyses that would allow the legislature to make informed decisions on riparian area protection. The new law mandates studies by three State agencies: the Department of Water Resources, Game and Fish Department, and Department of Environmental Quality. The State Water Resources Department will evaluate effects of ground water pumping and surface water use on riparian areas. The Game and Fish Department will develop a hierarchical riparian area classification system and use the system to map riparian areas in the State. The Department of Environmental Quality will identify activities, operations, and uses of land in riparian areas that may alter or destroy the riparian area and to report its findings to the Governor by October 1, 1993. To synthesize the reports of the three agencies, the bill also creates the Riparian Area Advisory Committee formed of 26 members, 19 of which are appointed by the Governor. The committee will represent seven State agencies, environmental interests, recreational users, counties, water interests, manufacturing, and farmers. Its final report is due December 1, 1994.

By enacting Senate bill 1545, the legislature established a nine-member advisory council on environmental education to promote coordination and planning with public and private agencies and educational institutions concerning the environmental education plan formulated by the Governor's Task Force on Environmental Education. The Arizona Advisory Council on Environmental Education may solicit monies for environmental education and develop models for community-based recycling, conservation, and integrated pest management.

The legislature also passed the State-Lands Private-Property Rights Protection Act, Senate bill 1053, a landmark and controversial bill that requires State agencies to determine if new anti-pollution regulations devalue property, and, if so, to compensate land owners. The goal of the new law is to establish a process by which the State can determine whether its actions result in a "taking" of private property that requires compensation under the Fifth or Fourteenth Amendments to the U.S. Constitution. The bill permits the State to exchange lands containing minerals or metals. A petition forced the bill to referendum too late to make the ballot in 1993, so its enactment will be delayed until 1994.

BLM implemented new rental fees for unpatented mining claims as mandated by the 1993 Interior Department and Related Agencies Appropriations Act (amendment 18 to H.R. 5503, signed October 5, 1992). The act requires holders of unpatented mining claims to pay the Federal Government a rental fee of $100 per year per claim. The new fee replaces the $100 annual assessment work per claim, and its stated purpose was for reducing surface disturbance carried out solely to maintain a mining claim and to discourage filing of nuisance claims. The perception of many in the mining industry, however, was that the fees were intended to curtail mining activity in the Western United States. Rental fees will be deposited into the general treasury, and a portion of the monies will be returned to BLM to fund its mining law administration program. The rental fee requirement was scheduled to expire September 30, 1994. Types of unpatented claims affected include lode claims, placer claims, mill sites, and tunnel sites.

In situ leaching of copper remained an imporatant element of U.S. Bureau of Mines (USBM) research during 1992. This technology utilizes a suite of vertical injection wells to pump leach solutions

through fractured copper ore. In situ leaching is potentially cheaper, more environmentally friendly (because it does not require surface disturbance), consumes less energy, and results in safer working conditions than conventional mining techniques. The USBM's showcase is the Santa Cruz deposit about 7 miles west of Casa Grande (Pinal County). Asarco, in joint-venture partnership with Freeport Minerals Co., provided funding for the project. After successful completion of the 1991 test involving monitoring of tracer solutions, the USBM began permitting for an 18-month test involving injection of dilute solvents and construction of a solvent extraction-electrowining plant on the site.

The USBM also continued its inventory of mineral resources in the Coronado National Forest in southeastern Arizona. Fieldwork was completed in the Patagonia, Huachuca, Tumacacori, Santa Catalina-Rincon, and Dragoon Mountains. Fieldwork was also completed for a mineral resource appraisal of the Coconino National Forest in north-central Arizona. In addition, the USBM completed a mineral appraisal of the detachment fault terrane in west-central Arizona and began preparing copies for distribution as MLA 13-92.

The Arizona Mining and Mineral Resources Research Institute was awarded $16,000 by the USBM with the stipulation that the monies be used only to support graduate students. Five fellowships were awarded for the 1992-93 academic year for the following research topics: application of neural networks to electrical geophysical exploration methods, behavior of iron particulates during combustion of pulverized coal, attenuation of arsenic in copper leach piles, studies of ground support interactions in block caving mines, and alkali and sulfur oxide capture mechanisms.

The Arizona Department of Mines and Mineral Resources published its annual directory of active mines in Arizona (D39) and the "Arizona Mining Update" (C37). The department also published "Copper Oxide Resources" (OFR92-10), which lists more than 800 properties with significant oxide copper resources, and "Arizona Copper Reserves" (OFR92-11), which reviews 75 major copper properties. Struggling with budget cutbacks, the agency closed its Tucson office in 1992, retaining its Phoenix headquarters.

The Arizona Geological Survey released several publications of interest to the minerals industry, including the following: CR-92-B "Location, Geologic Setting, and Production History of the Harvey Blackwater Nos. 1, 3, and 4 Uranium Mines, Apache County, Arizona and San Juan County, Utah"; OFR-92-1 "Mineral Deposits of the Bullard Mineral District, Harcuvar Mountains, Yavapai County, Arizona"; and the revised OFR-92-6 "Index to Published Maps of Arizona."

FUELS

Arizona continued to produce coal and minor amounts of oil and natural gas. According to U.S. Department of Energy statistics, Arizona continued to be 16th in the United States in coal output with 12.5 million short tons, dropping 5% from 1991 production. Arizona's 1992 production was 1.3% of U.S. coal production.[6] Peabody Coal Co. mined subbituminous coal from two surface mines in Navajo County in northern Arizona. As ranked by the National Coal Association, Peabody's Kayenta Mine remained 17th in the Nation and the Black Mesa Mine was 27th.[7] Kayenta supplied coal for the Salt River Project's Navajo Generating Station near Page. Black Mesa supplied, via the world's largest underground slurry pipeline, coal to Southern California Edison's Mohave Generating Staion near Laughlin, NV. Coal mining on the Navajo Nation in Arizona and New Mexico supplies 70% of the tribal annual income. Peabody employed 900 people at its Kayenta and Black Mesa operations, with 92% of the work force coming from Navajo and Hopi Tribes. Peabody pays the tribes about $33 million in annual royalties and $308,000 in tribal scholarship funds.

Because of low prices for uranium, Energy Fuels Nuclear Inc. kept all its properties idle in 1992. Company properties on standby status included Arizona One, Hermit, Kanab North, and Pine Nut. According to the U.S. Energy Information Administration, the average 1992 price for uranium deliveries from domestic supplies was $13.45. The Supreme Court refused to hear a case brought by Havasupai tribal members against uranium mining near Grand Canyon. The tribe claimed that Energy Fuels Nuclear Inc.'s idled Canyon Mine is in an area the Havasupai regard as sacred.

A project to clean up uranium mill tailings on Navajo Nation lands in Monument Valley, AZ, and Mexican Hat, UT, began in September. The project will continue for about 3 years at a cost of $21.6 million.

The Federal Radiation Exposure Compensation Act provided $30 million to compensate Navajo uranium miners and others who were exposed to radiation during the height of the Government's program to develop nuclear weapons, between the 1940's and 1970. Each eligible person or family received $100,000 and a formal apology. The Navajo Nation also is doing surface reclamation of abandoned uranium mine tailings.

According to the U.S Energy Information Administration, Arizona produced 94,000 barrels of crude oil, a drop of 15% from 1991 output.[8] State production of marketed natural gas was 771 million cubic feet,[9] down from the 1991 figure of 1,225 million cubic feet of marketed natural gas. Although Arizona is far from being a major oil- or gas-producing State, several companies undertook exploration programs during 1992. In the northeast corner of the State, for example, Chuska Energy Co. opened the Black Rock Field, discovered by Cities Service Corp. in the early 1970's.

REVIEW BY NONFUEL MINERAL COMMODITIES[10]

Metals

Copper.—Copper continues to be an

essential ingredient of modern living. The average American will consume 1,500 pounds of copper in her or his lifetime. We unthinkingly live and work in buildings equipped with copper wiring and copper pipes, punch a button to turn on a television or stereo, or use telephones, computers, and Fax machines—technologies that would not be available without copper or the mines that produce it. Arizona continued to be the Nation's premier copper-producing State, a lead it has maintained for more than 80 years. State production for 1992 totaled 1.15 million metric tons valued at $2.73 billion. Arizona's output and value rose 13% and 11%, respectively. During 1992, domestic copper consumption grew by 7.5%, a rise aided by a decline in interest rates and a 20% surge in U.S. housing starts. Sluggish domestic and world economies, however, continued to affect copper prices. Western World refined copper rose in 1992 by 2% to about 9.8 million short tons; copper consumption, however, was unchanged at 9.9 million short tons. The average Commodity Exchange (Comex) spot copper price during 1992 dropped to $1.03, compared to $1.05 per pound in 1991 and $1.19 per pound in 1990.

Of the country's top 25 copper mines in 1992, 16 were in Arizona. Copper production occured from 8 of Arizona's 15 counties in 1991, with Greenlee, Pinal, and Pima Counties (in decreasing order of production) leading the list. Four major companies mined copper in Arizona during 1992: Phelps Dodge Corp., headquartered in Phoenix and having operations in Greenlee and Cochise Counties; Cyprus Minerals Co., with operations in Gila, Mohave, Pima, Pinal, and Yavapai Counties; Magma Copper Co., headquartered in Tucson and having operations in Gila and Pinal Counties; and Asarco, with operations in Pima and Pinal Counties. Smaller copper-producing firms included A.F. Budge Ltd. (Yavapai County), Arimetco International Inc. (Cochise and Mohave Counties), and Oracle Ridge Mining Partners (Pinal County). Magma Gold Co. (Yavapai County) also recovered copper as a byproduct of precious-metal mining. Virtually all of Arizona's primary copper operations were open pit mines except for the San Manuel (the underground portion), Superior (Magma Mine), Casa Grande, and Oracle Ridge.

Phelps Dodge Corp. remained Arizona's leading copper company and was the second largest producer of copper in the world (after state-owned Codelco in Chile). "PD" operated the Morenci complex (Greenlee County) and Copper Queen Mine (Cochise County).

The gem in Phelps Dodge's portfolio continued to be Morenci, the largest copper mine in the United States and the second largest in the world (after Codelco-Chile's Chuquicamata Mine). The Morenci facility included the Morenci, Metcalf, and Northwest Extension open pits; two concentrators; and three solvent extraction units and an electrowining tankhouse (the Morenci SX-EW facility is now the largest in the world). Phelps Dodge owned 85% of the Morenci operation; the remaining 15% was held by Sumitomo Metal Mining of Arizona (a jointly owned subsidiary of Sumitomo Mining Co., Ltd. and Sumitomo Corp.). Morenci employed 2,100 people. Phelps Dodge reported the mine surpassed its 1991 production record by 14% to yield 353,000 metric tons (389,000 short tons), which, incidentally, was more than one-third of State copper production and more than one-fifth of U.S. production. Coupled with this output record was an outstanding safety record: more than 3.3 million employee-hours without a lost-time accident. The company completed construction of the $112 million Northwest Extension project in May, a feat that increased Morenci's already colossal output by 154,000 metric tons (170,000 short tons). The company reentered the Metcalf Mine (abandoned in 1980 because of a high stripping ratio) and successfully extended and relocated an in-pit ore crusher-conveyor system. The new system will permit deeper mining at the Morenci pit and the resumption of mining at Metcalf. Additionally, Phelps Dodge continued its feasibility studies for mining the Coronado deposit at Morenci, which contains 160 million metric tons (180 millon short tons) of sulfide mineralization grading 0.71% copper and 270 million metric tons (300 million short tons) of leachable material grading 0.29% copper.

Phelps Dodge also continued to operate the Copper Queen Mine (Cochise County), which consisted of a copper precipitate operation at the mined-out Lavender pit. The mine, near Bisbee, produced 1,300 metric tons (1,400 short tons) in 1992. Phelps Dodge Corp. also began preparing an environmental impact statement and filed permits for a 154-million-metric-ton(170-million-short-ton) leachable copper deposit at Bisbee.

Phelps Dodge continued to pursue several exploration properties, including the Cochise project near Bisbee and the Dos Pobres and Lone Star deposits near Safford. Cochise, if developed, could produce in excess of 36,000 metric tons (40,000 short tons) of copper for 10 years. Drilling at Dos Pobres increased reserves to 245 million metric tons (270 million short tons) grading 0.46% leachable mineralization and 210 million metric tons (230 million short tons) of sulfide material grading 0.89% copper. Adjacent to Dos Pobres is the company's Lone Star deposit, which contained, by company estimates, 1.45 billion metric tons (1.6 billion short tons) of leachable material grading 0.38% copper.

Cyprus Minerals Co., a subsidiary of Amoco Corp. until 1985, continued to be Arizona's second largest copper producer. During 1992, after furloughing 115 workers of a staff of 550 at its Denver-area headquarters, Cyprus Copper Co. relocated its office from the Englewood, CO, to Tempe. Cyprus' Arizona properties included its open pit Sierrita/Twin Buttes, Bagdad, Miami (formerly called Inspiration), Casa Grande, and Mineral Park.

Cyprus Minerals Co. reported corporatewide higher 1992 copper output, which it attributed to a production increase at Sierrita-Twin Buttes (Pima County). Output from these two adjacent mines, which Cyprus treats as a unit, was 131,000 metric tons (144,500 short tons), 5,900 metric tons (6,500 short tons)

higher than that of 1991. In its annual report, Cyprus indicated that greater mill throughput and recovery were responsible for the increase. Sierrita facilities included the Sierrita and Esperanza open pits, a 86,000-metric-ton-per-day sulfide ore concentrator, a ferromolybdenum plant, a rhenium plant, two molybdenum roasters, and an oxide-ore dump-leaching system and allied SX-EW plant. Sulfide ore from Sierrita and Twin Buttes was processed at the Sierrita concentrator into copper and molybdenum concentrates. About 42% of ore fed through the concentrator was from Twin Buttes. Twin Buttes oxide ore, however, was processed at Twin Buttes via agitated leach at the Twin Buttes SX-EW plant. This year was the last for Twin Buttes oxide ore, and in December the agitation leach plant closed. Electrowon cathode production was 17.4% of total copper production from Sierrita and Twin Buttes. In regard to 1992 copper output, Sierrita ranked sixth in the Nation and fourth in the State. Twin Buttes was 15th in the United States and 10th in Arizona.

Cyprus' Bagdad Mine, seventh in the United States and ranking fifth among Arizona's copper mines, continued to produce copper with byproduct molybdenum and silver. The Bagdad facility (Yavapai County) included an open pit mine, a 68,000-metric-ton-per-day sulfide ore concentrator, and an oxide dump-leaching system and SX-EW plant. The Bagdad SX-EW facility was the second largest SX-EW facility in the country. Copper production during 1992, according to Cyprus' Form 10-K, was essentially identical to that for 1991: about 99,600 metric tons (109,800 short tons). About 8.8% of that amount was electrowon copper cathode. Cyprus announced it would invest $54 million over the next 3 years in a cogeneration plant and improvements to the Bagdad mill. In return, the company expected companywide cost savings of about $0.02 per pound.

Cyprus' Miami Mine (Gila County) consisted of an open pit mine, heap leaching and an associated SX-EW plant, a smelter (410,000-metric-ton or 450,000-short-ton nameplate capacity) and acid plant, an electrolytic refinery, and a rod mill. Cyprus Miami's 1992 copper output was almost unchanged from that of 1991—57,100 metric tons (63,000 short tons) of copper cathode. The mine ranked 11th in the country and 8th in the State for 1992. Cyprus restarted its Miami smelter in March after a November 1991 fire idled the installation. As a function of the smelter shutdown, Cyprus' Miami smelter processed only 300,000 metric tons of concentrate during 1992. The fire hastened a $100 million smelter modernization that included installation of an ISASMELT system, developed in Australia at the Mount Isa Mine. Cyprus' Miami smelter conversion marked the first use of the ISASMELT process in the United States. The new furnace began operation in June and will achieve full capacity by mid-1993. According to Cyprus, the new furnace will reduce copper production costs $0.05 per pound, increase smelting capacity to about 590,000 metric tons (650,000 short tons) of concentrate per year, and make Cyprus self-sufficient in smelting. In addition, Cyprus announced it would spend $83 million on improvements to the Miami refinery to expand its capacity and lower production costs. The Miami rod plant produced at 93% capacity or about 114,000 metric tons (126,000 short tons) of rod in 1992, primarily produced from Cyprus cathode.

Cyprus' Casa Grande operation on the Tohono O'Odham Indian Nation land in Pinal County consisted of an underground mine and two concentrate roasters that, together, have the capacity of processing 136,000 metric tons (150,000 short tons) of copper concentrate annually. The Casa Grande facility roasted copper concentrates from other Cyprus operations and its SX-EW plant processed solutions from leaching roasted calcines and in situ underground leaching. The company continued to assess the feasibility of copper production from open pit mining and heap leaching. As ranked by output, Casa Grande was 25th in the Nation and 16th in Arizona in 1992.

Cyprus also leached dumps and operated a copper precipitation plant at its Mineral Park Mine (Mohave County). According to the company's 1992 Form 10-K, Mineral Park produced 1,800 metric tons (2,000 short tons) of copper, an increase of 8% over 1991 production.

Magma Copper Co. operated the underground and open pit San Manuel Mine, the open pit Pinto Valley deposit, a leach operation at Miami, and the underground Superior Mine. Magma had Arizona's third largest copper production for 1991.

When Magma separated in 1987 from Newmont Mining Corp., it was regarded by some to be a high-cost, debt-ridden orphan and a fading force in the mining industry. Beginning with meetings in 1989 between labor and management, Magma evolved into an efficient copper producer and a business-climate pioneer. By 1992, the company's internal transformation has been proven by tangible improvements in cost efficiency and safety. For example, at the onset of an October 1990 management-labor effort to evaluate the feasibility of developing the lower Kalamazoo ore body, the mining rate at San Manuel was 1,000 short tons of ore per day. By November, 2 months ahead of schedule, the production rate had jumped to 6,000 tons per day. The Kalamazoo evaluation program reduced production costs from $6.80 to $5.25 per short ton of ore hoisted to the surface. During 1992 the company achieved its production cost goal of $4.00 per ton and, at the same time, increased productivity by 7%. Magma was also the first U.S. mining company to implement a jointly designed gainsharing plan. In January, smelter and refinery employees received their first quarterly bonus checks, based on production gains in the final quarter of 1991 (San Manuel Mine and concentrator workers had received their first checks in 1991). Each check was about 10% of wages earned during the final quarter of 1991 and fell in the range of $600 to $800. During 1992, the San Manuel open pit won the Sentinels of Safety Award from the Mine Safety and Health Administration and the American Mining Congress for the safest U.S. open pit operation during 1991. The

approximately 225 open pit employees had worked 484,885 hours without a lost-time accident.

Magma's San Manuel was the largest underground copper mine in the United States and, according to USBM data, continued to rank third in the country in production terms and second in the State (the Arizona Department of Mines and Mineral Resources ranked it third, however, after Asarco's Ray operation). The San Manuel facililty included the underground block caving mine, open pit in situ leach operation, heap-leach operation, smelter, refinery, and rod plant. According to Magma's Form 10-K, San Manuel produced 99,700 metric tons (109,900 short tons) of copper from the underground operation and an additional 52,500 metric tons (57,900 short tons) from heap leaching, in situ mining, and other production. The open pit recorded a 29% production increase from that of 1991.

Block caving at San Manuel began in 1956 on the first level, or the 1,415-foot grizzly and 1,475-foot haulage levels. After 18-years of production, mining ended in October from the fourth grizzly and haulage levels: the 2,315- and 2,375-foot levels. Cumulative production by the end of October from the 1,400, 1,700, 2,000, 2,300, and 2,600 paired levels was more than 3.35 million metric tons (3.7 million short tons) of contained copper. During 1992, ore was still being produced from the fifth, and lowest, levels: the 2,615- and 2,675-foot levels, expected to be depleted in 1997. Facing reserve depletion, company officials watched San Manuel's mining costs move downward and continued to weigh the option of mining the lower Kalamazoo ore body. The San Manuel underground mine, according to Magma, is the State's largest consumer of cement, which is used for ground support.

Magma received installation permits from the Arizona Department of Environmental Quality for the major components of the company's proposed $100 million San Manuel smelter expansion program. As proposed, the program would involve the addition of a third unit to its sulfuric acid plant, enlarging a convertor furnace, improvements to the anode preparation facility, and construction of a plant to leach flue dust recovered from smelter stack gasses. The new facilities were expected to make smelter operation more efficient, improve its environmental compliance, and boost output by 54,000 metric tons (60,000 short tons) of copper by 1994. The San Manuel smelter is the largest and most modern smelting and refining complex in the country. With a rated production capacity of 910,000 metric tons (1 million short tons) of copper concentrate per year, the San Manuel smelter represented 25% of U.S. smelting and refining capacity.

The Pinto Valley open pit (Gila County) moved up from ninth to eighth in the United States in copper production and remained sixth among Arizona copper mines. Pinto Valley, according to Magma's 10-K form, produced 73,400 metric tons (81,000 short tons) of electrolytic (refined) cathode copper plus 17,100 metric tons (18,900 short tons) of electrowon copper cathode from its dump, tailings, and in situ leaching.

Magma's Superior Div. (or Magma Mine) contributed 11,100 metric tons (12,300 short tons) of copper to the State total, esssentially the same as 1991 production. The Superior underground operation was 17th in the country and 11th in the State. The company's Magma Mine at Superior reopened in 1990 after being in continuous operation from 1912 to 1982. Copper sulfide replacement ore was produced using undercut and fill methods. Magma's Superior Div. underwent a major exploration drilling program during 1992 to improve output and reduce production costs.

Magma's Miami operation (Gila County) produced 8,800 metric tons (9,750 short tons), almost identical to 1991 production. Materials leached at Miami included block-caved rubble in the depleted underground mine and concentrator tailings. In terms of 1992 production, Magma's Miami unit was 18th in the Nation and 12th among Arizona copper-producing mines.

Asarco completes the list of major copper mining companies in Arizona. In late 1992, Asarco announced it would unite its Texas smelter and refinery operations with its Arizona and Montana copper operations into the Southwest Copper Div., headquartered in Tucson. The Asarco Tucson office now oversees 3,500 workers, including 2,200 in Arizona. Asarco's mines included its open pit Ray Mine and the open pit Mission complex. Asarco also operated a smelter in Arizona at Hayden. The company finished its expansion program at Ray ahead of schedule, on the heels of the late 1991 completion of modernization at Mission.

During the year, a new labor contract was signed affecting Asarco employees in Arizona, Montana, and Texas. The new agreement affected Arizona workers at Mission, Silver Bell, and Hayden and provided for wage increases totaling $1.30 over the next 3 years and improved 401K and bereavement benefits. Unions participating in the new contract included the United Steelworkers of America, the International Brotherhood of Electrical Workers, the Teamsters Union, and the International Union of Operating Engineers.

In U.S. production terms, Asarco's Ray Mine (Pinal County) moved up from seventh to fourth during 1992. According to USBM production data, the mine was Arizona's third largest copper mine, behind only Morenci and San Manuel (however, according to data collected by the Arizona Department of Mines and Mineral Resources, Ray was second in the State). Asarco's Ray unit consisted of an open pit mine, dump and heap-leach operations, an SX-EW plant at Ray, and a concentrator at Hayden. Ray experienced higher operating costs and a production shortfall as a result of startup delays and from weather-related disruptions. Total recorded 1992 precipitation in the Ray area (which averages 17 inches per year) was 36 inches, 8 inches in December alone. In spite of the deluge, a $224 million expansion at Ray was completed in 1992 and boosted copper yield to 150,000 metric tons (165,000 short tons) from the 106,400 metric tons (117,300 short tons) produced in 1991. Although the keystone

piece of the expansion project was installation of a new $100 million concentrator, improvements also included addition of a tailings impoundment, an in-pit crusher, a conveyor system, and an expanded haulage truck fleet. The new mill was rated at a 27,000-metric-ton-per-day (30,000 short-ton-per-day) capacity. Expansion allowed Asarco to add 300 new employees and absorb many laid-off workers from Phelps Dodge's Tyrone and Molycorp's Questa Mines in New Mexico. As a function of the capital improvements and lowering the cutoff grade to 0.3% copper, Asarco announced a new reserve total for Ray in 1992: 1.1 billion short tons (998,000 metric tons) of 0.63% copper, a two-thirds increase. The larger reserve estimate added Ray to the select list of U.S. copper mines in the billion-short-ton-plus class (the only others being Kennecott Copper Corp.'s Bingham Canyon operation and Phelps Dodge Corp.'s Morenci complex).

Production from Asarco's Hayden INCO flash furnace (Gila County) broke last year's record production of 167,000 metric tons (184,000 short tons) to produce 189,000 metric tons (208,400 short tons) of contained metal from concentrate. During the year, Asarco achieved self sufficiency in supplying its smelters with concentrates from its own operations.

Asarco's Mission complex advanced a notch to ninth in the Nation and remained the State's seventh largest copper producer. Mission consisted of the consolidated operations of the Mission, Eisenhower, San Xavier, and Pima open pits. The mine, in Pima County south of Tucson, produced 93,000 metric tons (103,000 short tons) during 1992, 16% higher than 1991 output. Expansion at Mission, completed in late 1991, contributed the production increase.

Asarco's Silver Bell Mine continued to be on standby, although the company still produced a small amount of copper from dump leaching and a precipitation plant. Silver Bell ranked 23d in the United States and was 14th in the State. The company planned to finish a new SX-EW facility at Silver Bell by 1994.

Arimetco International Inc. (Arizona Metal Co.), a Canadian company headquartered in Tucson, continued mining the Johnson open pit (Cochise County) about 60 miles east of Tucson. All cathode from the Johnson property was sold to Billiton Metals Inc. under a 5-year contract. Mining of the Burro Pit was expected to continue through 1993. According to Arimetco's 1992 annual report, Johnson produced 3,700 metric tons (4,100 short tons). According to USBM data, Johnson ranked 21st in the country and 13th in the State.

By midyear, Arimetco had finished constructing a 4-metric-ton-per-day (4 short-ton-per-day) SX-EW plant and began producing copper from the Emerald Isle Mine (Mohave County). Emerald Isle produced 260 metric tons (290 short tons) of cathode during 1992.

Oracle Ridge Mining Partners continued to operate the Oracle Ridge Mine, owned 70% by South Atlantic Ventures Ltd. and 30% by Continental Materials Co. The underground mine, in the Santa Catalina Mountains northeast of Tucson, shipped its concentrates to Asarco's Hayden smelter. Oracle Ridge comprises the Hartman, Geeseman, Daily, and Leatherwood workings. According to the company, proven and probable reserves were about 3.6 million metric tons (4 million short tons) grading 2.35% copper using a cutoff of 1.5%; the property contained an additional 3.6 million metric tons of possible reserves.

In 1992, the Arizona Copper Co. (Azco Mining Inc.) issued draft and final environmental impact statements (EIS) for the Sanchez Mine, a proposed open pit heap-leach copper mine 10 miles northeast of Safford (Graham County). If it obtained all permits, the company anticipated it could begin plant construction as early as March 1993 and mine startup could be as early as 1994. A final feasibility study issued by Fluor Daniel Wright established a minable reserve of 173 million metric tons (191 million short tons) grading 0.317% copper per ton with a mine life of 20 years. The mine will employ 210 people with an annual payroll of $8.15 million. Azco awarded Davy McKee Corp. the contract for all engineering, procurement, and construction management services. The San Carlos Apache Tribe sought to delay construction until the company investigated mining impacts on the Gila River. The proposed Sanchez Mine is adjacent to Phelps Dodge's Lone Star copper property.

Cambior, through its subsidiary Carlota Copper Co., announced plans for a new copper mine (Gila County) in Tonto National Forest. Cambior completed an 18,700-foot drilling program to further evaluate its Carlota project (Gila and Pinal Counties) in the Globe-Miami district in east-central Arizona. Drilling results increased probable reserves on the property to more than 91 million metric tons (100 million short tons) grading 0.45% copper. Metallurgical and column leaching tests were made to characterize different ore types. The company indicated it would recover an average of 27,000 metric tons (30,000 short tons) annually by SX-EW from three pits: the Carlota/Cactus pit, and the smaller Eder North and Eder South pits. Assuming the company obtained all the necessary permits, commercial production could commence as early as the first part of 1995 according to Cambior's annual report. All production would be by SX-EW. Cambior was the sole owner of the property, acquired from Westmont Mining Co. in 1991. Situated mostly on Tonto National Forest, Carlota is 4 miles west of Miami and just west of Magma's Pinto Valley operation. Mine planners encountered the local opposition and land use controversy that has become predictable features of permitting mines in the developing west. Some residents expressed concerns regarding the mine, including fears of water table lowering and ground water contamination.

Gold.—Arizona ranked eighth of 13 States in 1992 lode gold output. Average gold price was $344.95 per troy ounce in 1992, compared with the average price in 1991 of $363.29. The State's gold output in 1992 was 6,656 kilograms, up from the revised 1991 total of 6,195 kilograms. Gold was recovered at 14 Arizona mines, and most production, by far, came from

La Paz County. For its final production year, Cyprus' Copperstone Mine (La Paz County) led all other State gold producers. Completing the rollcall of top five Arizona gold producers were: Magma's McCabe Mine (Yavapai County), San Manuel operation (Pinal County), Magma's Superior Div. (Pinal County), and Phelps Dodge's Morenci operation (Greenlee County). Nine other mines produced gold, including A.F. Budge Co.'s United Verde Extension property (Yavapai County), Asarco's Ray Unit (Pinal County), Asarco's Mission complex (Pima County), Cyprus' Sierrita operation (Pima County), Fischer-Watt Gold Co. Inc.'s Mystic Mine (Maricopa County), Magma's Pinto Valley operation (Gila County), Queenstake Resources Ltd.'s Gold Prince property (Cochise County), Republic Goldfields Inc.'s Congress Mine (Yavapai County), and Oracle Ridge Mining Partners' Oracle Ridge Mine (Pima County). Although there were certainly other small placer operations and recreational production, placer gold was reported to the USBM by only one company, Fayro Mining Co., that recovered gold from stream gravels in Mohave County.

According to its Form 10-K, Cyprus Minerals Co. produced 3,614 kilograms (116,200 troy ounces) from its Copperstone Mine in La Paz County during 1992, the last year of mine operation. Ore depletion and mine closure occurred in December. Arizona's largest gold mine, and the Nation's 22d largest, Copperstone, began operation in 1987. Although it began reclamation of the site, the company expected to process stockpiled low-grade ore until April 1993.

After acquiring the McCabe Mine from Stan West Mining Corp., Magma began mining and milling in 1992, during which it shipped gold concentrates to the San Manuel smelter. The company continued an underground exploration program to increase minable reserves. The McCabe underground operation was in Yavapai County, about 18 miles southeast of Prescott. Production occurred from four levels and was about 600 kilograms (20,000 troy ounces) during 1992. In comparison, 1991 production was 121 kilograms (3,900 troy ounces) of gold from concentrate shipped to the San Manuel smelter.

During September, Republic Goldfields Inc.'s Congress Mine (Yavapai County) was placed on standby, a status it kept through the end of 1992. The decision to place the mine on standby status affected about 50 employees. Only 15 months of underground reserves remained at the time of shutdown. Coupled with declining gold prices, Republic Goldfields Inc. indicated the mine could not generate enough cashflow to fund exploration and develop new reserves. While it continued to process old tailings, the company began working on developing the reserve base to a minimum of 5 years ahead of mining. According to Republic Goldfields Inc.'s Annual Report, the mine produced 280 kilograms (9,100 troy ounces) in 1992.

During spring 1992, Fischer-Watt Gold Co. Inc. announced the first mill production from the Mystic Mine facility northwest of Phoenix when it shipped 12 kilograms (367 troy ounces) of doré gold to Handy & Harman for refining and sale. The company changed its operations in April and began transporting ore to Republic Goldfields' mill at Congress instead of using its own gravity plant. Mining was completed in September. Since the onset of mining on the property in October 1991 to its end, Mystic produced 130 kilograms (4,200 troy ounces) of gold according to Fischer-Watt's Form 10-K. Fischer-Watt also owned one patented and two unpatented claims in the Oatman District (Mohave County) that it leased to Sun River Gold, Ltd.

Pima Mining Co. filed a draft environmental assessment for the Newsboy Mine, its proposed gold mine and 1,500-metric-ton-per-day mill south of Wickenburg. Newsboy reportedly contained minable reserves in two pits of 1.35 million metric tons grading 1.7 grams per ton. By yearend, BLM had not determined whether it would require an EIS, which was demanded by a vocal group of opponents.

Molybdenum.—Molybdenum prices continued to be weak because of poor steel industry demand. All of Arizona's molybdenum production was as a byproduct of copper production, and, therefore, was insensitive to continuing low molybdenum price levels. Of six remaining "moly" producing States, Arizona was second, in a neck-and-neck race with primary molybdenum producers in Colorado. Molybdenum output dropped 13%; the metal was recovered at Morenci, San Manuel, Sierrita-Twin Buttes, Bagdad, and Pinto Valley.

Cyprus' Sierrita led the State in molybdenum production. In its Form 10-K, Cyprus indicated Sierrita-Twin Buttes' 1992 production amounted to 7,000 metric tons (7,700 short tons), a drop of 10% from last year's total. Cyprus operated two molybdenum roasters at Sierrita in Pima County to process three-fourths of the company's molybdenum concentrate production from Sierrita-Twin Buttes, Bagdad, and its Thompson Creek molybdenum mine in Idaho. In second place among State molybdenum producers, Cyprus Bagdad produced 4,500 metric tons (5,000 short tons) of molybdenum, a 15% decrease from 1991.

According to its 1992 Form 10-K, Magma Copper Co.'s combined sales of molybdenum disulfide amounted to 2,400 metric tons (2,600 short tons), essentially the same production total as for 1991.

Silver.—Arizona remained fifth among the Nation's 18 States having 1992 silver production. State production rose to 165 metric tons (5.3 million troy ounces) from the 1991 total of 148 metric tons (4.8 million troy ounces). Arizona had seven mines among the top 25 silver producers in the United States, including Asarco's Mission complex (13th), Asarco's Ray unit (17th), Phelps Dodge's Morenci complex (20th), Cyprus' Bagdad Mine (21st), Magma's San Manuel operation (22d), and Magma's Pinto Valley operation (25th). Collectively, these six primary copper mines supplied 85% of Arizona's total silver production. Arizona's 1992 output equated to 9% of the U.S. total for silver. During 1992, 15 mines in Arizona produced silver as a primary product or byproduct, most of

which came from Pima and Pinal Counties. Only three of Arizona's silver producers were primary precious-metal mines: Cyprus' Copperstone Mine (La Paz County), Magma's McCabe Mine (Yavapai County), and Republic Goldfields Inc.'s Congress Mine (Yavapai County). Average price for silver during the year was $3.94 per troy ounce, down from 1991's average price of $4.04.

Other Metals.—The State continued to be an important or unique supplier of certain metals, including lead, rhenium, and tin. Additionally, two companies investigated potential sites in the State as locations for steel minimills to be fed with scrap iron.

Asarco continued to recover byproduct lead from its Mission copper ores. During 1992, Mission placed 20th in the country of U.S. lead-producing mines.

Arizona continued to be the only U.S. rhenium producer, which was recovered by scrubbers at Cyprus' Sierrita molybdenum roaster. Rhenium, which occured as a trace element associated with molybdenum, was recovered as pelletized ammonium perrhenate. The metal has two main uses: in high-temperature alloys for jet engine components and combined with platinum as a catalyst to produce lead-free, high-octane gasoline.

Birmingham Steel Corp. applied for a permit from the Arizona Department of Environmental Quality to build a steel minimill near the Palo Verde Nuclear Power Plant west of Phoenix. The $100 million facility would employ about 250 and would recycle scrap. If built, the plant would produce about 700,000 short tons of steel per year. According to the Arizona Department of Mines and Mineral Resources, North Star Steel also announced its desire to construct a steel minimill in Mohave County.

Tin production was reported from the Cheops Mine (Graham County) by Wilkins Exploration and Development Inc.

Industrial Minerals

Cement.—Arizona remained 17th of 37 States that reported portland cement production for 1992. Output remained essentially the same as estimated data for 1991. Production of masonry cement rose about 16%, reversing a downward trend begun in 1987. Arizona was 19th among 36 States that manufactured masonry cement.

Two companies continued to manufacture cement: (1) Arizona Portland Cement Co. (a subsidiary of California Portland Cement Co.), which produced cement from its plant and quarry at Rillito, north of Tucson (Pima County), and (2) Phoenix Cement Co. (owned by the Pima and Maricopa Tribes), which operated a plant at Clarkdale (Yavapai County).

Clays.—Arizona continued to supply three clays: ball clay, bentonite, and common clay. To protect production figures of the State's two bentonite producers, only the total for common clay is published in table 1.

One company, McKusick Mosaic Co., mined a small quantity of ball clay (used to make tile, wind chimes, cosmetic additives, sealant, and slip glazing material) at its Weary Lode Mine near Globe (Gila County).

Calcium bentonite continued to be produced by two Apache County companies: Englehard Corp. and United Catalysts Inc. Arizona dropped a notch to eighth of 13 States that produced bentonite. According to the Arizona Department of Mines and Mineral Resources, Englehard shipped its product east for processing into oil refinery catalysts and as a clarifier for oils. United Catalysts shipped raw clay mined near Sanders to a plant near Belen, NM, for processing into dessicants.

Four companies reported common clay production for 1992 (listed in order of decreasing production): Clinton-Campbell Contracting Inc. (owners of the Phoenix Brick Yard), Phoenix Cement Co., Magma Copper Co., and Pantano, a subsidiary of California Portland Cement Co. As reported to the USBM, Yavapai, Maricopa, Pima, and Pinal Counties (listed in decreasing order of production) supplied common clay in 1992. Most such material was used in the manufacture of structural clay products or as a source of alumina for cement clinker. Additionally, Building Products Co. continued to mine clay from three mines (Maricopa, Navajo, and Yavapai Counties) to supply material for its extruded clay sewer pipe factory in Phoenix. GSA Resources Inc. also mined hectorite near Kirkland (Yavapai County) and a saponite clay near Bagdad (Mohave County). According to the Arizona Department of Mines and Mineral Resources, GSA's hectorite was used to make pharmaceuticals (as a thickening agent); its saponite was shipped out of State for use in detergents and to remove ink from paper pulp to make white paper made from recycled paper fibers.

The Pantano Wash area in Pima County continued to provide almost one-half the clay mined in Arizona, according to the Arizona Department of Mines and Mineral Resources. The Pantano material has been called the only high-alumina clay in the State suitable for making high-quality face brick. Pantano clays supplied "fire clay," mixed kaolinite-illite clay minerals usable as a skeleton former and self-fluxing glass former in structural clay products. Where used for bricks and tile, it was also the dominant coloring agent. Clinton-Cambell Contracting Inc., which operated the Phoenix Brick Yard, produced structural clay products (bricks). The company mined clay filler at Tolleson in Maricopa County and blended it with Pantano Wash material that was hauled to Phoenix from 140 miles away. The Pantano deposit also was one of the alumina sources for Arizona Portland Cement's Rillito plant.

Gemstones.—In 1992, 10 States continued to account for 83% of U.S. natural gemstone output. Arizona continued to be an important supplier of gemstone materials on a national scale. During 1992, the State ranked third (after Tennessee and California) in production of gemstones, of which Arizona yielded the greatest variety. Its products included agate (particularly fire agate), amethyst, azurite, chrysocholla, fluorite, garnet, jade, jasper, malachite, obsidian (Apache

tears), onyx, peridot, petrified wood, precious opal, shattuckite, smithsonite, and turquoise. Arizona continued to lead the country in the value of its output of turquoise, peridot, petrified wood, and azurite-malachite; collectively, these gems accounted for in excess of 90% of State gem value. Furthermore, in terms of value, Arizona's turquoise and peridot continued to lead the world. Four manufacturers in Arizona produced synthetic or simulated gems valued at approximately $1.8 million. The 4 firms were among only 14 in the country, and Arizona ranked third of 8 States recording such production in 1992.

Gypsum.—Arizona continued to produce gypsum for making wallboard, portland cement, and for use as a soil amendment. The State was 10th of 19 States that reported 1992 crude gypsum production. Production and value for 1992 were higher by 21% and 15%, respectively. Ranked in decreasing order of 1992 production, four companies reported crude gypsum production: National Gypsum Co. (Pinal County), Western Gypsum Co. (Mohave County), Superior Companies (Pinal and Yavapai Counties), and Pinal Gypsum Co. (Pinal County). According to the Arizona Department of Mines and Mineral Resources, Western Organics also produced gypsum at its mine in La Paz County.

National Gypsum was, by far, the State's largest producer. The company also calcined gypsum at its wallboard plant in the Phoenix area in Maricopa County. According to the company's Form 10-K, its Arizona quarry produced 92,000 short tons during 1992; estimated reserves were given as 23.3 million tons. National Gypsum filed for protection under chapter 11 of the U.S. Bankruptcy Code in October 1990 to reorganize $1 billion in debt. In December, the company and and its bondholders each presented a reorganization plan at U.S. Bankruptcy Court hearings in Dallas. National Gypsum's plan would have placed about 30% of its common stock in the hands of its bondholders, whereas the bondholder's plan would have distributed nearly all the common stock to the bondholders. The Dallas U.S. Bankruptcy Court judge rejected the bondholder's plan and was expected to rule on the company proposal in January 1993.

Lime.—Lime was produced by only two companies in the State, and only one produced it commercially. Overall State lime production rose 7% during 1992, and Arizona continued to be ninth of 32 producing States. Chemstar Lime Inc. manufactured quicklime and hydrated lime at its Nelson plant in Yavapai County, the eighth largest lime plant in the United States. The company also produced quicklime at its plant near Douglas (Cochise County). Magma Copper Co. also made lime for its internal use at the San Manuel operation (Pinal County).

Perlite.—In 1992, Arizona continued to follow only New Mexico of six States reporting perlite production. State output rose 21% during the year; at the same time, value increased a healthy 44%. Harborlite Corp. and the Nord Perlite Co. were the State's only two producing companies. Each operated a surface mine near Superior in Pinal County. Using perlite shipped from other States, Therm-O-Rock Industries Inc. in Maricopa County expanded perlite for horticultural aggregate and for mineral fillers.

Pumice.—Arizona remained fifth of six States with reported 1991 pumice production. Tufflite Inc. produced pumice from its mine near Flagstaff (Coconino County) for stonewashing and horticulture, and, according to the Arizona Department of Mines and Mineral Resources, also for use as lightweight ready mix concrete and concrete block.

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimated data. This chapter contains estimates for 1991 and actual data for 1990 and 1992. Compared to 1990 data, State sand and gravel production increased 7% in 1992, growing to 33.8 million short tons. Value also rose about 10%. Arizona's aggregate business grew 10% to 15% during the year, thanks to a decline in interest rates and growth in the market for single family residences. The new Intermodal Surface Transporation Efficiency Act (enacted in 1991) also promised to channel Federal monies into new Arizona highway construction.

In decreasing order of production, Arizona's largest producers of construction sand and gravel were, for 1992: The Tanner Cos. (a subsidiary of Ashland Oil Inc.), CalMat Co. (a subsidiary of California Portland Cement Co.), Salt River Sand and Rock Co., Sunward Materials Co., (a subsidiary of Blue Circle West Inc.), and Peter Kiewit and Sons Co. (a subsidiary of Union Rock and Materials Corp.). Maricopa was, by far, the leading county, followed by Pinal, Pima, and Mohave Counties. As in most States, the majority of Arizona's construction sand and gravel was used as concrete and asphaltic aggregate, for road base and fill, and for plaster or gunite sands. Rarely, such substances were used as filtration media or for railroad ballast.

As population growth occurs in the west, companies producing aggregate continued to experience conflicts with their neighbors. Aggregate has a low unit value, is expensive to transport, and must be mined near its customers who often do not appreciate the tradeoff of a nearby unaesthetic mine for their roads, homes, buildings, parking lots, and sidewalks. Attempts to expand existing quarries and permit new ones often triggered local hostility. CalMat, for example, finally withdrew a request for expansion of its sand and gravel operation in Mesa after intense local opposition. Residents of Peoria, in the northwestern Phoenix metropolitan area, protested blasting noise from a rhyolite quarry owned by Arizona Quality Granite Co. In this case, however, the owner contended that some explosions were not

TABLE 2
ARIZONA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	9,422	$38,149	$4.05
Plaster and gunite sands	1,654	11,387	6.88
Concrete products (blocks, brick, pipe, decorative, etc.)	W	W	4.24
Asphaltic concrete aggregates and other bituminous mixtures	2,710	10,796	3.98
Road base and coverings[1]	7,409	19,379	2.62
Fill	2,757	5,274	1.91
Railroad ballast	W	W	6.93
Other miscellaneous uses[2]	305	1,801	5.90
Unspecified:[3]			
Actual	7,658	28,070	3.67
Estimated	1,927	8,661	4.49
Total	33,842	123,517	3.65
Total[4 5]	30,701	123,517	4.02

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

from quarrying operations but from bombs intended to sabatoge the operation. The Arizona State Mine Inspector provided the company with blasting guidelines to halve the intensity of explosions and promised to monitor the site for vibrations, dust, and noise.

Industrial.—Two companies mined industrial sand in Arizona. State production of industrial sand rose 64% for 1992. Arizona Silica Sand Co.'s mined silica sand at its Houck Mine (Apache County). The company marketed its product both domestically and around the world for hydraulic fracturing, for ground fillers, for blasting, as refractory sand, and for molding sand. Silica Mines Inc. produced silica sand at its mine near Oracle (Pinal County) and sold its product to Asarco's Hayden copper smelter as siliceous convertor flux.

Stone.—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—Relative to 1991 figures, production and value of Arizona's crushed stone was estimated to have fallen in 1992. Construction surges occured in the form of increased single housing starts and highway construction particularly in the Phoenix metropolitan area.

Two companies in Arizona—Specialty Minerals Inc. and Georgia Marble Co. Inc.—continued to produce finely ground calcium carbonate for functional fillers. During late December 1991, Pfizer Inc.'s Mineral Div. acquired Calcium Products Co.'s Santa Rita quarry and marble filler mill in the Santa Rita Mountains south of Tucson. After passing through a corporate readjustment, Pfizer operated the mine and plant as Specialty Minerals Inc., a subsidiary of Minerals Technologies Inc. During August, Pfizer offered a majority interest of the new corporation to the public, indicating that the quarry did not fit the company's strategic plan. It planned to retain 40% of the stock in Mineral Technologies Inc. During 1992, about half of a $6 million expansion project was completed at the quarry and plant. Improvements included rebuilding two Raymond mills and installing a sand circuit to supply coarse material for cultured marble and animal feed. The company continued to supply finely ground filler for wallboard joint compound and planned to market its material also for sealants, plastics, stuccoes, and grouts. Pfizer also produced coarser limestone for the decorative rock, asphalt, and construction industries.

Georgia Marble Co. Inc. owned the Andrada Marble Co. and operated the Andrada quarry in Pima County near Tucson. In early 1992 Georgia Marble completed a new processing plant at the quarry. Its products were similar to those of Pfizer: sized marble for landscaping, pool plaster, and livestock feed supplement in addition to fine-ground calcium carbonate for functional fillers.

Dimension.—According to the State Department of Mines and Mineral Resources, several dimension stone companies were active in Arizona during 1992. These included: American Sandstone (a division of Blaser Corp.), Anasazi Co., Halquist Stone Co., Inc. (Apache Stone Division), Drake Stone Products, Dunbar Stone Co., Harley Gray Stone Co., Hudman Stone, Outland Resources Inc., and Western States Stone Co. The companies quarried sandstone, marble, and schist in Coconino, La Paz, Maricopa, and Yavapai Counties. Products included facia, tiles, blocks, and shaped stone.

Other Industrial Minerals.—Arizona mineral companies produced or were developing a wide variety of other industrial minerals, including diatomite, specular hematite, nitric acid, pyrites, salt, slag, sulfuric acid, tailings processed for soil amendment, exfoliated vermiculite, and zeolites.

During spring 1992, Arimetco

TABLE 3

ARIZONA:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	438	2,172	401	2,461	8,583	33,516
Plaster and gunite sands	41	375	15	71	1,597	10,941
Concrete products (blocks, brick, etc.)	W	W	—	—	W	W
Asphaltic concrete aggregates and other bituminous mixtures	217	1,204	176	444	2,117	8,797
Road base and coverings[2]	851	2,409	581	1,960	5,898	14,890
Fill	174	719	80	174	2,503	4,382
Railroad ballast	—	—	—	—	W	W
Other miscellaneous uses[3]	45	315	—	—	259	1,486
Unspecified:[4]						
Actual	1,063	4,923	212	317	6,384	22,830
Estimated	336	1,323	151	783	1,440	6,554
Total[5]	3,164	13,441	1,616	6,211	28,781	103,396
Total[6 7]	2,870	13,441	1,466	6,211	26,110	103,396

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Excludes 280,000 short tons valued at $470,000, not reported by county.
[2]Includes road and other stabilization (cement and lime).
[3]Includes filtration.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value in thousand metric tons and thousand dollars.

International Inc. formed an industrial Minerals division after acquiring a 3,100-acre diatomite property from the University of Arizona. The Whitecliffs diatomite deposit (Pinal County), near San Manuel, is the largest known diatomite deposit in the State and, according to the company, contained a 30-year reserve base. The mine ceased production in mid-1990, when it was operated by Whitecliffs Industries. Test runs began at an existing plant, which was refurbished during the year. Arimetco planned to produce several grades of diatomite by capitalizing on Arizona's dry climate and solar drying. It was anticipated that the diatomite would be used in insulation and as a filler-extender.

Swansea Minerals Inc. continued to report production of a small amount of specular hematite from tailings at the Swansea Mine (La Paz County). Its product was used to produce pigments.

Apache Nitrogen Products, Inc.'s St. David facility (Cochise County) supplied ammonium-based explosives to regional mines as well as urea and ammonium nitrate liquid fertilizer for the agricultural industry.

Magma Copper Co. reported production of pyrites from its Superior operation in Pinal County as an ore concentrate in 1992. Arizona was the only State in the country that reported such production. The company marketed its pyrites as a source of high-quality sulfuric acid. The pyrites were marketed as a source of iron for brown glass.

Arizona remained 12th of 14 salt-producing States. Morton International Inc. continued to be the State's only salt producer during 1992. Morton mined salt from its Southwest Salt Mine, a solution mining-solar evaporation operation in Glendale in Maricopa County. Most of Morton's output was used as a water softener and for animal consumption; a small amount was marketed to a local pickle company; none went for "round cans" sold in supermarkets. According to the company, it is the only U.S. plant that wet harvests its product. Production decreased in 1992. Morton reported in its annual report that the company responded to increased environmental concerns by lining the solar evaporation ponds with protective linings. A new laser system also was installed to enable uniform harvesting and an improvement in salt quality.

According to the Arizona Department of Mines and Mineral Resources, Minerals Research and Recovery, Inc. of Tucson recovered and processed copper smelter slag for roofing granules, abrasives, filtration media, nuclear shielding, and ship ballast from the slag pile of Phelps Dodge's now idle New Cornelia Smelter at Ajo (Pima County). The company marketed its product in the United States and throughout the world.

Arizona remained the largest producer of byproduct sulfuric acid, all generated at the State's copper smelters and roasters. Most such acid was used by the copper industry for leaching ore.

Sulfuric acid prices, like those of sulfur, were severly depressed during the year.

Ironite processed and blended tailings at its plant in Humboldt (Yavapai County) from the defunct Iron King Mine's zinc-copper beneficiation mill to make soil supplements.

Arizona jumped to 6th (from 10th) of 18 producing States in 1992 production of exfoliated vermiculite. Therm-O-Rock Industries and W. R. Grace and Co. exfoliated vermiculite at their plants in Maricopa County. Both companies sold material used mainly as a soil conditioner and for loose-fill and block insulation. A small amount was sold as lightweight aggregate for concrete and as a mineral filler.

GSA Resources Inc. and UOP Inc. (a parnertship between Union Carbide Corp. and Allied Signal Inc.) produced the zeolite chabazite from the Bowie deposit that straddles the Cochise-Graham County line. Based on their combined production, Arizona was fifth of seven producing States in 1992 zeolite production. UOP processed the zeolite into specialty molecular sieve products at the company's plant in Mobile, AL.

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[1]State mineral specialist, U.S. Bureau of Mines, Denver, CO. She has 14 years of government and industry experience.

[2]Director, AZ Dep. Mines and Miner. Resour., Phoenix, AZ.

[3]Leaming, G. F. The Copper Industry's Impact on the Arizona Economy 1992. WEAC. Apr. 1993. Available from the AZ Mining Association.

[4]Work cited in footnote 3.

[5]Much information in this section came from Niemuth, N.J., State Activities—Arizona. Min. Eng.—Annual Review 1992, May 1993 and from M. S. Fulp's exploration reviews for the southwestern U.S. in the Society of Economic Geologists quarterly newsletter.

[6]Coal Production. Energy Information Administration. Oct. 1993.

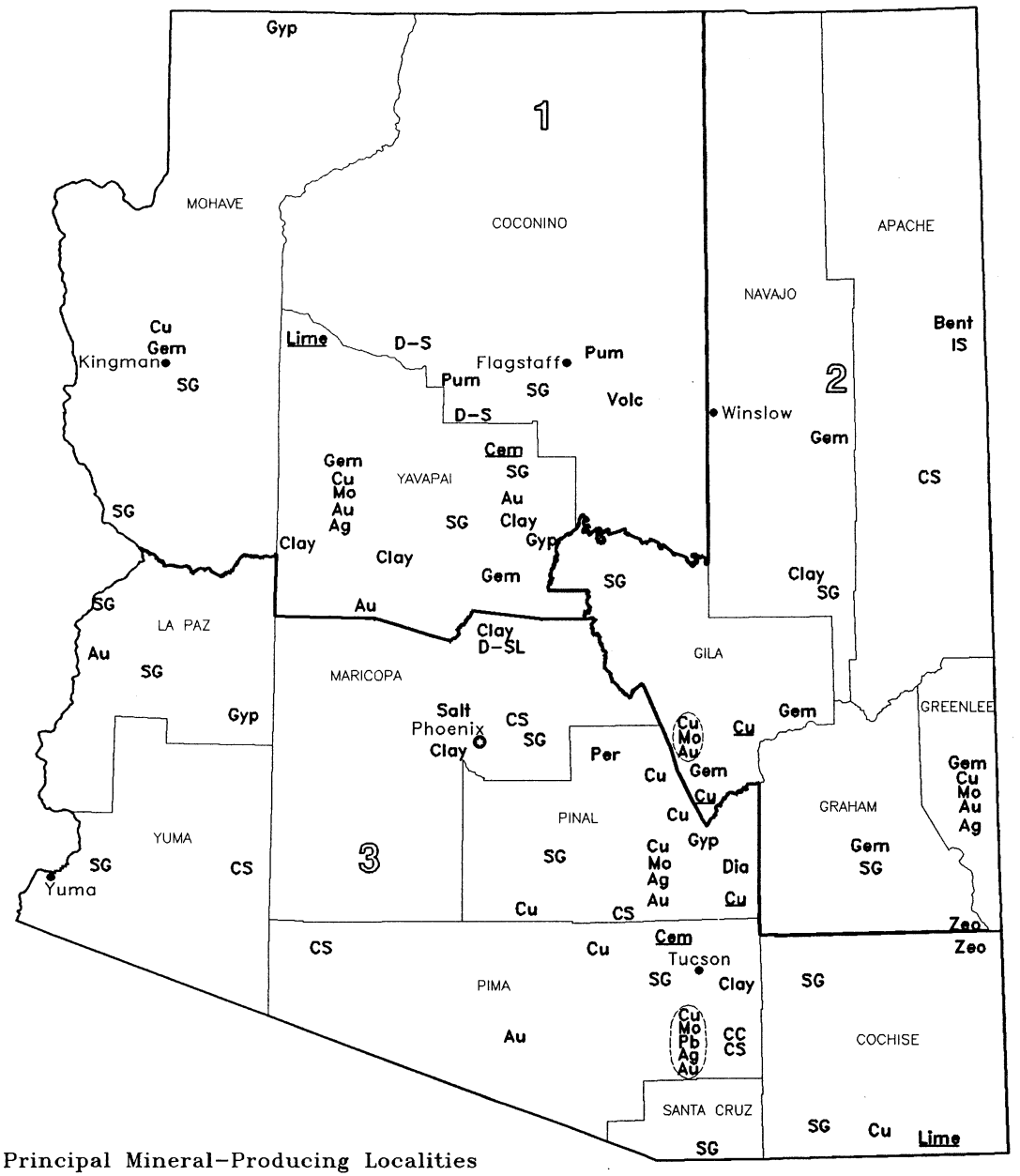
[7]Facts About Coal—1993. National Coal Association.

[8]Petroleum Supply Annual 1992, v. 1. Energy Information Administration. May 1993

[9]Natural Gas Annual 1992, v. 1. Energy Information Administration. Nov. 1993.

[10]All individual mine production data cited in this section are from published sources.

ARIZONA



Principal Mineral-Producing Localities

LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Ag	Silver
Au	Gold
Bent	Bentonite
Cem	Cement plant
Clay	Clay
CC	Calcium Carbonate
CS	Crushed Stone
Cu	Copper
Cu	Copper plant
D-S	Dimension Sandstone
D-SL	Dimension Slate
Dia	Diatomite
Gem	Gemstones
Gyp	Gypsum
IS	Idustrial Sand
Lime	Lime plant
Mo	Molybdenum
Pb	Lead
Per	Perlite
Pum	Pumice
Salt	Salt
SG	Sand and Gravel
Volc	Volcanic cinder
Zeo	Zeolite

Concentration of mineral operations

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Arizona Portland Cement Co., a subsidiary of California Portland Cement Co.[1 2]	Box 338 Rillito, AZ 85654	Quarry and dry-process, four-rotary-kiln plant	Pima.
Phoenix Cement Co.[1 2]	Box 428 Clarkdale, AZ 86324	Quarry and dry-process, three-rotary-kiln plant	Yavapai.
Clays:			
Building Products Co.	4850 West Buckeye Rd. Phoenix, AZ 85043	Open pit mines	Maricopa, Navajo, Yavapai.
Clinton-Campbell Contracting Inc.	1814 South 7th Ave. Phoenix, AZ 85007	do.	Maricopa and Pima.
Engelhard Corp.	Box 155 Sanders, AZ 86512	Surface strip mine	Apache.
McKusick Mosaic Co.	Route 1, Box 35-D Globe, AZ 85501	Surface mine	Gila.
United Dessicants, a division of United Catalyst Inc.	Box 32370 Louisville, KY 40232	Surface strip mine	Apache.
Copper:			
Arimetco International Inc.	6245 E. Broadway, Suite 350 Tucson, AZ 85711	Open pit mines, dump- and heap-leach, SX-EW plants	Cochise and Mohave.
Asarco Inc.:			
Southwest Copper Division	1150 N. 7th Ave. Tucson, AZ 85705	Office	Pima.
Hayden Unit	Box 98 Hayden, AZ 85235	Smelter and acid plant	Gila.
Mission Complex[3 4 5]	Box 111 Sahuarita, AZ 85629	Open pit mines and mill	Pima.
Ray Unit[3 5]	Box 8 Hayden, AZ 85235	Open pit mine, dump- and heap-leach, precipitation, SX-EW plants	Pinal.
Silver Bell Unit	Marana, AZ 85653	Leach dumps and precipitation plant	Pima.
Cyprus Copper Co., a division of Cyprus Minerals Co.:	1501 Fountain Head Pkwy. Tempe, AZ 85282	Office	Maricopa.
Cyprus Badgad Copper Corp.[5 6]	Box 245 Bagdad, AZ 86321	Open pit mine, mill, dump-leach, SX-EW plant	Yavapai.
Cyprus Casa Grande Corp.	Box 15009 Casa Grande, AZ 85222	In situ mine and SX-EW plant	Pinal.
Cyprus Miami Mining Corp.	Box 4444 Claypool, AZ 85532	Dump- and heap-leach, SX-EW, smelter, refinery, rod mill	Gila.
Cyprus Mineral Park Corp.[5]	HC-37 Box 500 Kingman, AZ 86401	Dump-leach and precipitation plant	Mohave.
Cyprus Sierrita Corp.[5 6]	Box 527 Green Valley, AZ 85622	Open pit mines, mill, leach dumps, SX-EW plants	Pima.
Magma Copper Co.:			
Corporate Headquarters	7400 N. Oracle Rd. Tucson, AZ 85704	Offices	Do.
Pinto Valley Div.[3 5 6]	Box 100 Miami, AZ 85539	Open pit mine, mill, leach dumps, in situ leach, SX-EW leaching, SX-EW	Gila.
San Manuel Div.[3 5 6 7]	Box M San Manuel, AZ 85631	Underground mine, mill, in situ and heap	Pinal.
Superior Div.[3 5]	Box 37 Superior, AZ 85273	Underground mine and concentrator	Do.

See footnotes at end of table

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Copper—Continued:			
Phelps Dodge Corp.:			
Corporate Headquarters	2600 N. Central Ave. Phoenix, AZ 85004-3014	Offices	Maricopa.
Copper Queen Branch	Highway 92 Bisbee, AZ 85603	Leach dumps, in situ leaching, precipitation plant	Cochise.
Morenci Branch[3 5 6]	4521 State Hwy 191 Morenci, AZ 85540	Open pit mine, mills, dump-leach, precipitation, and SX-EW plants	Greenlee.
Oracle Ridge Mining Partners, a subsidiary of South Atlantic Ventures Ltd.[3 5]	Box 7 San Manuel, AZ 85631	Underground mine and mill	Pima.
Gold:			
A. F. Budge Ltd.[5 8]	Box 938 Jerome, AZ 86331	Underground mine and tailings leach	Yavapai.
Cyprus Copperstone Gold Corp.[5]	Box AI Parker, AZ 85344	Open pit mine, agitation leach	La Paz.
Fischer-Watt Gold Co. Inc.	340 Freeport Blvd., Suite 3 Sparks, NV 89431	Underground mine	Maricopa.
Magma Gold Co.[5 8]	Box 460 Humboldt, AZ 86329	do.	Yavapai.
Republic Goldfields Corp.[5]	Box 361 Congress, AZ 85332	do.	Do.
Gypsum:			
National Gypsum Co:			
Gold Bond Building Products Div.	Box 20863 Phoenix, AZ 85036	Plant	Maricopa.
Feldman Quarry	Star Route, Box 3990 Winkelman, AZ 85292	Open pit mine and crushing plant	Pinal.
Pinal Gypsum Co.	Box 99 Coolidge, AZ 85228	Open pit mine	Do.
Superior Companies[1 2]	100 West Coolidge Phoenix, AZ 85013	Quarries and plant	Pinal and Yavapai.
Western Gypsum	Box 850 St. George, UT 84770	Open pit mine and crushing plant	Mohave.
Western Organics Inc.	Box 6876 Phoenix, AZ 85005	Open pit mine	La Paz.
Iron oxide pigment:			
Swansea Minerals Inc.	6360 E. Rose Circle Dr. Scottsdale, AZ 85251	Mine tailings	Do.
Lime:			
Chemstar Inc.[2]	2800 N. 44th St., #400 Phoenix, AZ 85008	Quarries and lime kilns	Cochise and Yavapai.
Perlite:			
Harborlite Inc.	Box 960 Superior, AZ 85273	Open pit mine and plant	Pinal.
Nord Perlite Co., a subsidiary of Nord Resources Corp.	Box 127 Superior, AZ 85273	do.	Do.
Therm-O-Rock Industries Inc.[9]	6732 West Willis Rd. Chandler, AZ 85226	Plant	Maricopa.
Pumice:			
Arizona Tufflite Inc.	2432 West Peoria, #1081 Phoenix, AZ 85029	Open pit mine	Coconino.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Salt:			
Morton Salt Co., a subsidiary of Morton International Inc.	13000 W. Glendale Ave. Glendale, AZ 85307-2408	Solution mining and solar evaporation	Maricopa.
Sand and gravel (construction):			
CalMat Co. of Arizona, a subsidiary of CalMat Co.[2]	Box 52012 Phoenix, AZ 85072	Pits and plants	Do.
Peter Kiewit & Sons Co., a subsidiary of Union Rock and Materials Corp.	2525 West Beryl Ave, #100 Phoenix, AZ 85021	do.	Maricopa and Pima.
Pioneer Sand and Gravel Co.	5901 W. Broadway Rd. Phoenix, AZ 85043	do.	Maricopa.
Salt River Sand & Rock[2]	Box 728 Mesa, AZ 85211	do.	Do.
Sunward Materials Co., a subsidiary of Blue Circle West, Inc.	2625 S. 19th Ave. Phoenix, AZ 85009	do.	Maricopa and Pima.
The Tanner Companies, a subsidiary of Ashland Oil Inc.	Box 52124 Phoenix, AZ 85072	do.	Coconino, La Paz, Maricopa, Pima, Pinal, Yavapai,Yuma.
Sand and gravel (industrial):			
Arizona Silica Sand Co.	Box 108 Houck, AZ 86506	Open pit mine	Apache.
Silica Mines Inc.	Box 332 Oracle, AZ 85623	do.	Pinal.
Stone (crushed):			
Arizona Quality Granite Co.	7401 W. Villa Rita Dr. Peoria, AZ 85345	Quarry and plant	Maricopa.
Georgia Marble Co. Inc.	4901 E. Drexel Rd. Tucson, AZ 85706	do.	Pima.
Specialty Minerals Inc.	Box 759 Sahuarita, AZ 85629	do.	Do.
Western Arizona Rock Products Inc.	Box 178 Dateland, AZ 85333	do.	Yuma.
Stone (dimension):			
American Sandstone (a division of Blaser Corp.	Box 1154 North Highway 89 Chino Valley, AZ 86323	Quarries and plant	Coconino and Yavapai.
Drake Stone Products	Box 11676 Prescott, AZ 86304	Plant	Yavapai.
Dunbar Stone Co.	Box 246 Ash Fork, AZ 86320	Quarries and plant	Coconino, Maricopa, Mohave, Yavapai.
Harley Gray Stone Co.	Box 323 Paulden, AZ 86334	Quarries	Coconino.
Hudman Stone	9640 W. Picture Rocks Rd. Tucson, AZ 84743	do.	Do.
Outland Resources Inc.	Box 4105 Kingman, AZ 86402	do.	Mohave.
Western States Stone Co.	2830 Grand Ave. Phoenix, AZ 85017	Quarries and plant	Coconino, La Paz, Maricopa, Mohave, Yavapai.
Vermiculite (exfoliated):			
W. R. Grace & Co., Construction Products Div.	4220 West Glenrosa Phoenix, AZ 85019	Plant	Maricopa.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Zeolite:			
GSA Resources[1]	Box 509 Cortaro, AZ 85652	Surface strip mine	Cochise.
UOP	115 N. 5th St. Grand Junction, CO 81501	do.	Do.

[1]Also clays.
[2]Also crushed stone.
[3]Also gold.
[4]Also lead.
[5]Also silver.
[6]Also molybdenum.
[7]Also lime.
[8]Also copper
[9]Also vermiculite (exfoliated).

THE MINERAL INDUSTRY OF ARKANSAS

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Arkansas Geological Commission for collecting information on all nonfuel minerals.

By Doss H. White, Jr.,[1] and William V. Bush[2]

Arkansas 1992 nonfuel mineral value reported by the State's mineral producers totaled $403.8 million, an increase of $43 million. Excluding clay and lime, value increased for all major mineral commodities mined in the State. Arkansas ranked 26th nationally in mineral value and led the Nation in the production of bromine and natural abrasives.

TRENDS AND DEVELOPMENTS

Over the past decade (1983-92), Arkansas nonfuel mineral sales increased from $246.4 million to $403.8 million. Beginning in 1983, mineral sales increased each year excluding 1985 (-$2.6 million), 1986 (-$7 million), 1990 (-$1 million), and 1991 (almost -$20 million). Despite the sporadic downturn in sales, mineral value increased almost 64% over the 10-year period.

Many of the year's mineral-related developments were of a controversial nature. In February, a panel of the Eighth U.S. Circuit Court of Appeals reversed a permanent injunction against exploratory drilling in the Crater of Diamonds State Park. The injunction, issued in August 1990, followed a lawsuit by several environmental groups.[3]

In 1989, four mining companies, Arkansas Diamond Development Co., Continental Diamonds Inc., Kennecott Corp., and Capricorn Diamonds Pty. Ltd., formed a joint venture and pooled $350,000 to drill up to 30 holes in the park to determine the configuration and quality of the diamond pipe. After four holes were drilled, a Federal district judge halted drilling as a result of a lawsuit filed by the Sierra Club, the Arkansas Wildlife Federation, and Friends of Crater of Diamonds State Park. The suit charged that the exploration was part of a three-phased program leading to commercial diamond mining.

Following the reversal of the court injunction, a disagreement developed between the four mining companies and the Director of the Arkansas Department

TABLE 1
NONFUEL MINERAL PRODUCTION IN ARKANSAS[1]

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
Abrasives[2]	metric tons	W	W	W	$154	W	W
Bromine[e]	thousand kilograms	177,000	r$173,000	170,000	167,000	171,100	$170,000
Clays	metric tons	989,383	21,578	3856,582	38,048	3837,427	32,972
Gemstones		NA	1,503	NA	1,846	NA	31,493
Sand and gravel:							
Construction	thousand short tons	r10,411	r37,371	e8,300	e31,100	10,908	39,627
Industrial	do.	742	7,209	746	7,738	868	10,458
Stone (crushed)[4]	do.	e17,800	e76,900	22,140	101,427	e25,200	e118,900
Combined value of bauxite (1990), cement, clays [fire, (1991-92), kaolin (1992)], gypsum (crude), lime, stone [crushed dolomite and traprock (1991-92), crushed slate and dolomite (1990), dimension], talc and pyrophyllite (1990), tripoli, vanadium (1990), and values indicated by symbol W		XX	r63,357	XX	r43,677	XX	e60,372
Total		XX	r380,918	XX	r360,990	XX	403,822

[e]Estimated. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Grindstones, pulpstones, and sharpening stones; excludes mill liners and grinding pebbles.
[3]Excludes certain clays; kind and value included with "Combined value" data.
[4]Excludes certain stones; kind and value included with "Combined value" data.

of Parks, Recreation, and Tourism (ADPRT) over when the test drilling could resume. The companies requested the earliest possible date because of the limited amount of time remaining in the "nonconforming use permit" issued by the U.S. Department of the Interior (DOI) to conduct the test drilling. DOI was involved because the Agency granted the State $743,000 in 1977 to assist in the development of the park.

The companies proposed an early May date, while the ADPRT Director insisted on a date after the July 4 weekend. In late May, a June 2d date was agreed on by both parties; drilling began, but was slowed because of muddy ground. The test drilling was scheduled for a 57-day period.[4]

When drilling began, opponents visiting the first drill site discovered "violations" to court-established guidelines governing the drilling. The "violations" were in the form of "broken trees and shrubs" along a bulldozed road leading to the site. Information on the "violations" was presented to court officials and the attorney general's office in an ill-fated attempt to get the drilling stopped.[5]

Early drilling evaluations were favorable; a hole drilled to the west of the main crater intersected lamproite, the diamond host rock, indicating that the deposit was larger than originally thought.[6] Drilling was completed late in the summer, and a report on the findings was issued late in the year.

While the drilling was ongoing, a Canadian mining company, Armeno Resources Inc., purchased mineral leases in Pike and Howard Counties in an area extending west from the Crater of Diamonds Park.[7]

A second mining project had a group of Arkansas citizens and officials up-in-arms. The Doe Run Mining Co. received permission from the Bureau of Land Management, DOI, to drill 20 exploratory holes for lead in the Mark Twain National Forest in southern Missouri. Some Arkansas citizens and officials in Randolph County on the Arkansas-Missouri State line feared the drilling could contaminate subsurface water supplies flowing from Missouri into Arkansas. In June, the Arkansas Attorney General filed a notice of appeal objecting to the DOI's decision to allow the lead exploration.[8]

On the local level, citizens of Gravette and Sulfur Springs circulated petitions opposing a proposed quarry by Benton County Stone and Rock Inc.[9]

ENVIRONMENTAL ISSUES

At yearend, State officials continued their investigations into the sources of widespread mercury contamination in fish in the Ouachita and Saline Rivers. Extensive testing by the Arkansas Department of Pollution Control and Ecology eliminated several suspected sources. Investigations early in the project ruled out the State's approximately 50 abandoned mercury mines as the source of the contamination. A possible source under investigation at yearend was wind-borne mercury from Texas lignite mining; the lignite is burned in Texas powerplants. Arkansas contacted Texas officials for any information on airborne mercury from lignite mining.[10]

EXPLORATION ACTIVITIES

In December, a report on the Crater of Diamonds Phase I exploration-evaluation program was released. A four-firm consortium funded the program.

Drilling, 1.74-meter (26 1⅞-inch) diameter holes, totaled 2,651 meters (8,699 feet). Individual holes were drilled to depths up to 204 meters (670 feet). Drilling determined that the "martini glass"-shaped deposit covered approximately 19 hectares (47 acres) and contains a calculated tonnage of diamond-bearing rock of approximately 68 million metric tons (75 million short tons). The consortium has requested permission from the State to conduct bulk sampling in 1993.

LEGISLATION AND GOVERNMENT PROGRAMS

A bill was passed by the 1992 Arkansas Legislature and signed by the Governor to tax lead ore, even though there is no lead mining in the State. Senate 43 would levy a severance tax of $0.15 per short ton or 10% of market value, whichever is greater, on lead ore. This law would discourage future mining if an economically minable deposit were discovered.

Arkansas received $1.1 million as its 1992 share of revenue associated with mineral leases on Federal public lands within the State. The monies were collected and disbursed by the DOI Minerals Management Service.[11]

At yearend, the ADPRT was considering a request by the four-company diamond mining consortium for permission to conduct a trenching and bulk sampling program at the Crater of Diamonds State Park.

The Arkansas Geological Commission (AGC) is divided into the Geology and Land Survey Divisions. The Geology Div. was charged with providing information on the mineral and fossil fuel resources, geology, and hydrology of Arkansas to interested parties.

Work continued on a study of ilmenite deposits in southern Howard County. The project was initiated to establish deposit boundaries and titanium dioxide percentages present. A completion date was projected for 1993. Work continued on a Regional Gas Atlas; information gathering was essentially completed, and manuscript completion was projected for 1993.

Geology studies included the ongoing geological mapping in the Ouachita Mountains. The project, a multiyear effort, was designed to evaluate the economic potential of the Ouachitas in Arkansas. Mapping was nearing completion, and preparations were under way for publication in 1993. This was part of the COGEOMAP program with the U.S. Geological Survey (USGS).

The AGC entered into an agreement with other State geological surveys in the

New Madrid Seismic Zone (NMSZ) to form a State Geologists Advisory Group to the Central United States Earthquake Consortium (CUSEC). The group was established to create cooperation in joint investigations and scientific exchanges concerning earthquake hazard identification and risk reduction and to work with and support the CUSEC. An ongoing earthquake-related project, a study on the paleo-seismicity of the NMSZ, was completed.

In the hydrogeology sector, three cooperative programs with the USGS Water Resources Div. continued. These involved surface and subsurface water quantity and quality. Hydrologic information continued to be in great demand because of concern over water quality, availability, waste disposal siting, and source(s) of water supplies for home, municipal, water-district, and agricultural uses.

The State Geologist served on several State commissions, and staff geologists continued to serve as advisors to various regulatory agencies and special-purpose groups charged with safeguarding the public's welfare.

The Arkansas Department of Pollution Control and Ecology oversaw the State's abandoned mine land program. During the past 6 years, contractors working with the department have begun or completed six projects. During 1992, revegetation on the Shiloh ($543,000) and Spadra East ($389,000) projects was completed and permanent vegetation had emerged on these sites. Earthwork activity was under way at yearend on the Rock Creek, Beaulah, and Harmony projects.

The Booneville Plant Materials Center, established by the Soil Conservation Service in 1987, evaluated plants for specific natural resource problems. During the year, research focused on (1) finding more productive grasses and legumes to support livestock grazing on mine sites, (2) determining the best fruit and nut trees for mine-site growth, (3) determining the most economical methods to establish previously selected vegetation on mined lands, and (4) technology transfer to landowners, mine operators, and State and Federal agencies responsible for managing mined lands.[12]

FUELS

Coal production in 1992 totaled 57,200 metric tons or 63,000 short tons compared with that of 1991 when 42,600 metric tons (47,000 short tons) was mined.

In the oil and gas sector, a Yell County petroleum test well was abandoned at 6,297 meters (20,661 feet), a new Arkansas depth record. The average well drilled in the gas-rich Arkoma Basin during 1992 was approximately 1,524-meters (5,000-feet) deep, with a success ratio of approximately 60%.

Oil and condensate production totaled 10,388,328 barrels. At $17 per barrel, this equates to $176.6 million. Natural gas production from north Arkansas fields was 4,759,367 million cubic meters and from south Arkansas was 1,027,172 million cubic meters. The average value of north Arkansas gas was $61.79 per million cubic meters and $31.78 from the south Arkansas fields.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Abrasives (Natural).—Arkansas retained its first place ranking among the three States with natural abrasive production. Nine companies in the Hot Springs area reported natural abrasive production. Production declined 26%, but value increased 54%.

Novaculite, a fine-grained silica-rich rock, was the principal material mined. Diamond saws were used to cut the crude material to shape, and smaller saws and grinders were used to fabricate final products of whetstones, hones, scrapers, and files.

Crude novaculite was shipped to both European and Asiatic countries for shaping and finishing. The crude rock was moved to the coast by rail and transported overseas by ship.

Bromine.—Arkansas, the only domestic bromine producer, accounted for approximately 40% of the world's total output. Bromine value accounted for almost 42% of the State's total mineral value. Production was reported at 171 million kilograms valued at $170 million. Four firms in Columbia and Union Counties, Arkansas Chemical Inc., Dow Chemical U.S.A., Ethyl Corp., and Great Lakes Chemical Corp., produced bromine from bromine-bearing brines pumped to the surface from the Smackover Formation. Dow was owned by the Ethyl Corp., and Great Lakes was part owner of Arkansas Chemical.

Sales were to the chemical industry to produce products for agricultural pest control, water treatment, fire control, and oilfield fluids.

Cement.—Cement value from sales of both portland and masonry cement ranked fourth among the mineral commodities mined or manufactured in Arkansas in 1992. Portland cement sales and value were concealed, but both increased. Masonry cement output and value also increased over that estimated for 1991. Arkansas ranked 24th in tonnage and 27th in value among the 37 States with portland cement production, and 14th in tonnage and 19th in value among the 36 masonry cement-producing States.

The State's cement industry consisted of two firms, Arkansas Cement Corp. in Foreman, a subsidiary of Ash Grove Cement Co., and Holnam Inc. near Saratoga. The two operated five wet-process kilns using materials mined instate, limestone, clay, and sand, for clinker manufacture.

Clays.—The State ranked 11th in tonnage and 17th in value among the 44 clay-producing States. Clay production and value, excluding fire clay and kaolin, totaled 837,000 metric tons (923,000 short tons) and $2,972,000 million.

The Arkansas clay industry consisted of 11 companies with mines in 10 counties. Common clay and/or shale, fire clay, and kaolin were produced. Pertinent figures on the Arkansas clay

TABLE 2
ARKANSAS: CLAY INDUSTRY STATISTICS

		Common clay-shale		Fire clay		Kaolin	
		1991	1992	1991	1992	1991	1992
Number of companies		7	8	1	1	3	2
Number of mines		16	16	1	1	3	2
Output	thousand metric tons	645	837	W	W	233	W
Value	thousand dollars	$2,632	$2,972	W	W	$5,416	W
Unit value	dollars	$3.70	$3.22	$28.44	$328.44	$23.20	$26.31

W Withheld to avoid disclosing company proprietary data.

industry are given in table 2.

Eighty-five percent of the common clay, used in brick, concrete block, roofing granules, and structural concrete manufacture, was mined in Crittenden, Hot Spring, and Montgomery Counties. Brick production utilized 395,000 metric tons of clay, an increase over the 279,000 metric tons used in brickmaking in 1991.

Fire clay and kaolin were mined in Pulaski County. Fire clay sales were for the production of refractory shapes, and the major end uses reported for kaolin were (1) in refractory grogs, (2) in aluminum sulfate manufacture, and (3) as a pesticide and related product carrier.

Gemstones.—Arkansas was a major gemstone producer, and over the past several years has ranked consistently in the top 10 gemstone-producing States. In 1992, the State ranked ninth in value. Arkansas is famous for its quartz crystals, which occur in veins in sandstone and shale in the central part of the Ouachita Mountains. Quartz was collected for both cabinet specimens and jewelry. Arkansas was the only State with "lascas" production, the feed material used for synthetic quartz manufacturing.

An Arkansas mining firm capitalized on the inauguration of an Arkansas citizen as President of the United States. Coleman Mining, Hot Springs, was picked by the Congressional Inaugural Luncheon planners to design and produce a quartz crystal and novaculite paperweight for the inaugural luncheon participants.[13]

The State is also known for its Crater of Diamonds State Park. It has been estimated that from 1906 to 1972 between 100,000 to 160,000 diamonds were discovered. For a small fee, the public can search in the park for diamonds.

Other "gemstones" mined and sold in Arkansas included agates, amber, chert, novaculite, petrified wood, sodalite, and freshwater pearls.

Gypsum.—The State continued as the Nation's ninth leading gypsum producer; firms in 21 States mined gypsum in 1992. Gypsum value ranked ninth among the 17 industrial minerals produced in Arkansas. Production and value statistics were concealed, but output and sales increased over 1991 levels.

Two companies produced gypsum from mines in Howard and Pike Counties. Briar Gypsum Co. Inc. and Harrison Gypsum Co. operated surface mines and crushing facilities. Briar Gypsum's output was used in wallboard manufacture, and Harrison's gypsum was sold to cement companies for use in clinker manufacture.

Lime.—Arkansas maintained its 28th place ranking among the 32 lime-producing States. Arkansas Lime Co., Independence County, produced both quicklime and hydrated lime. Production and value fell below that reported in 1991. Sales were to the sugar and crude oil refining industries, paper manufacturers, and water purification plants.

Quartz.—Arkansas was the leading State in quartz crystal mining. Much of the crystal output was mined in the Ouachita National Forest, and mining was administered by the U.S. Forest Service.

Arkansas was also the only State with quartz lascas production. Quartz lascas, a low-impurity quartz used as a raw material in the manufacture of fused and cultured quartz, was produced by Coleman Quartz, Jessieville. After mining, the material was treated with oxalic acid and deionized water to remove surface contaminants. The material was then sorted, dried, and subjected to a light table examination to identify remaining impurities. The quartz was shipped to the crystal producers in 45-kilogram (100-pound) bags.

Sand and Gravel.—The State maintained its 32d place ranking among the 50 sand and gravel-producing States. Sand and gravel ranked 3d, valuewise, among the 16 industrial minerals produced instate and accounted for 12% of the State's total mineral value. Production of both construction and industrial sand and gravel, 10.7 million metric tons (11.8 million short tons), increased over the 8.2 million metric tons (9 million short tons) estimated for Arkansas producers in 1991. Value, $50 million in 1992, increased $11 million over the $38.8 million estimated for 1991.

Construction.—Production of construction sand and gravel is surveyed by the U.S. Bureau of Mines (USBM) for even-numbered years only; data for odd-numbered years are based on annual company estimates. This report contains actual data for 1990 and 1992 and estimates for 1991.

TABLE 3
ARKANSAS: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	4,865	$18,990	$3.90
Plaster and gunite sands	W	W	7.00
Concrete products (blocks, brick, pipe, decorative, etc.)	68	684	10.06
Asphaltic concrete aggregates and other bituminous mixtures	1,952	7,093	3.63
Road base and coverings	1,113	3,251	2.92
Fill	127	377	2.97
Snow and ice control	38	147	3.87
Railroad ballast	W	W	4.44
Other miscellaneous uses[1]	12	44	3.67
Unspecified:[2]			
Actual	1,440	4,291	2.98
Estimated	1,293	4,751	3.67
Total	10,908	[3]39,627	3.63
Total[4 5]	9,896	39,627	4.00

[1]Includes filtration.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data do not add to total shown because of independent rounding.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

Fifty-eight Arkansas construction sand and gravel firms reported 1992 production at 9.9 million metric tons (10.9 million short tons). Sales (value) were reported at $39.6 million. This was $8.5 million above the Bureau estimate for 1991.

The 58 companies operated 83 mines in a 41-county area. The five leading counties, in descending order of tonnage, were Ouachita, Pike, Marion, Pulaski, and Calhoun, which accounted for approximately 44% of the production. Leading end uses, as reported by the producers, were for (1) concrete aggregate, (2) asphaltic concrete, and (3) road base and cover.

Industrial.—As in past years, four firms comprised the Arkansas industrial sand and gravel industry. Production and value, 787,000 metric tons (868,000 short tons) and $10.5 million, respectively, exceeded the 677,000 metric tons and $7.7 million mined in 1991.

Slightly more than 90% of the output was sand. Production was in Crawford, Hempstead, Izard, and Miller Counties. Principal sales were to the glass (container and flat), foundry, and sandblasting industries.

Stone.—The production of stone is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This report contains estimated data for 1990 and 1992 and actual data for 1991.

Crushed.—Arkansas ranked 19th among the 49 crushed stone-producing States. The estimated crushed stone value, $118.9 million, was approximately 29% of the State's 1992 total, and crushed stone ranked second behind bromine in sales. The 1992 value was $17.5 million above the $101.4 million produced in 1991. Estimated production, 22.9 million metric tons (25.2 million short tons), rose 2.9 million metric tons (3.1 million short tons) above that reported in 1991.

In the last year that industry reported, 34 companies operated 52 quarries in a 28-county area. The predominate stone types produced were granite (42%), limestone (25%), and sandstone (16%). The remaining 17% was dolomite, traprock, and "other" stone types. Sales were for graded road base, cement manufacture, riprap and jetty stone, bituminous aggregate, and construction aggregate.

Dimension.—Three companies produced dimension stone from five quarries in Independence, Logan, and Sebastian Counties. Limestone-marble and sandstone were quarried to produce cut/veneer stone, shaped stone (columns, fireplace mantels, urns, animal shapes, etc.), rough blocks, and flagging. Output and value decreased below that reported by the industry in 1991.

Eureka Stone Co. operated a limestone quarry at Eureka Springs. The company also sold marble shapes from stone quarried out-of-State. The company was sold in February to a local businessman; the previous owner will remain with the firm to do custom stone carving.[14]

Oran McBride Stone Co. operated a stone company west of Batesville. The company quarried sandstone and also sold limestone and marble purchased from out-of-State sources. The company sold stone for floor and wall applications, marble columns, limestone archways, and various architectural shapes.[15]

Talc.—The Milwhite Co. Inc., a talc producer in past years, did not report production in 1992. Milwhite operated a talc mine in Saline County and a grinding mill at Bryant.

Tripoli.—Malvern Minerals Co. Inc., Hot Springs, mined tripoli, a cryptocrystalline material composed of almost pure silica, from a deposit east of Hot Springs. Crude tripoli was trucked to the Malvern plant where it was ground, dried, and air separated into sized products. Sales were to the abrasive and filter industries. Production and value declined below that reported in 1991.

TABLE 4
ARKANSAS: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)[1]	1,366	4,754	3,103	13,168	397	1,074
Concrete products (blocks, brick, etc.)	W	W	W	W	W	W
Asphaltic concrete aggregates and other bituminous mixtures	W	W	1,530	5,999	W	W
Road base and coverings	308	1,220	526	1,316	279	714
Fill	68	191	19	44	40	141
Snow and ice control	W	W	—	—	W	W
Railroad ballast	W	W	—	—	—	—
Other miscellaneous uses[2]	226	800	40	546	273	615
Unspecified:[3]						
Actual	1,176	2,782	64	422	199	1,087
Estimated	123	464	898	3,293	272	994
Total[4]	3,267	10,211	6,181	24,789	1,460	4,627
Total[5 6]	2,964	10,211	5,607	24,789	1,324	4,627

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes plaster and gunite sands.
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

Other Industrial Minerals.—Several mineral commodities, in addition to those listed in table 1 and previously described, were either recovered as byproducts from mineral processing operations or shipped to industries in Arkansas for finishing or processing into higher value products.

Ammonia was produced by Nitrogen Products Inc. at a 190,000-metric-tons-per-year (210,000-short-tons) facility at Helena. Dimension stone was shipped into Arkansas for finishing into monuments and for building purposes. Mineral pigments were purchased by the Arkansas brick producers from out-of-State sources. Synthetic graphite was produced by the Great Lakes Carbon Group, Ozark, and Superior Graphite Co., Russellville. The two plants produced graphite electrodes. Sulfur was recovered by MKP Operating Co., Lafayette County, and the Ethyl Corp., Columbia County. The former company operated a petroleum refining facility, and the latter a bromine extraction complex. Vermiculite, from South Carolina, was exfoliated by Strong-Lite Products Corp. at its Pine Bluff plant.

Metals

Aluminum.—The Aluminum Co. of America operated an aluminum chemicals plant at Benton in Saline County. Alumina for plant feed was received from the company's Port Comfort, TX, plant.

Iron and Steel.—Four companies, Arkansas Steel Associates, Nucor Corp., Nucor-Yamato Steel Co., and Quanex Corp., comprised Arkansas steel industry.

Work continued on the expansion of Nucor-Yamato's mill at Blytheville and Nucor Corp.'s new $300 million mill at Hickman. The Blytheville expansion, scheduled for completion in 1994, will allow the facility to roll wider flange beams. The Hickman mill, scheduled for completion in mid-1993, will have a 910,000-metric tons (1-million-short-tons) capacity. Quanex Corp.'s MacSteel Div. at Ft. Smith operated two 50-ton electric arc furnaces and had an annual capacity of about 300,000 metric tons.

Uranium.—In April, Sequoyah Fuels Corp. began a phased restart of its uranium processing facility near Gore. The plant was closed in early October 1991 when contamination was discovered at several locations within the plant grounds. During the startup period, the plant produced depleted uranium tetrafluoride used to fabricate armor-piercing ammunition and armor plating. After a 3-week restart period, the plant began production of uranium hexafluoride, which was shipped to a U.S. Department of Energy facility for further refining and use as a nuclear fuel.[16]

Vanadium.—U.S. Vanadium, a Strategic Minerals Corp. subsidiary, operated the Nation's only vanadium mine and mill south of Hot Springs. During 1992, the mine was inoperative and the mill operated on spent catalysts and vanadium residues.

[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 32 years of mineral-related industry and government experience and has covered the mineral activities in Arkansas since 1989. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

[2]Assistant State geologist, Arkansas Geological Commission, Little Rock, AR.

[3]Arkansas Democrat-Gazette. Arkansans Capitalize on Clinton. Jan. 17, 1993.

[4]———. Court Lifts Ban on Test Drilling at Diamond Park. Feb. 6, 1992.

[5]Nashville News. Tourism Official, Mining Companies at Impasse Over Re-start of Drilling. Apr. 23, 1992.

[6]Batesville Daily Guard. Opponents of Diamond Test Drilling Cite Violations. June 22, 1992.

[7]Arkansas Democrat-Gazette. Drilling Shows Diamond Area May Be Larger Than Believed. June 16, 1992.

[8]Nashville News. Mineral Leases Are Being Sought in Howard, Pike. June 25, 1992.

[9]The Sentinel-Record. Bryant Fights Drilling in Mark Twain Forest. Apr. 6, 1992.

[10]Gravette News Herald. Rock Quarry Opponents Start Petition Drive to Stop Project. Sept. 9, 1992.

[11]Arkansas Democrat-Gazette. 5 Scratched From List of Mercury Suspects. Jan. 17, 1993.

[12]Johnson County Graphic. State Receives 1992 Mineral Revenue. Apr. 7, 1993.

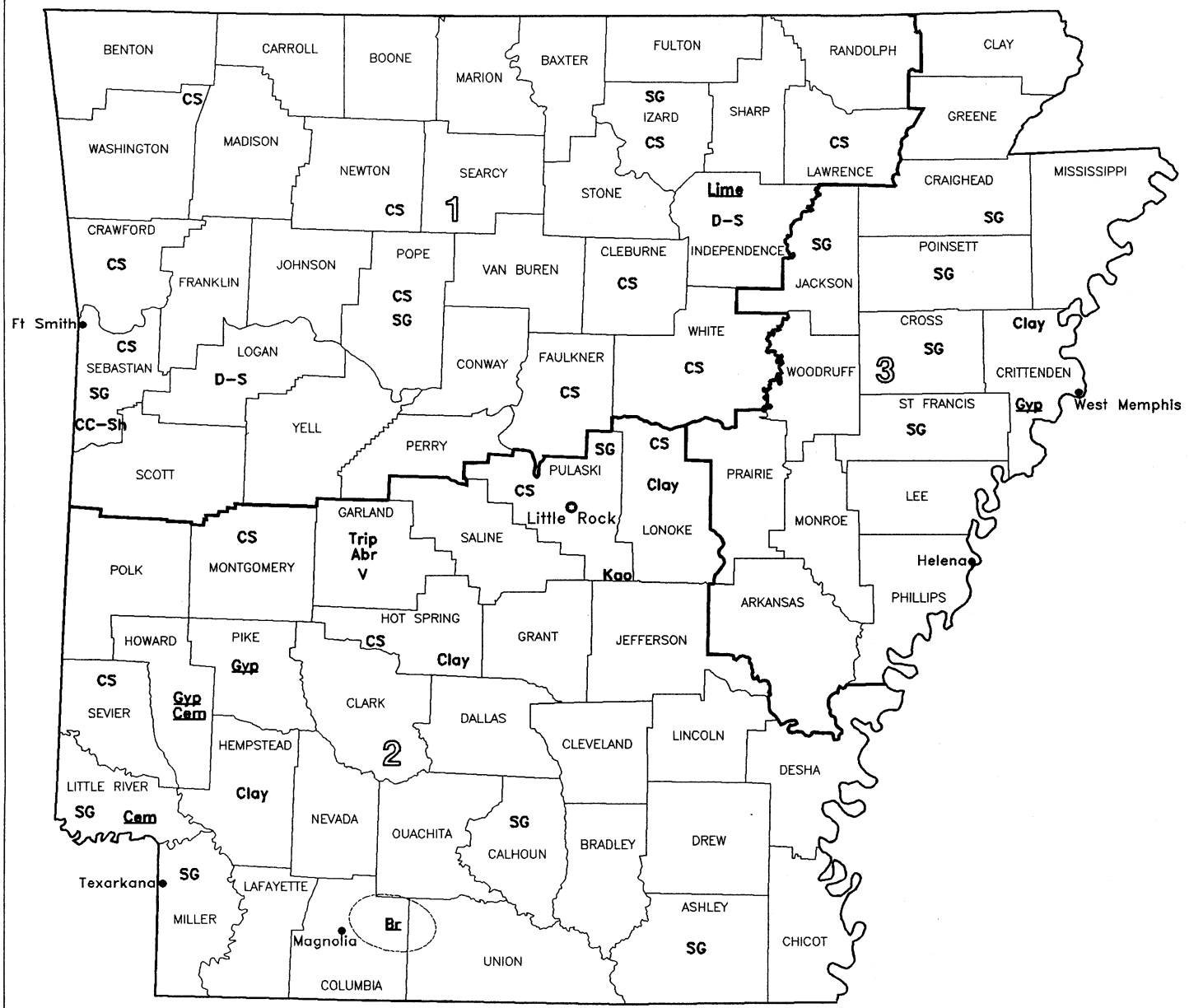
[13]Boonesville Democrat. Center Has Various Purposes. July 29, 1992.

[14]The Eureka Springs Times-Echo. Eureka Stone Company Changes Hands but Quality Continues. Apr. 16, 1992.

[15]Arkansas Democrat Gazette. The Rocky Road to Success. July 23, 1992.

[16]Fort Smith Southwest Times Record. Sequoyah Fuels Begins Restart. Apr. 17, 1992.

ARKANSAS



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Abr	Abrasives
Br	Bromine plant
CC-Sh	Common Clay & Shale
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
D-S	Dimension Stone
Gyp	Gypsum plant
Kao	Kaolin
Lime	Lime plant
SG	Sand and Gravel
Trip	Tripoli
V	Vanadium

Concentration of mineral operations

Principal Mineral–Producing Localities

TABLE 5
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Abrasives:			
Oilstones and whetstones:			
Hiram A. Smith Whetstone Co. Inc.	1500 Sleepy Valley Rd. Hot Spring, AR 71901	Quarry	Garland.
Tripoli:			
Malvern Minerals Co. Inc.	Box 1246 Hot Spring, AR 71901	Mine	Do.
Bromine:			
Arkansas Chemicals Inc.	Route 6, Box 98 El Dorado, AR 71730	Brine wells and plant	Union.
Dow Chemical U.S.A.	2030 Dow Center Midland, MI 48640	do.	Columbia.
Ethyl Corp., Arkansas Div.	Box 729 Magnolia, AR 71753	do.	Do.
Great Lakes Chemical Corp.	Box 2200 West Lafayette, IN 47906	do.	Union.
Cement:			
Arkansas Cement Corp., a subsidiary of Ash Grove Cement Co.[1]	Box 25900 Overland Park, KS 66225	Plant	Little River.
Ideal Cement Co., a subsidiary of Ideal Basic Industries Inc.[1]	Box 8789 Denver, CO 80201	do.	Howard.
Clays:			
Acme Brick Co., a division of Justin Industries Inc.	Box 425 Fort Worth, TX 76101	Pits and plants	Hot Spring and Sebastian.
Arkansas Lightweight Aggregate Corp.	El Dorado, AR 71730	Pit and plant	Crittenden.
Eureka Brick & Tile Co.	Box 379 Clarksville, AR 72830	Mine	Johnson.
A.P. Green Refractories Co., a subsidiary of USG Corp.	Box 164069 Little Rock, AR 7726	Pit and plant	Pulaski.
Gypsum:			
Harrison Gypsum Co. Inc.	Box 336 Lindsay, OK 73052	Mine	Pike.
Lime:			
Arkansas Lime Co., a subsidiary of Rangaire Corp.[1]	Box 2356 Batesville, AR 72501	Quarry and plant	Independence.
Perlite:			
Strong-Lite Products Corp.	Box 8029 Pine Bluff, AR 71611	Plant	Jefferson.
Sand and gravel:			
Construction:			
Beazer USA	Box 6657 Shreveport, LA 71136	Pits and plant	Little River, Ouachita, Pike.
Boorhem-Fields Inc.	Box 2196 Little Rock, AR 72203	do.	Calhoun, Craighead, Poinsett, St. Francis.
Industrial:			
Gifford-Hill & Co. Inc.	Box 6615 Shreveport, LA 71136	do.	Miller.
Unimin Corp.	Box 29 Guion, AR 72540	do.	Izard.

See footnotes at end of table.

TABLE 5-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone:			
Granite:			
McGeorge Contracting Co. Inc.	Box 7008 Pine Bluff, AR 71611	Quarries and plant	Pulaski.
Minnesota Mining & Manufacturing Co.	3M Center, 223-4N-05 St. Paul, MN 55144	Quarry and plant	Do.
Limestone:			
McClinton-Anchor Co., a subsidiary of Ashland Oil Inc.	Box 756 Fayetteville, AR 72701	Quarries and plant	Benton, Madison, Washington.
Midwest Lime Co.	Box 2608 Batesville, AR 72501	Quarry and plant	Independence.
Sandstone:			
Arkhola Sand & Gravel Co.,[1] a subsidiary of Ashland Oil Inc.	Box 1627 Fort Smith, AR 72901	Quarries and plant	Crawford and Sebastian.
H M B Construction Co.	Box 5606 Texarkana, TX 75501	Quarry and plant	Sevier.
M & M Rock Co. Inc.	Box 1190 Conway, AR 72032	do.	Faulkner, Perry, White.
Sulfur (recovered):			
Ethyl Corp., Arkansas Div.	Box 729 Magnolia, AR 71753	Sulfur recovered in bromine extraction	Columbia.
Phillips Petroleum Co.	724 Adams Bldg. Bartlesville, OK 74004	Sulfur recovered as a byproduct of petroleum refining	Lafayette.
Talc:			
The Milwhite Co. Inc.[2]	Box 15038 Houston, TX 77020	Mine and plant	Saline.
Vanadium:			
Strategic Minerals Corp.	Route 6, Box 943 Hot Spring, AR 71901	Mine and mill	Garland.
Vermiculite (exfoliated):			
W. R. Grace & Co.	62 Whittemore Ave. Cambridge, MA 02140	Plant	Pulaski.
Strong-Lite Products Corp.	Box 8029 Pine Bluff, AR 71611	do.	Jefferson.

[1]Also produced limestone.
[2]Also produced slate.

THE MINERAL INDUSTRY OF CALIFORNIA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the California Department of Conservation, Division of Mines and Geology, for collecting information on all nonfuel minerals.

By Fred V. Carrillo,[1] James F. Davis,[2] and John T. Alfors[3]

California ranked third in the Nation in total value of nonfuel mineral production in 1992. Reported production valued at $2,345,838,000 was 7.33% of the U.S. total. The value of the commodities produced in California during the year decreased about 7.5% following last year's 9% decline. California was the sole producer of boron and tungsten and led all States in the production of asbestos, portland cement, diatomite, calcined gypsum, rare-earth concentrates, and construction sand and gravel. It was second in natural calcium chloride, gold, magnesium compounds, pumice, industrial sand and gravel, and soda ash. Construction sand and gravel, portland cement, gold, and boron, in

TABLE 1
NONFUEL MINERAL PRODUCTION IN CALIFORNIA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Asbestos	metric tons	W	W	W	W	10,998	$4,452
Boron minerals	do.	1,093,919	$436,176	1,240,158	$442,531	1,008,889	338,700
Cement (portland)	thousand short tons	10,032	604,080	e8,702	e522,120	8,035	428,016
Clays[2]	metric tons	2,163,515	40,217	2,074,707	27,464	1,905,710	26,173
Gemstones		NA	1,501	NA	10,450	NA	9,916
Gold[3]	kilograms	29,607	368,300	r30,404	r355,125	33,335	369,723
Lime	thousand short tons	345	19,425	307	20,389	280	18,072
Mercury	metric tons	(4)	(4)	(4)	1	(4)	(4)
Pumice	do.	71,739	5,088	61,237	4,372	W	W
Rare-earth metal concentrates	do.	W	W	16,465	W	20,699	W
Sand and gravel:							
Construction	thousand short tons	r130,491	r617,984	e101,900	e489,100	112,888	522,108
Industrial	do.	2,452	48,055	2,104	41,690	2,096	42,396
Silver[3]	metric tons	21	3,209	W	W	18	2,259
Stone:							
Crushed	thousand short tons	e42,500	e200,600	45,816	216,156	e40,800	e198,300
Dimension	short tons	r e45,547	r e4,946	44,757	5,254	e23,292	e4,148
Combined value of barite (1990), calcium chloride (natural), cement (masonry), clays (fuller's earth), copper (1990-91), diatomite, feldspar, gypsum (crude), iron ore (usable), magnesium compounds, mica [crude (1991)], molybdenum, perlite, potash, salt, soda ash, sodium sulfate (natural), talc and pyrophyllite, titanium concentrates (ilmenite), tungsten, and values indicated by symbol W		XX	421,820	XX	403,592	XX	381,575
Total		XX	r2,771,401	XX	r2,538,244	XX	2,345,838

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" data.
[3]Recoverable content of ores, etc.
[4]Less than 1/2 unit.

order of value, were the four largest commodities in the State.

TRENDS AND DEVELOPMENTS

Industrial minerals comprised about 82% of the State's nonfuel mineral production value. In 1992, 34 mineral commodities, including 8 metals, were produced in California. Continuing declines in industrial minerals prices and demand, owing to continued reduction in construction activity within the State, caused another drop in the total production value, although it was considerably less than the previous year's decline.

EMPLOYMENT

According to the California Department of Employment Development, the California nonfuel mining industry employed 7,700 workers in December 1992, down about 7% from that of 1991. Of these, 2,200 were metal mining jobs and 5,700 were nonmetallic mineral mining jobs.

REGULATORY ISSUES

New regulations were adopted by the California Air Resources Board in January, which require metal processing companies to reduce emissions of particles containing arsenic, cadmium, lead, and nickel. Under the new regulations, uncontrolled smelters and foundries will be required to reduce emissions by an average of 95% when these materials are reheated during recycling.

EXPLORATION ACTIVITIES

The continuing drop in gold and silver prices led to declines in precious-metals exploration throughout the State. However, exploration continued in the mother lode areas of the Sierras and in the desert areas of southern California. Additional gold reserves were discovered at the 16 to 1 underground gold mine in Sierra County using new exploration techniques with a metal detector. Viceroy Gold Corp. reported additional gold reserves near the southern boundary of its Castle Mountain Mine in San Bernardino County. Canyon Resources drilled its Briggs property in Inyo County.

LEGISLATION AND GOVERNMENT PROGRAMS

The first payments required of all active surface mining operations in the State became due July 1 for the 1991 calendar reporting year. Fees were assessed according to a new schedule effective May 1 under the amended Surface Mining and Reclamation Act. Fees were based on production by weight and ranged from $100 to $2,000 for aggregate products, industrial minerals, and precious metals.

The Federal Environmental Protection Agency (EPA) began cleanup of the Sulphur Bank mercury mine Superfund site in Lake County in May. The $1.25 million project was the first stage in a long-term effort to stabilize the Sulphur Bank site where waste rock piles near the inactive mine are eroding into Clear Lake.

Cleanup plans also were announced by EPA in October for the Iron Mountain Mine in Shasta County. The plan called for an effluent processing plant that will use lime to neutralize the acidic runoff from two of the mine's largest pollution sources, the Richmond and Lawson tunnels, and for expansion at the Spring Creek Debris Dam.

The State of California received $28,984,484 as its share of 1992 mineral revenues collected from Federal public lands. In addition to sharing bonuses, rents, and royalties collected by the Minerals Management Service, an additional $20,230,000 was paid to California by the Federal Government as part of its 8(g) tract settlements in April 1992.

FUELS

Based on the first 10 months of production data, California's oil production for 1992 totaled 348 million barrels, down 0.8% when compared with the 1991 figure of 350.8 million barrels and down 17.9% when compared with the 1985 alltime high of 423.9 million barrels. State onshore production decreased to 283.0 million barrels in 1992, dropping from 296.0 million barrels in 1991; State offshore production decreased to 22.0 million barrels in 1992, dropping from 23.2 million barrels in 1991; and Federal offshore production increased to 42.6 million barrels in 1992, up from 31.6 million barrels in 1991.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Boron Minerals.—California remained the sole source of domestic boron mineral production. Boron minerals sales valued at more than $338 million were slightly lower than those of 1991. Production of mineral concentrates and chemicals decreased from 1,240,000 metric tons in 1991 to 1,009,000 metric tons in 1992. Production from four California operations was principally from Kern County, with the balance from San Bernardino County.

The U.S. Borax & Chemical Corp. was the State's major producer from mining operations at Boron, Kern County. Production also was reported from North America Chemical Corp.'s Trona and Westend plants in San Bernardino County.

American Borate Co. reported mining a limited amount of colemanite from its Billie Mine in Death Valley National Monument, which was milled at Newport Mineral Venture's Amargosa Valley mill in Clark County, NV.

Calcium Compounds.—California was a distant second to Michigan, the leading State in natural calcium chloride production. National Chloride Co. of

America, Leslie Salt Co., and Hill Brothers Chemical Co. produced calcium chloride from dry-lake brine wells in San Bernardino County. Hill Brothers Chemical also produced calcium chloride from a second operation near Cadiz Lake.

Cement.—Portland cement production, 8,035,000 short tons valued at more than $428 million, was the State's second most valuable mineral commodity in 1992. The reported production was only slightly lower than 1991's estimated 8,702,000 short tons and about 20% lower than that reported in 1990. California continued to lead all States in the production of portland cement.

Clays.—Clay production in 1992 decreased slightly from that of 1991 to 1.906 million metric tons (2.1 million short tons) valued at more than $26 million. Common clay and shale comprised the bulk of the clays produced, but higher valued bentonite, fuller's earth, and kaolin production accounted for much of the value of California's clay production. Principal uses were for brickmaking, portland cement, ceramics, pet waste absorbents, and in structural concrete. Clay production was reported from 44 pits in 20 counties throughout the State. The Amador County Board of Supervisors approved use permits for North American Refractories Co.'s new clay mine and tile manufacturing plant in the Carbondale area, 6 miles northwest of Ione. The process will include mining, crushing, and screening clay, forming it into shapes for floor and roof tiles and baking in a gas-fired kiln.

Diatomite.—California retained its lead as the principal State in diatomite production during 1992, despite a slight reduction in total output. Celite Corp.'s diatomaceous earth mining facility, south of Lompoc in Santa Barbara County, was California's and the world's largest major producer of diatomite. Production also was reported from Santa Barbara County by Grefco Inc. and from Shasta County by Dicalite Corp.

Feldspar.—Feldspar production in California in 1992 was only reported from the CISCO plant in Orange County, which produced a feldspar-silica mixture.

Gypsum.—California's crude gypsum production in 1992 was only slightly lower than that of 1991. Mined gypsum was reported from five locations in Imperial, Kern, San Bernardino, San Luis Obispo, and Ventura Counties, with total State production of crude gypsum ranking fifth in the United States.

Calcined gypsum output from eight plants continued the State's ranking as the number one producer of calcined gypsum in the Nation. Byproduct gypsum was reported in Contra Costa and San Joaquin Counties. Continued weakness in the wallboard market caused most plants to operate well below capacity level.

California's 1992 production of calcined gypsum dropped 20% from that of 1991. U.S. Gypsum's Plaster City Mine and plant in Imperial County was the State's leading producer as well as the leading individual mine in the United States.

Lime.—Lime production of 280,000 short tons was 27,000 short tons below 1991's reported production, with value reportedly also down about 11%. Lime production was reported from 10 plants in Contra Costa, Glenn, Imperial, Monterey, San Joaquin, Santa Barbara, Tuolumne, and Yolo Counties. Chemstar Inc., with plants in Contra Costa, Los Angeles, and Monterey Counties, was the State's largest producer of hydrate and quicklime. Quicklime also was produced in Monterey County at the National Refractories & Minerals Corp. Natividad plant.

Holly Sugar Corp. used quicklime at four plants in Glenn, Imperial, San Joaquin, and Santa Barbara Counties.

Pumice.—California pumice producers included California Industrial Minerals Co. in Madera County, Glass Mountain Pumice Inc. in Siskiyou County, and the major producer, U.S. Pumice Co., in Mono County. Principal uses of pumice were as abrasives, in concrete aggregate, and in building and landscaping. Lesser amounts of pumice were used as dilutents and in stonewashing. California remained second in the Nation, after Oregon, as the largest source of pumice.

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

California construction sand and gravel and crushed stone statistics are compiled by geographical districts, as depicted in the principal mineral-producing localities map.

California led all States in the production and value of construction sand and gravel, which was the State's most valuable mineral commodity in 1992. A reported production of 112,887,954 short tons from 337 operations was valued at $522,107,997. One-half of the State's production came from seven companies, which, in order of rank, included California Portland Cement, a subsidiary of CalMat Co., Beazer USA/Hanson PLC, RMC Lonestar, A. Teichert & Sons Inc., Owl Rock Products Co., Granite Construction Co., and Pharris, C.L. Sand and Gravel Inc.

Despite numerous complaints from citizens groups, several sand and gravel operations received permits for expansions or new operations. Quality Rock Co. received a new permit to construct a new sand and gravel processing facility north of Moor Park's city limits in Ventura County. Granite Rock Co. received approval from the San Benito County planning commissioners to use three canyons in the Anzar Hills as a dump for unusable mining waste. North Star Rock Products received approval in December for the proposed expansion of its Birchville Rock Quarry near Grass Valley. Tarmac California sold its aggregate operations in Imperial, Riverside, and San Bernardino Counties to Granite Construction Inc. in August. American Rock and Asphalt Inc. received

TABLE 2
CALIFORNIA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	41,401	$198,097	$4.78
Plaster and gunite sands	3,489	18,357	5.26
Concrete products (blocks, brick, pipe, decorative, etc.)	463	3,844	8.30
Asphaltic concrete aggregates and other bituminous mixtures	16,959	95,192	5.61
Road base and coverings[1]	19,737	79,846	4.05
Fill	8,406	23,045	2.74
Snow and ice control	80	488	6.10
Railroad ballast	187	998	5.34
Other miscellaneous uses[2]	1,171	6,842	5.84
Unspecified:[3]			
Actual	12,766	51,883	4.06
Estimated	8,228	43,517	5.29
Total[4]	112,888	522,108	4.63
Total[5 6]	102,410	522,108	5.10

[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

clearance from Lake County to mine gravel along Putah Creek near Middletown. Syar Industries was allowed to continue mining gravel alongside the Russian River by a Sonoma County Superior Court in July. Butte County board of supervisors approved the extension of the use permit of Green Rock Quarries near Oroville in March.

Industrial.—Industrial sand and gravel production remained steady at about 2,100,000 short tons, which was used primarily in glassmaking.

California was second among the States in the production of industrial sand and gravel with both output and value similar to that of 1991. Production remained high owing to demands from local industry, particularly those of the glass container industry. The State's reported production of 2,095,541 short tons was valued at $42,396,000.

Eight companies reported industrial sand and gravel production from Amador, Contra Costa, Monterey, Orange, Riverside, Santa Cruz, and Ventura Counties. Owens-Illinois Inc., UNIMIN Corp., and Carona Industrial Sand Co. were the top firms in the State in both production and value.

In the State, the most important sources of industrial sand were the Ione Formation of Eocene Age in northern California, the Silverado (Paleocene) and Tejon (Eocene) formations in southern California, and the Eureka Quartzite of Middle Ordovician Age in central California.

Stone (Crushed).—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Other Industrial Minerals.—KCAC Inc.'s Joe Asbestos Mine near King City in San Benito County was the State's sole producer of asbestos. Barite was crushed and ground at Standard Industrial Mineral's Laws Mill in Inyo County and Geo International's plant in Sacramento County.

California potash production was from the near-surface brines at Searles Lake. Two seawater magnesia operations in Monterey and San Mateo Counties accounted for all of California's magnesium compounds production in 1992. Leslie Salt Co. produced salt from plants in Alameda, Napa, San Bernardino, and San Mateo Counties.

Metals

Gold.—California remained the second largest gold-producing State in the United States, after Nevada, with a reported production of 33,335 kilograms of gold (1,071,744 troy ounces), valued at nearly $370 million. Production was nearly 10% higher in 1992 than the revised 1991 output of 30,404 kilograms (977,510 troy ounces), which despite lower prices resulted in a $15 million increase in value. Production was reported from 16 lode mines in Calaveras, Imperial, Kern, Lassen, Napa, San Bernardino, Sierra, and Tuolumne Counties. Three placer operations were also reported in San Bernardino, Sierra, and Yuba Counties.

Cutbacks in personnel were announced at the State's two largest gold mines, Homestake Mining Co.'s McLaughlin Mine in Napa County and Gold Fields Operating Co.'s Mesquite Mine in Imperial County. Homestake reported production of 291,094 ounces of gold in 1992 in its annual report, making it the State's largest producer.

Viceroy Gold Corp. poured its first gold ore from the open p , heap-leach Castle Mountain Mine in San Bernardino County in February. Under an agreement with the Nature Conservancy, Viceroy established a 60,000-acre desert tortoise preserve at the adjoining Walking Box Ranch. Construction be n on a new grinding circuit scheduled for completion by July 1993, which is expected to increase recovery rates of recently discovered high-grade ore. Development

TABLE 3

CALIFORNIA:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	652	3,143	830	2,399	989	4,735	4,761	24,145
Plaster and gunite sands	W	W	96	304	45	340	427	2,481
Concrete products (blocks, brick, etc.)	—	—	—	—	—	—	(2)	W
Asphaltic concrete aggregates and other bituminous mixtures	242	3,027	536	5,451	W	W	2,546	17,503
Road base and coverings[3]	608	2,904	1,045	2,718	426	1,808	4,138	18,315
Fill	163	343	124	206	280	967	913	2,900
Snow and ice control	6	32	—	—	W	W	W	W
Railroad ballast	10	30	—	—	W	W	W	W
Other miscellaneous uses[4]	26	196	9	25	242	1,166	46	213
Unspecified:[5]								
Actual	13	43	2	3	16	83	1,058	5,437
Estimated	142	1,386	173	776	—	—	1,624	8,433
Total[6]	1,862	11,104	2,816	11,881	1,999	9,099	15,513	79,428
Total[7 8]	1,689	11,104	2,555	11,881	1,813	9,099	14,073	79,428

	District 5		District 6		District 7		District 8	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	829	4,630	4,473	21,182	1,610	9,719	3,536	15,419
Plaster and gunite sands	94	542	W	W	376	2,602	168	785
Concrete products (blocks, brick, etc.)	74	544	—	—	W	W	W	W
Asphaltic concrete aggregates and other bituminous mixtures	736	3,456	1,847	10,297	W	W	1,215	5,786
Road base and coverings[3]	1,402	6,971	1,788	7,846	402	1,530	1,760	7,060
Fill	560	1,351	762	3,029	805	2,358	844	1,175
Snow and ice control	69	432	—	—	—	—	W	W
Railroad ballast	107	587	W	W	—	—	W	W
Other miscellaneous uses[4]	102	693	561	3,343	451	2,946	77	474
Unspecified:[5]								
Actual	119	646	42	261	—	—	4,518	20,274
Estimated	561	2,776	—	—	32	161	1,641	7,918
Total[6]	4,653	22,628	9,474	45,958	3,676	19,315	13,759	58,892
Total[7 8]	4,221	22,628	8,595	45,958	3,335	19,315	12,482	58,892

See footnotes at end of table.

TABLE 3—Continued

CALIFORNIA:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 9		District 10		District 11		District 12	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	6,717	27,943	323	1,346	14,223	69,040	2,457	14,396
Plaster and gunite sands	992	4,161	W	W	1,119	5,970	W	W
Concrete products (blocks, brick, etc.)	—	—	—	—	W	W	160	1,797
Asphaltic concrete aggregates and other bituminous mixtures	3,804	16,894	W	W	4,254	23,863	1,126	6,103
Road base and coverings[3]	3,027	9,776	397	1,171	3,487	15,467	1,217	4,218
Fill	444	860	543	714	2,200	7,751	767	1,392
Snow and ice control	—	—	—	—	—	—	—	—
Railroad ballast	W	W	—	—	W	W	W	W
Other miscellaneous uses[4]	25	223	255	1,229	302	1,546	104	503
Unspecified:[5]								
Actual	4,409	16,394	23	35	1,955	4,927	610	3,780
Estimated	2,703	15,711	525	2,609	216	1,017	610	2,730
Total[6]	22,120	91,962	2,067	7,104	27,757	129,582	7,051	34,920
Total[7 8]	20,067	91,962	1,875	7,104	25,181	129,582	6,397	34,920

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Excludes 140,000 short tons valued at $235,001, not reported by county.
[2]Less than 1/2 unit.
[3]Includes road and other stabilization (cement and lime).
[4]Includes filtration.
[5]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[6]Data may not add to totals shown because of independent rounding.
[7]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[8]Total quantity and total value in thousand metric tons and thousand dollars.

and exploration drilling programs also were continued at the Castle Mountain Mine during the year.

The 1,000-acre Hayden Hill gold mine project north of Susanville in Lassen County was dedicated in August. Included in the project are a 256-acre surface gold mine, ore processing plant, gold processing plant, and cyanide heap-leach facility. Siskon Gold Corp. proposed in November to develop an underground gold mine on a 22-acre San Juan Ridge property near North Columbia in Nevada County. Rand Mining Co. received construction and operating permits for its Baltic Mine Project near Randsburg in Kern County in December.

Silver.—Silver production in the State was reported from 12 lode and 2 placer operations in 1992, principally as byproducts of gold production. California's total reported output of 18 metric tons (578,713 troy ounces) of silver was valued at $2,259,000, about 20% higher than 1991 in the amount produced despite declining prices, which lowered the corresponding value increase. Cactus Mining Co.'s Yellow Aster Mine in Kern County and Homestake Mining Co.'s McLaughlin Mine in Napa County were the largest producers. Silver production was reported in Calaveras, Imperial, Kern, Lassen, Napa, San Bernardino, Sierra, Tuolumne, and Yuba Counties.

Tungsten.—California was the only producer of mined tungsten concentrates in the United States in 1992. Curtice Tungsten Inc. intermittently operated its Andrew Tungsten Mine near Los Angeles and U.S. Tungsten Corp., Bishop, Inyo County, continued as the only other company producing tungsten concentrate. Low prices in the existing tungsten market limited both mine production and operations at its APT conversion facility.

Other Metals.—A small amount of mercury was recovered at Homestake Mining Co.'s McLaughlin Mine in Napa County. Byproduct molybdenum shipments were reported from Umetco Minerals Pine Creek Mine in Inyo County. All of the State's 1992 molybdenum production also was recovered as byproduct from Umetco Mineral's Pine Creek operation. No lead or zinc production was reported in 1992. Iron ore production was reported from the Beck Mine, San Bernardino County.

Molycorp Inc. mined bastnasite at its Mountain Pass open pit.

American Steel, a division of Portland, OR.-based American Industries Inc., entered into a joint venture with Los Angeles-based Reliance Steel and Aluminum Co. to construct a $7 million

steel distribution center in West Sacramento. Construction was begun on the 110,000-square-foot center in September.

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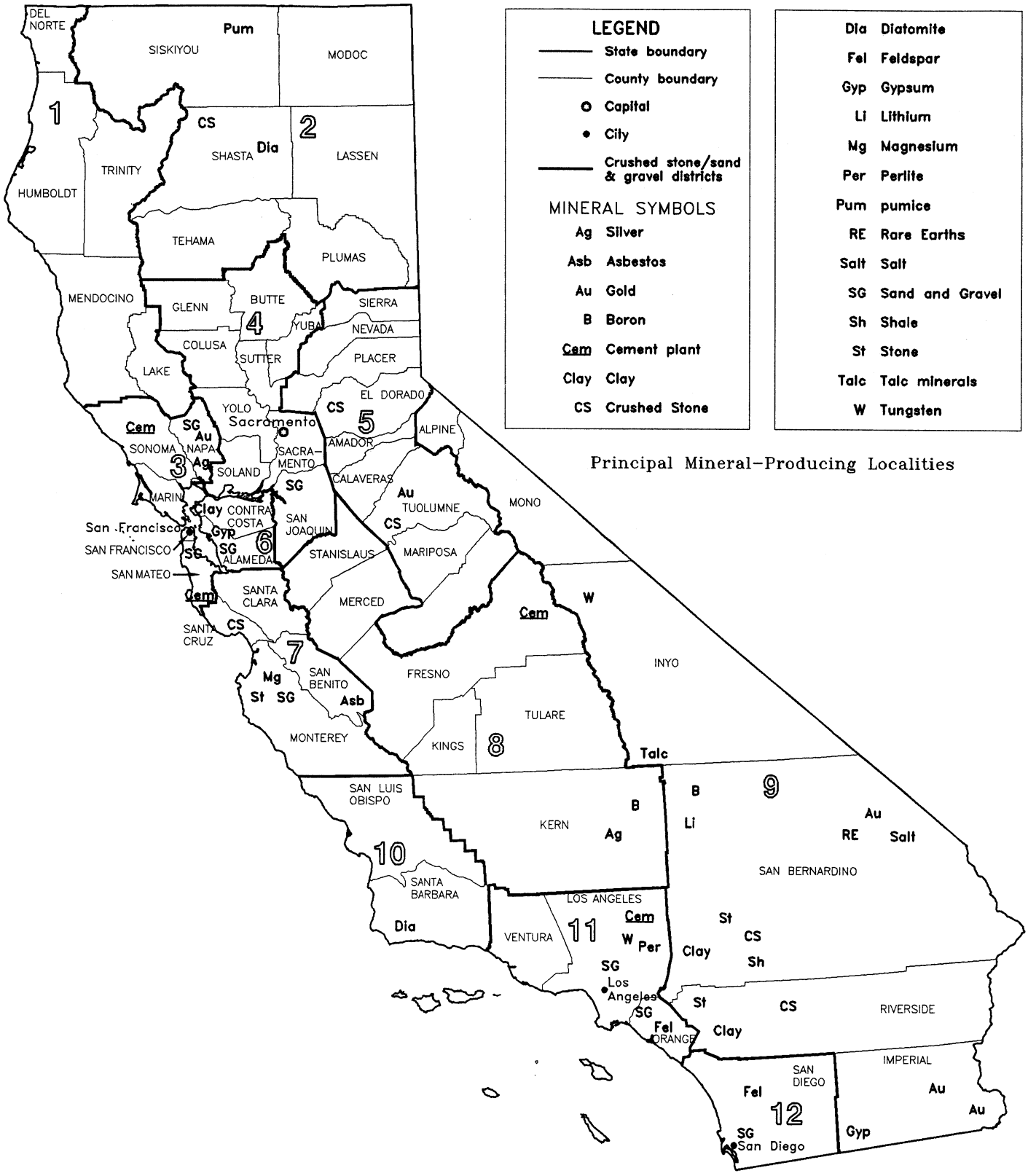
[1]State mineral officer, U.S. Bureau of Mines, Reno, NV. He has 27 years of mineral-related government experience and has covered the mineral activities in California for 11 years. Assistance in the preparation of the chapter was given by Marguerite Roberto, program assistant.

[2]State geologist, California Department of Conservation, Division of Mines and Geology, Sacramento, CA.

[3]Geologist, California Department of Conservation, Division of Mines and Geology, Sacramento, CA.

CALIFORNIA



Principal Mineral-Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Asbestos:			
KCAC Inc.	Box K King City, CA 93930	Surface mine and plant	San Benito.
Boron minerals:			
Kerr-McGee Chemical Corp.[1]	Kerr-McGee Center Oklahoma City, OK 73125	Evaporators and plant	San Bernardino.
U.S. Borax & Chemical Corp.	3075 Wilshire Blvd. Los Angeles, CA 90010	Surface mine and plant	Kern.
Calcium chloride:			
Leslie Salt Co.,[2] a subsidiary of Cargill Inc.	Box 5621 Minneapolis, MN 55440	Solar evaporators	San Bernardino.
National Chloride Co. of America	Box 604 Norwalk, CA 90650	do.	Do.
Cement:			
CalMat Co.[3]	3200 San Fernando Rd. Los Angeles, CA 90065	Plants	Various.
Mitsubishi Mining & Cement Co. (Kaiser Cement Corp.)	300 Lakeside Dr. Oakland, CA 94612	do.	Do.
Southwestern Portland Cement Co.[4]	Box 937 Victorville, CA 93292	Plant	San Bernardino.
Clays:			
Excel-Mineral Co., Inc.	Box 878 111 South La Patera Lane Goleta, CA 93116	Pits	Kern.
Riverside Cement Co.[5]	Box 832 Riverside, CA 92592	do.	Various.
Lightweight Processing Co.	715 North Central Ave. Suite 321 Glendale, CA 91203	do.	Ventura.
Lincoln Clay Products Co.	Box 367 Lincoln, CA 95648	Pit	Placer.
Lone Star Industries Inc., Pacific Region, Santa Cruz plant[5]	11555 Dublin Canyon Rd. Pleasanton, CA 94566	Pit	Santa Cruz.
Port Costa Materials Inc.	Box 5 Port Costa, CA 94569	Pit	Contra Costa.
Diatomite:			
Grefco Inc.	3435 Lomita Blvd. Torrance, CA 90509	Surface mine and plant	Santa Barbara and Shasta.
Manville Products Corp.	2500 Miguelito Rd. Lompoc, CA 93436	do.	Santa Barbara.
Feldspar:			
California Silica Products Co.[6]	Box 249 31302 Ortega Highway San Juan Capistrano, CA 92693	do.	Orange.
U.S. Silica Co.	3231 Oceanside Dr. Oceanside, CA 92054	Mine and plant	San Diego.
Gold:			
Gold Fields Operating Co.[7]	HCR 75 Glamis 100 Brawley, CA 92227	Surface mine	Imperial.
Homestake Mining Co.[7]	650 California St. San Francisco, CA 94108	Surface mine and plant	Napa.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Gypsum:			
U.S. Gypsum Co.	Plaster City, CA 92269	Surface mine and plant	Imperial.
Lime:			
Chemstar Inc.[8]	901 Mariners Island Blvd. Suite 425 San Mateo, CA 94404	do.	Monterey.
National Refractories & Minerals Corp.	Box 1938 Salinas, CA 95039	do.	Do.
Perlite:			
American Perlite Co.	11831 Vose St. North Hollywood, CA 91605	Surface mine and mill	Los Angeles.
Pumice:			
U.S. Pumice Co.	20219 Bahama St. Chatsworth, CA 91311	Mine and mill	Mono.
Rare earths:			
Molycorp Inc.	Union Oil Center 461 South Boylston St. Los Angeles, CA 91017	Surface mine	San Bernardino and Los Angeles.
Sand and gravel (construction):			
CalMat Co.[9]	3200 San Francisco Rd. Los Angeles, CA 90065	Pits	Various.
Beazer USA/Hanson PLC	Box 832 Riverside, CA 92502	do.	Do.
Owl Rock Products Co.	Box 330 Arcadia, CA 91006	do.	Do.
A. Teichert & Sons Inc., Teichert Aggregates	Box 15002 Sacramento, CA 95851	do.	Do.
Granite Construction Co.	Box 900 Watsonville, CA 95077	do.	Do.
Sodium compounds:			
Kerr-McGee Chemical Corp.	Box 367 Trona, CA 93562	Plant	San Bernardino.
Stone:			
Beazer USA/Hanson PLC	Box 832 Riverside, CA 92502	Quarries	Various.
Tungsten ore and concentrate:			
U.S. Tungsten Corp., a subsidiary of Strategic Minerals Corp. (Stratcor)[10]	Route 2 Bishop, CA 93514	Underground mine and plant	Inyo.
Vermiculite (exfoliated):			
W.R. Grace & Co.	1114 Avenue of the Americas New York, NY 10036	Plants	Alameda and Orange.

[1]Also lime, potassium salts, sodium carbonate, and sodium sulfate.
[2]Also salt.
[3]Also clays, gypsum, and iron ore.
[4]Also clays.
[5]Also cement and industrial sand.
[6]Also industrial sand.
[7]Also silver.
[8]Also magnesium compounds.
[9]Also stone.
[10]Also molybdenum.

THE MINERAL INDUSTRY OF COLORADO

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Colorado Geological Survey for collecting information on all nonfuel minerals.

By Eileen K. Peterson[1] and James A. Cappa[2]

In 1992, Colorado's nonfuel mineral production was valued at about $384 million, an increase of more than 13% from the value of production reported to the U.S. Bureau of Mines (USBM) for 1991. The continued effects of an economic slowdown on metal values were evident for copper, gold, lead, molybdenum, silver, and zinc. Significant increases were noted in the value of production of cement, gold, gypsum, construction and industrial sand and gravel, and crushed and dimension stone. Modest increases in values were noted for clays, lime, and Grade-A helium. Both production and value dropped significantly for copper, lead, and zinc.

Nationally, the State rose from 31st to 29th in total nonfuel mineral value and from 1.12% to 1.2% of the U.S. total. The principal minerals produced, in order of decreasing value, were construction sand and gravel, portland cement, molybdenum, crushed stone, and gold. Among the six metals produced, only gold showed an increase in both quantity and value of production. Major construction projects in Colorado accounted for the increases in production for most industrial minerals.

TRENDS AND DEVELOPMENTS

Business trends in Colorado continued to buck the national downward trend during 1992. Mirroring the statewide economic upturn, the value of all minerals produced in the State in 1992 rose more than $61 million, with coal production accounting for $15 million of the increased value. Colorado's nonfuel mining industry reversed a downward trend, in both production and value, that began in 1989.

Colorado was one of six Rocky Mountain States described as the hottest economic area in the Nation in 1992 because the economies of those States were performing at levels significantly better than the national average. The upward trend in Colorado was expected to continue during 1993.

TABLE 1
NONFUEL MINERAL PRODUCTION IN COLORADO[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	262,292	[2]$1,864	[2]263,866	[2]$1,964	[2]242,310	[2]$1,796
Gemstones		NA	66	NA	287	NA	225
Gold[3]	kilograms	2,357	29,176	3,181	37,154	3,763	41,741
Peat	thousand short tons	W	W	W	396	W	333
Sand and gravel (construction)	do.	r23,051	r77,761	e26,400	e88,200	29,455	105,281
Silver[3]	metric tons	23	3,557	20	2,565	W	W
Stone:							
Crushed	thousand short tons	[4] r7,600	[4] r6,100	8,401	41,022	e12,000	e60,400
Dimension	short tons	r e5,483	e(5)	W	W	e6,454	e252
Combined value of cement, (portland), clays [bentonite (1990-91), fire (1992)], copper, gypsum (crude), helium (Grade-A), lead, lime, molybdenum, perlite, sand and gravel (industrial), stone [crushed traprock, (1990)], vanadium (1990), zinc, and values indicated by symbol W		XX	r228,181	XX	166,817	XX	174,750
Total		XX	r376,705	XX	338,405	XX	384,778

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

[3]Recoverable content of ores, etc.

[4]Excludes certain stones; kind and value included with "Combined value" data.

[5]Revised data must be withheld to avoid disclosing company proprietary data; value included with "Combined value" data.

Production of industrial minerals increased significantly with continued improvements in commerical and private construction businesses. During 1992, 21,064 residential units valued at more than $2.4 billion were permitted for construction, up from 14,071 residential units valued at about $1.5 billion in 1991. Construction permits also were issued for 25 hotels and other shelters valued at slightly more than $10 million. Other permitted commercial buildings were valued at more than $389 million, up from $300 million in 1991.

Work on the new Denver International Airport and Interstates 70 and I-79 provided a strong base for commercial construction activity. Construction of the airport, at a cost of $2.7 billion, makes it one of the largest ongoing construction projects in the United States. Construction of runways, taxiways, and parking aprons alone will require more than 6 million square yards of pavement. Production of construction aggregate in Colorado is expected to remain high at least until the project is completed, scheduled for late 1993.

The final link in Interstate 70 was formally dedicated in October, marking the end of a 12-year effort to construct the interstate through scenic Glenwood Canyon in western Colorado. The $484 million construction effort to complete 12 miles of highway included 30 million pounds of structural steel, 30 million pounds of reinforcing steel, and 400,000 cubic yards of concrete.

Rumors of an upcoming repeal, or drastic changes, in the 1872 Mining Law caused concern for many mining companies and government agencies in Colorado. Expected impacts included loss of jobs, loss of income from taxes to the State, and loss of access to public lands. Despite nearly 2 years of hearings, the U.S. Congress did not pass a proposed 1-year moratorium on sales of Federal land to miners. Patenting of mining claims is expected to increase significantly in 1993 in anticipation of additional legislation along these lines. Uncertainties during the year and apprehension over upcoming Federal legislation resulted in little in the way of new development or exploration activity in Colorado and the rest of the Western United States in 1992.

The prospect of changes in the 1872 Mining Law immediately cast a pall over what could have become another golden age for western mining. Although metal prices are low, numerous large- and mid-size mining companies have come to Colorado as a base for exploration activities in the west. Advanced mining and processing techniques have increased yields, especially for gold, making once marginal deposits of development interest from an economic standpoint. Expected legislative changes will impact exploration activities whether they are ever passed or not.

Because of increasing Federal, State, and local regulations, mine operators continued to place more emphasis on managing environmentally sound operations to meet regulatory requirements, satisfy public interest groups, and protect fragile ecosystems. Compliance with new and existing regulations will undoubtedly require more of mine operators' time and increase operating expenses at all mines.

Passage of the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) provided highway construction money and was expected to boost both quarrying and construction activities for several years to come. Although the U.S. Congress did not fully fund the bill during its first 2 years, ISTEA funding increased nationwide highway and street construction in 1992 by 11%. Future funding commitments were expected to increase construction activity by about 8% in both 1993 and 1994.[3] Production of construction aggregate should closely reflect increases in highway funding.

Suburban growth, coupled with increasingly restrictive environmental and zoning regulations and depletion of reserves at existing production sites, could result in significant increases in construction aggregate costs in the near future. The use of crushed stone may increase, relative to the use of sand and gravel, as producers are forced to look at underground mining to avoid some public visibility and protests.

In the future it may be necessary for land use planners to "require" that usable construction aggregate resources be mined prior to zoning for residential, recreational, or land fill use. As producers are forced to move further from points of consumption, costs to consumers will increase dramatically. Protection of aggregate deposits from urban encroachment is, however, very uncommon in today's urban communities.

Colorado residents set a record for recycling at a rate 16% above the national average. The average resident recycled nearly 13 pounds of aluminum and nearly 14 pounds of glass. About 80% of the aluminum cans in the State are recycled. Commercial recycling of construction wastes is also on the rise in Colorado, with numerous companies providing recycling for asphalt, concrete, tires, porcelain products, and metals. Several counties provided programs to collect hazardous household chemicals not wanted in landfills.

EMPLOYMENT

In 1992, Colorado's mining employment, including coal production, totaled 4,820, down a little more than 8% from the 5,213 reported for 1991. Nonfuel mining employment averaged 2,185 with an additional 892 people employed in mills and preparation plants. Coal mining and processing accounted for an additional 1,743 employees. The average unemployment rate for Colorado in 1992 was about 5.4%.

According to U.S. Department of Labor statistics, injuries reported from Colorado nonfuel surface and underground mines, mills, and preparation plants included 108 injuries resulting in lost workdays and 80 injuries resulting in no lost workdays during 4.2 million employee-hours worked. Coal mines and preparation plants in Colorado reported 2 fatalities, 97 injuries resulting in lost workdays, and 63 injuries resulting in no lost workdays during 3.3 million employee-hours worked.

ENVIRONMENTAL ISSUES

Although the domestic mining industry has spent $14 billion in the past 20 years to improve the environment, second only to oil and gas industry expenditures among all manufacturing groups,[4] the industry continued to be assailed as a despoiler of the environment. In response to legislation, public pressure, and concern for the environment, mining companies have drastically changed the way they do business. Environmental planning and reclamation of depleted mining sites have become integral parts of today's mining operations and a significant economic component of the cost of doing business.

The U.S. Environmental Protection Agency (EPA) completed studies to determine the effects of burning a wide variety of wastes, such as waste fuels, industrial waste, spent organic solvents, and used tires, as fuel in cement kilns. EPA found there was no threat to human health or to the environment from emissions created by burning many hazardous waste in cement kilns. New regulations are expected in 1994 to eliminate excessive regulations prohibiting the use of hazardous waste in the production of cement or other building materials. Whether these findings will calm public fears remains to be seen.

EPA abandoned plans announced in April to redefine when waste material is hazardous. As a result of widespread criticism of the planned changes, the Agency will develop a new proposal within 2 years. At least 42 State attorneys general had objected to the rule changes. Under current regulations, the EPA requires that refinery wastes, heavy-metal sludge, and toxic solvents be given special treatment and not be disposed of in landfills used for conventional garbage. Industry had argued that the definition is too broad: it does not consider the effect of dilution with other nontoxic wastes and includes nontoxic materials derived from a waste that is considered hazardous.

The Occupational Safety and Health Administration (OSHA) ruled that six minerals, including actinolite, tremolite, and anthophyllite, would no longer be treated as forms of asbestos in health and safety regulations. These minerals are commonly found in aggregates and will now be treated as particulates. The OSHA ruling could save operators $7 million annually in control measures designed to deal with the minerals.

Also of interest to aggregate producers were new EPA regulations to implement air pollution controls. New standards were set for particulate matter that apply to calciners and dryers at plants processing or producing construction products. EPA anticipated the new regulations could result in product price increases of less than 0.5%, but could go as high as 1.75% for the lightweight aggregate industry.

Stormwater runoff permits, required by EPA under the Clean Water Act, affected most mining operations in Colorado. The permit is required for any "contaminated" runoff into waters of the United States originating from lands disturbed by mining, mineral beneficiation, or mineral processing activities. EPA decided the requirements apply to inactive as well as active mines. The Colorado Department of Health has issued general permits for mining-related stormwater runoff. The full impact of the requirements on mining operations, and land owners, is not yet known.

The Colorado Department of Health, Division of Minerals and Geology, and the EPA signed a memorandum of understanding (MOU) to implement a procedure by which the State would receive protection from liability pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The procedure would protect the State from provisions of the Superfund Amendments and Reauthorization Act of 1986 while engaged in cleanup of abandoned or inactive mines.

The State, through the MOU, has avoided becoming a third party in litigations over cleanup responsibility. Several Colorado companies have become embroiled in such lawsuits as third parties. In one instance, a scrap recycling company was sued by a county for damage to county property due to waste the company had sold as recycled metals to a smelter that operated on county land. Fear over potential financial liability under CERCLA has resulted in many companies backing off from cleanup activities.

The Colorado Mined Land Reclamation's Inactive Mine Program reported that 3,000 of the 21,000 abandoned mines inventoried in Colorado have been made safe. Many of the 21,000 mines are on the 8 million acres controlled by the Bureau of Land Management (BLM) and the 14 million acres administered by the U.S. Forest Service. The State Geological Survey worked with the Forest Service to inventory, and prioritize for action, abandoned mine sites on national forests in Colorado.

The EPA conducted washing tests on contaminated soils at the Sand Creek Superfund site west of Stapleton International Airport, Denver County, during the year. The tests were conducted using an innovative technology that works much like a household washing machine. The process scrubbed at least 90% of the contaminants from 6,000 pounds of soil during one test run. The test site, an abandoned industrial site, contains at least 21,000 short tons of contaminated soil. Petroleum products and heavy metals, such as arsenic, cadmium, and nickel, were found in the soil. Washing the soil is cheaper than incineration, $50 per short ton as opposed to $1,000 per short ton.

After 10 years of litigation, ASARCO Inc. reached an agreement with the Colorado Department of Health and the Colorado Attorney General's office on a proposed remediation plan for Asarco's 106-year-old Globe plant in north Denver. Asarco will undertake the cleanup of contamination in the soil, ground water, and surface water, both in and around the plant, as well as isolation of a former neutralization pond at the plant. The plan also included a community medical monitoring program, reimbursement of costs incurred by the State, and reimbursement for natural resource damages. Costs of the cleanup

were estimated to be between $31 and $38 million. The 89-acre plant site has been a metals processing facility since it began operation in 1886 as a gold and silver smelter. Currently, the plant is a refinery for cadmium, widely used in rechargeable batteries.

The U.S. Bureau of Reclamation held dedication ceremonies for the Leadville Mine Drainage Tunnel water-treatment plant, and Resurrection/Newmont Mining Co. and ASARCO Inc. Joint Venture completed construction of the Yak Mine Drainage Tunnel water-treatment plant. Drainage from both the tunnels is acidic and has excessive levels of heavy metals, created by the oxidation of sulfide minerals. Naturally occurring oxidation has been exacerbated by past mining activities.

The Yak Tunnel, completed in 1906, was the first project in the Leadville, CO, area designed to dewater mines. Functioning as both a drain and as an ore haulage tunnel, the 6.4-kilometer-long tunnel drained 97 kilometers of underground workings within a 41-square-kilometer area. During World War II, the War Production Board ordered emergency production and subsidized the operations of many mines, mills, and smelters in the Leadville area. To help boost production, the Leadville Mine Drainage Tunnel was constructed by the USBM in 1943 to help dewater Leadville area mines. During the 1950's, the tunnel was extended to a length of more than 3 kilometers. In 1959, the Bureau of Reclamation acquired the drain as a supplementary source of water.

In 1983, the California Gulch, into which the Yak Tunnel drains, was among the first mine drainage sites in the Nation to be named to the EPA Superfund priority cleanup list. As the last major active mining company in the Leadville area, the Resurrection-Asarco Joint Venture was identified as a "responsible party" despite the fact the mining operation is beyond the Superfund site and does not impact California Gulch. Resurrection-Asarco Joint Venture spent $8.5 million to build the California Gulch water-treatment plant and will have an estimated annual plant operating cost of nearly $1 million in perpetuity. Sludge from the plant (about 195 metric tons per year) will be mixed with mine zinc concentrates and shipped to a smelter for recovery of metals.

The Bureau of Reclamation water-treatment plant for the Leadville drain cost about $5 million and will have an annual operating cost of about $600,000. An undisclosed amount of sludge from the treatment plant will be sent to a landfill for disposal.

Nine years after Colorado first filed suit against Idarado Mining Co., reclamation plans for company Superfund mine properties in the Red Mountain area of Ouray County have been approved. The $11 million cleanup plan includes 5 years of reclamation work followed by 10 years of evaluation. The settlement also included $1 million in compensation for loss of natural resources and $100,000 to improve fish habitation on the San Miguel and Uncompahgre Rivers. Work on direct revegetation of tailings piles will start in 1993. A $5 million bond will be posted to cover costs should the company go out of business before reclamation efforts are found to be acceptable. In addition to its own mine sites, the company will clean up polluted water discharges from a dozen other mines in the area.

In the Aspen area of Pitkin County, the Atlantic Richfield Co. (ARCO) agreed to pay the State $144,000 to defray cleanup costs at the Smuggler Mountain Superfund site. That payment was in addition to an $1.6 million payment agreed to earlier. The USBM also agreed to pay $1.6 million to EPA for liability from sampling and redisposal of mine tailings and waste rock at the site in the late 1940's and early 1950's. The area is contaminated with lead and mining waste. Three residential developers agreed to pay the EPA a total of $78,675 toward cleanup costs for disturbing mine wastes while building townhomes, apartments, and mobile home parks on the site. Cleanup of the Superfund site was halted during the summer of 1991 when residents balked at the severe remediation plans of EPA—excavating and replacing up to 1 foot of topsoil.

Cleanup plans submitted by Cotter Corp. for its uranium-vanadium mill south of Canon City were rejected by Colorado Department of Health officials. The State will work with Cotter Corp. to revise the plan to address health risks from windblown material from the mill site.

Tailings removal from numerous uranium processing sites in western Colorado began during the year and others were scheduled to begin in the coming years. The largest projects are in the Gunnison, Montrose, and Rifle areas.

What is undoubtedly one of Colorado's worst mine reclamation disasters continued to unfold during the year when Summitville Consolidated Mining Co. filed for chapter 7 bankruptcy protection in December and walked away from ongoing reclamation work at the Summitville Mine in Rio Grande County. Despite attempts by the State to force parent company Galactic Resources Inc., Vancouver, to continue detoxification efforts and operation of a water-treatment system, the EPA had to take over operation of the facility in mid-December to avoid the release of toxic chemicals into the Alamosa River. Upon assuming cleanup at the mine site, EPA began the search of other potentially responsible parties who might share in the cleanup expense. Operating costs for the water-treatment plant have been estimated to be running as high as $50,000 per day.

Colorado State officials had estimated that Summitville would require at least $20 million of cleanup work; however, the mine operators had only been required to post a $4.7 million reclamation bond. Late in the year, the State ordered the two companies to resume operations in compliance with State and Federal environmental laws. Neither company had complied with that order by yearend. The uncertain financial condition of the parent company led some State officials to fear that the company also might file for bankruptcy protection to avoid the costly cleanup. Summitville Consolidated Mining Co. had spent more than $2 million for grading, topsoil replacement, and surface water control before abandoning the site in

December.

Mining at the site ended in 1991, and heap leaching was completed in March of 1992 and reclamation begun. The mine operated for only 5 years but reclamation could take much longer. During the life of the mine, the company lost $70 million because of environmental problems and failures in basic design. The company had four serious releases of cyanide into the Alamosa River while it operated the heap-leach mining operation. The State agency charged with monitoring the mine was widely criticized for allowing continued operation of the mine. However, the State legislature had made drastic cuts in funding for the Mined Land Reclamation Div. leaving it severely understaffed; at times only 5 regulators were available to monitor as many as 2,000 mining operations.

EXPLORATION ACTIVITIES

Continued low metal prices attributed to cutbacks in exploration activity in Colorado during 1992. The pattern of decline is expected to continue as long as metal prices remain low. Rumors late in the year about changes in regulations on holding mining claims and obtaining mineral patents were expected to increase exploration activity early in 1993 to determine what claims should be retained.

Caprock Exploration drilled out a resource of 710,338 metric tons, or 783,000 short tons, containing up to 8% zinc, plus copper, lead, and silver, in the North Park area several years ago but has not announced any plans for development. Caprock had been contacting major mining companies looking to put the property into commercial production. Low metal prices for these metals has not helped prospects for development of these resources.

Challenger Gold conducted exploration drilling on the Baca Land Grant in Saguache County. The company completed mapping and sampling as well as 31 reverse-circulation drill holes.

Kennecott Exploration Co. conducted exploration drilling in Pike National Forest, Park County, and in the San Isabel National Forest, Chaffee County. Silver and zinc were the focus of the exploration effort. Although neither metal is of particular development interest now, because of low market prices, the development process for any prospect is long and market conditions could change by the time a mining operation could be developed.

The Uranerz Co. completed a 3-year exploration project on the Dawson gold prospect south of Canon City, Fremont County. More than 20 diamond drill holes were completed. The property reportedly contains about 3,920 to 4,043 kilograms, or 126,000 to 130,000 troy ounces, of in-place gold reserves.[5]

Hecla Mining Co. completed six reverse-circulation drill holes on its Round Mountain property just outside Silver Cliff, Custer County. Gold mineralization in Tertiary volcanic rocks was the target of exploration drilling.

Canyon Resources, Tenneco Minerals, Noranda, and ACNC completed about 50 diamond drill holes while exploring the Tennessee Pass property in Lake County. Canyon Resources is conducting additional work north of Leadville, Park County.

Teck Resources completed several large-diameter drill holes in the Powderhorn titanium district in Gunnison County. The holes were drilled to test a sulfation method of processing perovskite ore, to obtain better data on perovskite concentration, and to gather information for baseline environmental studies. Teck Resources planned to do additional drilling in 1993.[6]

Larimer County Commissioners issued a special review permit to Diamond Co. NL for diamond exploration in the State Line kimberlite district. The district has attracted much attention during the current rush in diamond exploration.

A rare black marble was discovered near Redstone, Pitkin County. The jet-black marble is worth about twice as much as the most expensive white marble. No development plans were announced during the year.

LEGISLATION AND GOVERNMENT PROGRAMS

The following Colorado legislative bills, signed by the Governor, addressed environment, reclamation, safety, taxes, and wilderness issues.

Senate bill 92-105 implements the 1990 amendments to the Federal Clean Air Act in Colorado. The 1992 Colorado Clean Air Act impacts stationary sources of air pollution but not mobile sources. Construction industry stationary sources such as asphalt and concrete plants and crushing equipment are exempt from local control but remain under State rules. The legislation also defined "potential to emit" as the maximum capacity of a stationary source to emit a pollutant under its physical and operational design plus operating restrictions. The 1993 legislature is expected to address air pollution standards for mobile sources.

House bill 92-1200 established standards for Colorado's antidegredation program for water quality. The legislation prescribed water quality permit fees, enabled the State to operate a stormwater discharge program, and required a study of the State's water quality control program. The State also used the legislation to notify the Federal Government that the State will return the Safe Drinking Water Act program to the EPA, if the boundaries and cost of the program are not addressed by the Federal Government.

Senate bill 92-163 was passed to bring the State coal reclamation program into conformance with Federal requirements.

House bill 92-1223 placed the Mined Land Reclamation Div. and the Division of Mines under a Director of Minerals and Geology. The bill also provided for a study and report on the Geological Survey and required specific studies and plans to foster the Colorado mineral industry.

House Joint Resolution 92-1032 created a task force to study current policies and procedures for valuation of producing metal mines for property tax valuations.

Several bills of interest to the mining

industry failed to pass during the legislative session. A bill allowing for local regulation of mining sites failed to pass as did a bill to establish a separate environmental enforcement statute. A proposal to allow for local government representation on the Mined Land Reclamation Board also failed to pass.

Passage of Amendment 1 in November, a tax and spending limitation, is expected to decrease State government spending on construction projects. Long-term effects of the amendment remain to be seen.

On the Federal scene, a significant impact on mineral exploration and development in the west is the expected result of the 1993 Appropriations Act for the U.S. Department of the Interior, signed in October 1992. The act included a requirement for holders of unpatented mining claims to pay the Federal Government a new rental fee of $100 per claim per year. The rental fee will expire September 30, 1994, unless extended. Payment of the fee replaces a requirement for performance of a minimum of $100 of assessment work per claim per year. The 2 rental years start September 1, 1992, and run to August 31, 1994. Enforcement of this fee was expected to result in forfeiture of many mining claims in Colorado. Many claimholders able to conduct the $100 of assessment work on their own time may not be able to raise the money to pay rental fees. The BLM was expected to draft rules for implementing the rental fee provision with final rules expected early in 1993. Small miners, who have 10 or fewer claims and who meet certain criteria with respect to levels of production or exploration activity and unreclaimed surface disturbance, may be exempted from the rental fee.

The U.S. Senate did not approve a 1-year halt in Federal land sales by granting patents, or title, to mining claims. The U.S. Department of the Interior issued regulations that would halt what it called "frivolous" appeals on land management decisions. The BLM no longer automatically halts exploration or development work while an appeal is being heard by the Interior Board of Land Appeals. The Department set a limit of 30 days in which an appeal must be made, and subsequent stays of action will follow a review period of only 40 days. Subsequent appeals will not be heard.

A proposed rule was issued by the BLM that would regulate use and occupancy of unpatented mining claims on public land. The proposed rule would restrict the use of unpatented mining claims and mill site locations on BLM-managed Federal lands under the 1872 Mining Law. Use of such lands would be limited to activities related to prospecting, mining, or processing operations and other needed activities. The proposed rule would apply only to lands managed by the BLM and would not apply to State or private lands where the mineral estate has been reserved to the United States or to lands administered by other Federal agencies.

The Comprehensive National Energy Policy Act, signed by the President, included a provision that obligates the Federal Government to fund reimbursement of remediation expenses of uranium mill sites where the waste was generated in fulfilling Government contracts. The number of uranium mill sites in Colorado that will be affected by this act is not yet known.

An attempt by the U.S. Forest Service to designate critical habitat for an obscure alpine plant in Park County was abandoned. The Forest Service had planned to establish a 695-acre Research Natural Area. When the proposed action was challenged by a county mining association, it was disclosed that the Forest Service did not have legal authority to undertake the proposed action.

The 1992 U.S. Congress failed to pass wilderness legislation before it adjourned. Senate bill 1029 would have provided for the protection of 700,000 acres of public land in 24 parcels in Colorado. It was expected that the bill would be the starting point for wilderness legislation during the 1993 session.

U.S. Senate bill 2552, the "Hard Rock Mining Reclamation Acceleration Act," proposed to establish a cost-sharing program for a demonstration reclamation project. State and local governments would be required to contribute at least 20% of the remediation costs. Several mine sites in Colorado were being considered as the demonstration site.

The USBM Denver Research Center studied stope leaching of fragmented mineralized rock with environmentally acceptable leachants. This research was aimed at recovering low-grade reserves in underground stopes and minimizing surface disposal of mine tailings. Research was conducted at the Colorado School of Mines experimental mine near Idaho Springs.

The USBM and the Colorado School of Mines continued work on a study of the use of an onboard computer and ultrasonic sensors to automatically guide an articulated dump truck.

The Solar Energy Research Institute (SERI) in Golden, Jefferson County, a National Laboratory, is seeking ways to merge its discoveries with businesses that can put products on the market. The lab has an annual budget of $95 million, a staff of 500, and is the only National Laboratory devoted to finding environmentally safe fuels and electricity.

During 1992, the Colorado Geological Survey (CGS) continued work on coalbed methane research in the San Juan and Sand Wash Basins. The CGS cooperated with the U.S. Geological Survey to core drill two holes into the 26.6-million-year-old Creede Caldera to gain a better understanding of one of the most mineral-rich areas in the world. The CGS continued work on a mineral occurrence map of the State. CGS completed work on the "Atlas of Major Rocky Mountain Gas Reservoirs," due out in 1993, and a guide to "Gold Panning and Gold Placering in Colorado" (Information Series 33).

Reclamation work supervised by the Colorado Mined Land Reclamation Div. continued throughout the State.

The Colorado State Board of Land Commissioners released a Proposed Multiple Use Policy for State trust lands during the year. The plan outlined a proposal that could allow some form of increased public access to as much as 75% of the 3 million surface acres of

land managed by the board. The board also is responsible for 4 million acres of mineral rights given to the State at the time of statehood to benefit various trusts.

USBM personnel at the Intermountain Field Operations Center in Denver continued work on accessing the mineral potential of Federal lands in Colorado. During the year, a final report on the 849,870-hectare (2.1-million-acre) San Juan National Forest was published (MLA OFR 2-92). The forest includes the southern extreme of the Colorado Mineral Belt.

The final report on columbium and tantalum in Colorado was reviewed. Publication of the report is scheduled for early 1993.

The first draft report was completed on the Leadville 1° by 2° quadrangle. This report includes many wilderness and forest studies previously conducted by the USBM. Publication of the report also is expected in 1993.

An allotment grant of $16,000 from the USBM was received by the Mining and Mineral Resources Research Institute at the Colorado School of Mines under provisions of Public Laws 98-409 and 100-483. The purpose of the institute is to coordinate and administer training and research in mining, mineral resources, minerals development, and mineral processing.

According to the U.S. Minerals Management Service, Colorado received $45 million in 1992 as the State's share of revenues collected from mineral leases on Federal lands within the State. Although that amount was the third highest State share in the Nation, it was substantially less than the $58 million received in 1991. About 34% of Colorado's 26.9 million hectares (66.5 million acres) is public land. Colorado received royalties from the production of carbon dioxide, coal, natural gas, gas plant products, petroleum, and sodium.

The BLM distributed $6.4 million to Colorado in Payment in Lieu of Taxes for fiscal year 1992. These payments are made to States to offset the loss of revenues caused by tax-exempt Federal land located within the jurisdiction of local governments.

FUELS

The oil, gas, and coal industries of Colorado are significant contributors to the economy of the State. Estimated values of production for 1992 are $557 million for oil, $423 million for natural gas, $100 million for carbon dioxide, and $307.6 million for coal. The Department of Energy reported production of oil at 29.8 million barrels, gas production at 285 billion cubic feet, and coal production at 18.86 million short tons. The Colorado Oil and Gas Conservation Commission estimated carbon dioxide production at 270.3 million cubic feet.

The Colorado Oil and Gas Conservation Commission had requests for 2,001 drilling permits in 1992, up from the 1,319 permits issued in 1991. Based on large part on the development of gas reserves qualifying for section 23 tax credits, Colorado ranked fourth in the Nation in terms of well completions in 1992, according to Petroleum Information.[7] Well completions in 1992 totaled 1,019, up 42% from that in 1991. The State's gas well completions, 779 wells, was second only to Texas. The Wattenberg field north of Denver was the Nation's leading field in terms of 1992 well completions with 621 wells completed by yearend.

The "Atlas of Major Rocky Mountain Gas Reservoirs," funded by the Gas Research Institute (GRI), and written by the Geological Surveys of Colorado, New Mexico, Utah, and Wyoming, will include more than 140 Colorado reservoirs in 27 gas plays. The atlas is due to be published in 1993.

Legal developments likely to significantly impact Colorado's oil and gas industry include expiration of the tight formation and coalbed methane tax credits.

Colorado coal mines produced about 7% more coal in 1992 with 18.86 million short tons as compared with the 1991 figure of 17.7 million short tons. Twenty mines reported production during 1992. Colorado's coal reserves, about 17 billion short tons, underlie about 28% of the State and represent the eighth largest demonstrated coal reserve in the Nation.

During 1991, Mid-Continent Resources Inc.'s underground Coal Basin Mine near Redstone, Pitkin County, closed permanently after 34 years of operation. Mid-Continent could not find a buyer in 1992 for the financially troubled mine and faces a huge reclamation problem at the mine. The State Division of Minerals and Geology has estimated it will take $3 million and 3 to 5 years to clean up the mine site.

The Golden Eagle Coal Mine near Weston closed temporarily and 100 workers were laid off. Entech Inc. (a subsidiary of Montana Power Co.) bought the mine in 1991. The company hoped to reopen the mine if additional customers could be found.

The Department of Energy awarded a $15 million contract to Amax Coal Industries and the Amax Research and Development Center to develop clean coal technology at the company's facilities in Golden, CO.

ARCO Coal Co. started use of state-of-the-art longwall equipment at the company's West Elk Mine. The new equipment brought production levels for the mine to 3.5 million short ton per year.

On the oil shale front, Colorado Clean Fuels signed a 15-year lease for the former Unocal oil shale plant near Parachute. The $650 million plant had been idle since 1991 when Unocal shut down the operation. Colorado Clean Fuels will lease and refurbish the plant to convert natural gas into methanol. The $50 million conversion project is scheduled for completion in late 1993.

The New Pharaho Corp. announced it was test marketing SOMAT, a shale oil modified asphalt product designed to increase the life of asphalt roads. The company was encouraging county, municipal, State, and Federal highway departments to test the product on highway construction and repair projects in 1993.

Rio Blanco Oil Shale, Inc. conducted environmental monitoring, site maintenance, and cleanup activities on company oil shale leases in Rio Blanco

County.

The uranium business in Colorado was virtually nonexistent in 1992. All Colorado Plateau mines in western Colorado and the Schwartzwalder Mine in the Front Range were temporarily closed. Continued low prices will likely keep the mines closed in 1993.

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Of the six primary metals produced in Colorado during 1992, only gold showed an increase in both production and value. Continued low metal prices have forced several companies to reorganize and consolidate operations and offices. Mines put on standby, or closed, during recent years awaiting higher prices remained closed during 1992.

Average metal prices in 1992 as compared with 1991 were as follows: gold, $344.97 per troy ounce compared with $353.29; silver, $3.94 per troy ounce compared with $4.04; copper, $1.07 per pound compared with $1.09; lead, $0.35 per pound compared with $0.33 per pound; and zinc, $0.58 per pound compared with $0.53 per pound in 1991. Only lead and zinc had higher average prices in 1992 than those in 1991.

Copper, Lead, Silver, and Zinc.—In 1992, each of these metals was produced as a byproduct of gold production at one or more of the gold mines operating in Colorado. Production of copper, lead, silver, or zinc was reported in Clear Creek, Costilla, Gilpin, Lake, Rio Grande, and Teller Counties. Compared with 1991 production figures, copper production fell nearly 99%, lead fell about 62%, silver fell slightly, and zinc fell 17%.

Closure of the Sunnyside Mine, San Juan County, in 1991 resulted in most of the decreases in production of these metals. Joint-venture partners Echo Bay Mines Ltd. and Alta Bay had produced all four metals plus gold at the mine. Echo Bay maintained its interest in the mine and assumed Alta's share of future environmental liabilities at the site. Although a maintenance crew remained at the mine, no plans for reopening the facility were announced during 1992.

Asarco and Resurrection Mining Co. continued production at the Black Cloud Mine and mill near Leadville, Lake County. According to Asarco's 1992 Annual Report, the Leadville mine had average ore grades of 2 grams of gold per metric ton, 44.6 grams per metric ton silver, 3.78% lead, and 8.1% zinc. Asarco's annual report also indicated 5,533 metric tons (6,100 short tons) of contained lead, 14,787 metric tons (16,300 short tons) of contained zinc, 426 kilograms (13,700 troy ounces) of gold, and 10.5 metric tons (339,000 troy ounces) of silver were produced from the Black Cloud Mine in 1992. About 160 people are employed at the mine and mill complex.

Homestake Mining Co. announced plans for decommissioning and final reclamation of the Bulldog Mountain Mine. The silver mine above Creede, Mineral County, was placed on standby in 1985; silver prices in recent years have not provided an incentive to reopen the mine. Closure activities will include removal of the mill, sealing of portals, and recontouring and revegetation of disturbed areas. During the 1970's and early 1980's the mine was Colorado's largest silver producer and the fourth largest primary silver producer in the nation. Production from the mine, from 1969 to 1985, was 787 metric tons (25.3 million troy ounces) of silver and 22,045 metric tons (48.6 million pounds) of lead.

Earth Sciences Inc. maintained its mining claims in the Empire Hill-Weston Pass area southeast of Leadville, Park County. The area is favorable for silver-lead-zinc deposits.

Canyon Resources Corp. was reevaluating its mining claims in the Tennessee Pass area north of the Leadville mining district. Exploration work in the 1980's resulted in the discovery of gold-silver and base metal mineralization at several locations on the claims held by the company. Canyon Resources is looking for a joint-venture partner to fund further exploration and development.

Worldwide, demand for silver in 1992 exceeded the total new supply for the third consecutive year. Silver supplied from mine production and secondary sources totaled 15,604 metric tons (501.7 million troy ounces) while demand for fabrication uses was 18.4 metric tons (590.3 million troy ounces).[8] That increased demand did, however, not translate into higher silver prices during 1992.

Gold.—Total gold output in the State rose more than 15% from that of 1991 despite mine closures and temporary shutdowns. Gold production was reported to the USBM from seven mines, one each in Clear Creek, Costilla, Gilpin, Lake, and Rio Grande Counties and two in Teller County.

Despite the roller coaster that gold prices have been on for several years, mining companies remain interested in gold for the long term as can be seen by the number of companies conducting exploration, development, or production activities in Colorado. Although some economic analysts stated we had seen the bottom for gold prices, the market price did not reflect a comeback during 1992.

Battle Mountain Gold Co.'s San Luis Gold Mine in Costilla County replaced Summitville Consolidated Mining Co.'s (Galactic Resources Ltd.) Summitville Mine in Rio Grand County as the largest gold producer in Colorado. Cripple Creek & Victor Mining Co.'s two mines in Teller County reported the second highest production, followed by Asarco's Black Cloud Mine in Lake County, Summitville Consolidated Mining Co.'s Summitville Mine in Rio Grande County, Solution Golds Ltd.'s Druid Mine in Gilpin County, and Franklin Consolidated's Franklin Mine in Clear Creek County.

Colorado's newest and largest gold producer, the Battle Mountain Gold Co.'s San Luis Gold Mine in Costilla County, came on-line in 1991 and quickly became the largest gold producer in the State. The 800-acre mine site is on private land

in south central Colorado.

Early in the year the company encountered elevated levels of cyanide in the tailings facility, resulting in intermittent shutdowns of the facility to correct the problem. The elevated levels of cyanide were traced to a higher than anticipated copper content in the ore body. The high copper levels increased cyanide consumption in processing the ore, and the original detoxification system failed to adequately remove the additional cyanide load from the discharge stream. As a result, cyanide levels exceeded permit limits and Battle Mountain Gold was fined $168,000 by the Colorado Mined Land Reclamation Div. The lined tailings facilities performed as designed, and no release of cyanide was noted. The company installed a new detoxification unit during 1992 to reduce cyanide levels in the discharge stream.

Battle Mountain Gold Co.'s 1992 Annual Report showed the company processed 1.6 million short tons of ore during the year, up from 743,000 short tons in 1991. Mill recovery for gold was 88% compared with 76% in 1991. The report also showed 55,000 troy ounces (1,711 kilograms) gold recovered and 28,000 troy ounces (0.87 metric tons) silver recovered during 1992 as compared with 22,000 troy ounces (684 kilograms) and 14,000 troy ounces (0.4 metric tons), respectively, in 1991. Gold production was, however, 20% below planned levels because of the intermittent closures mentioned earlier.

The annual report indicated cash costs at the mine were $316 per troy ounce gold, and total operating costs were $463 per troy ounce. The company expected both cash and operating costs to fall in 1993 now that the cyanide problem has been successfully addressed.

Battle Mountain can run 4,535 metric tons (5,000 short tons) of ore per day through its milling operation. The mining and milling operations are expected to continue for 7 to 10 years.

Total minable reserves at the San Luis project are estimated at 10.98 million metric tons (12.1 million short tons) of ore grading an average 1.13 grams of gold per metric tons (0.04 troy ounce per short ton). The deposit contains an estimated 13,219 kilograms (425,000 troy ounces) of recoverable gold.

The project is an open pit mining operation with two pits being worked 24 hours per day. The carbon-in-leach milling plant has a rated capacity of 4,463 metric tons (4,920 short tons) per day. Tailings from the milling operation are treated with sulfuric acid to liberate and volatilize (pass off as vapor) the cyanide. Tailings are then pumped to a lined 81-hectare (200-acre) impoundment with an underdrain system that returns process water to the mill for reuse.[9]

Cripple Creek & Victor Gold Mining Co. (CC&VGMC) is owned by Pikes Peak Mining Co. (80%), a subsidiary of NERCO Minerals, and Golden Cycle Corp. (20%). The joint venture controls about 90% of the historic Cripple Creek mining district in Teller County. Production during 1992 came from the Ironclad and Globe Hill pits. Production from the two pits in 1992 amounted to 1,320 kilograms (42,450 troy ounces) gold and 0.37 metric ton (11,854 troy ounces) silver.[10]

The company began the permitting process on the nearby Cresson deposit in August. Permitting and construction are planned for 1993 with production beginning in 1994, unless the permitting process is delayed because of political reactions to the Summitville disaster, as previously described under "Environmental Issues." Total heap leachable reserves in the Cresson pit are estimated to be 31 million metric tons (34 million short tons) with an average gold grade of 1.2 grams per metric ton (0.0368 troy ounces per short tons).[11] The proposed Cresson pit would be 762 meters (2,500 feet) by 488 meters (1,600 feet) with heap-leach piles 84 meters (275 feet) high. The Teller County Planning Commission gave the mine conditional approval late in the year. State approval was pending at yearend.

In 1992, the company completed more than 146,305 meters (480,000 feet) of rotary and core drilling in the Cripple Creek mining district. The company added 37,320 kilograms (1.2 million troy ounces) of geologically indicated gold reserves this year and now has 102,630 kilograms (3.3 million troy ounces) in indicated gold reserves. Ten near-surface deposits have been identified; however, only the three deposits currently in production or being permitted are proposed for development at this time.

NERCO Inc., parent company of NERCO Minerals, announced during the year that the subsidiary company was for sale. Despite that announcement the company continued to spend money on development of the various pits and exploration drilling. NERCO Inc.'s parent company, PacifiCorp, announced plans to sell the financially strapped mining subsidiary to reduce debt and concentrate on its coal and natural gas businesses.

Asarco's Black Cloud (Leadville) Mine in Lake County was the third largest gold producer in the State. Although the mine is primarily a lead-zinc producer, 426 kilograms (13,700 troy ounces) of gold was recovered in 1992.

The Summitville Gold Mine, Rio Grande County, was the fourth largest gold producer in the State. As mentioned previously, mining at the site ended in 1991 and heap leaching was completed in March 1992. Reclamation was started by Summitville Consolidated Mining Co., a subsidiary of Galactic Resources Ltd. of Vancouver, British Columbia. Only a minimal amount of gold was recovered during 1992. Over the 5-year life of the mine, the company recovered about 9,330 kilograms (300,000 troy ounces) of gold.

Summitville Consolidated Mining Co. filed for protection under chapter 7 bankruptcy and walked away from the mine in December, leaving the water-treatment plant unstaffed. At the request of the State, EPA immediately took over operation of the plant to prevent releases of cyanide into the Alamosa River. At yearend it was unclear if the State would be able to force the parent company to assume responsibility for operating the water-treatment plant.

Although the mine operated for only 5 years, reclamation could take much longer. During the life of the mine, the company lost $70 million because of environmental problems and failures in

basic design. The company had four serious releases of cyanide into the Alamosa River while it operated the heap-leach mining operation.

Elsewhere during the year, Solution Gold Ltd. continued to produce gold at the Druid Mine by reprocessing old mine tailings in the Central City area of Gilpin County. The company began recovering gold in 1991 by heap leaching old mine tailings with cyanide to recover the remaining gold. During the year, the company announced plans for a second heap-leach pad, adding 272,160 metric tons (300,000 short tons) of capacity. A final expansion to 907,200 metric tons (1 million short tons) is planned for 1993.

The Druid Mine facility combines remining of dump rock and mill tailings with the treatment and disposal of mining-related waste materials and contaminated soils disturbed during construction of casinos in the historic Central City and Black Hawk mining districts. In the future, the company expects to receive approval as an off-site repository for disposal of solid mine-related waste from some of the 25 Superfund sites in the area.

Also in Gilpin County, Franklin Consolidated Mining Co. Inc. began producing copper, gold, lead, silver, and zinc from the Franklin Mine. Franklin Consolidated Mining Co. Inc. and Adonos Resources Inc., Toronto, Canada, under a 50-50 joint-venture agreement, agreed that Franklin Consolidated would operate the mine. Adonos Resources had concluded that the operation would be only marginally economic; however, Franklin Consolidated requested the opportunity to reopen and operate the mine. Franklin Consolidated is required, under the agreement, to reimburse Adonos Resources for past expenditures within a fixed period or forfeit its 50% interest to Adonos Resources. Mineral extraction is by direct cyanidation of mill ore followed by flotation of lead and zinc.

Gold King Consolidated Inc., through subsidiary Gold King Mines Corp., considered reopening the Gold King Mine near Silverton. However, no plan was announced during 1992.

Goldrush Mining Corp. changed its name to Goldrush Casino & Mining Corp. and diverted its attention from reopening the Bates-Hunter Mine in Central City, Gilpin County, to joint venturing in the casino business.

Hendrick Mining Co. continued work in the Cross Mine, Boulder County, but no production was reported to the USBM.

Levon Resources dropped its interest in the Carbonate Hill gold project in the Cripple Creek mining district, Teller County.

Sovereign Gold Co. Inc. retained control of the Carter-Raymond gold property in the Gold Brick mining district, Gunnison County. No development plans were announced during 1992.

No movement toward reopening the Sunnyside Mine in San Juan County was reported during the year. When the mine was closed in 1991, about 10 employees remained to do minor maintenance and continue exploration. Alta Gold relinquished its 40.2% effective interest in the Sunnyside Mine to Echo Bay in return for interest in four other properties.

Molybdenum.—Both production and value of molybdenum continued to fall in 1992. Climax Molybdenum Co., a unit of Climax Metals Co. (subsidiary of AMAX), operated the Henderson Mine in Clear Creek County while the Climax Mine on the Lake and Summit Counties boundary remained on standby.

Worldwide, the molybdenum market saw its fourth consecutive year of oversupply and the average dealer-oxide price for 1992 was at its lowest level in more than 20 years, $1.85 per pound. Molybdenum is used as an alloying agent in specialty steels, cast irons, and nickel-, cobalt-, and titanium-based alloys. Such metallurgical applications account for about 90% of overall usage. Other uses include applications in the chemical sector such as in the formulation of catalysts, lubricants, and pigments. Increased production of byproduct molybdenum from a resurgence in copper production likely will continue to affect the market and may keep AMAX's production at low levels for yet another year.

According to AMAX's 1992 Annual Report, production from the Henderson Mine amounted to 7.08 million short tons (6.4 million metric tons) of 0.43% molybdenum disulfide. Concentrate production was reported to be 33.3 million pounds (12,105 metric tons). The annual report listed reserves at the Henderson Mine to be 185 million short tons (168.7 million metric tons) and at the Climax Mine to be 136 million short tons (123 million metric tons).

During 1992, AMAX began production from the new 7,700-foot level of the Henderson Mine and worked on development of the 8,100-foot level. During the year, cumulative production from the mine reached the 100 millionth short ton level, despite cutbacks in production in recent years.

Redevelopment work at the company's Climax Mine was completed in 1992; however, plans to reopen the mine during 1992 were put on hold pending improvement in market conditions. Ore processing facilities at the Climax Mine were consolidated and redesigned for a 22,680-metric-ton-per-day (25,000-short-ton-per-day) capacity.

Other Metals.—Golden Aluminum Co., a subsidiary of the Adolph Coors Co. of Golden, Jefferson County, operated an aluminum rolling mill in Fort Lupton, Weld County. The plant used patented technology to manufacture aluminum sheet for rigid packaging. The company was formed to capitalize on the parent company's expertise in aluminum can manufacturing and recycling. The Fort Lupton mill operated at full capacity, 31,752 metric tons (70 million pounds) annually, for most of the year. Late in the year, Coors announced a spinoff company, ACX Technologies, Inc., would take over operation of all nonbeer operations, including the aluminum rolling mill.

CF&I Steel Corp., Pueblo County, filed for chapter 11 bankruptcy protection in late 1990 citing problems funding the company's pension plans. In 1992, Oregon Steel Mills, Portland, OR, announced plans to buy the steel

company, pending bankruptcy court approval. The company expected to spend about $165 million over a 5-year period to make improvements at the Pueblo mill.

Asarco has operated the Globe smelter in north Denver for more than 100 years. In 1992, Asarco recovered cadmium as a byproduct of the extraction and refining of lead and zinc metals from sulfide ore concentrates (from lead smelter baghouse dust). The smelter is one of only four sources of primary cadmium in the United States. Settlement of an ongoing lawsuit with the State over environmental damage at the facility, and in the surrounding neighborhoods, is expected in 1993.

Industrial Minerals

The State's industrial minerals sector manufactured (cement) or produced 14 different industrial minerals in 1992. The top three, in terms of value, were (1) construction sand and gravel, (2) portland cement, and (3) crushed stone. With few exceptions, both value and quantity of production for most industrial minerals increased in 1992. A strong construction industry, driven in part by a rising population and a stronger than average economy, was reflected in significant improvements in construction-related mineral industries.

Increasingly stringent zoning and environmental regulations have put a strain on aggregate producers (sand, gravel, and crushed stone) and other industrial mineral processors. Most companies have experienced difficulties in getting permits approved when trying to expand operations or develop new operations, particularly quarries. The "not in my back yard" or "NIMBY," syndrome is forcing operations to move further from market areas, resulting in higher transportation cost and ultimately, in higher aggregate prices and construction costs to be passed on to the consumer.

Construction aggregate is used extensively in infrastructure construction as bulk material and as an ingredient in "bound materials" such as asphalt and concrete.

Although construction aggregate is an important part of the industrial minerals market in Colorado, several other commodities contribute significantly to the total value, including portland cement, clays, gypsum, and lime.

Cement.—Cement production was estimated to have risen significantly in 1992, perhaps as much as 27% for portland cement. Most of the increase went into construction of the new Denver International Airport where approximately 1 million short tons of cement will be required to complete the facility.

Holnam Inc. operated a dry-process plant at Laporte, Larimer County, that produced portland cement and a wet-process plant at Portland, Fremont County, that produced both portland and masonry cement. Southwestern Portland Cement Co. operated a dry-process plant at Lyons, Boulder County, that produced both portland and masonry cements.

Clays.—Clay production fell slightly in 1992. Production of common clay, fire clay, and bentonite clay were reported from one or more of the following counties: Boulder, Douglas, El Paso, Elbert, Fremont, Jefferson, and Pueblo. Major clay producers were Denver Brick Co., Lakewood Brick & Tile Co., and Robinson Brick & Tile Co. The clays were used as waterproof sealants, common and face bricks, and in mortar and cement manufacturing.

Bricks were manufactured by: Colorado Brick Co., Boulder County; Denver Brick Co., Douglas County; Lakewood Brick & Tile Co., Jefferson County; Robinson Brick Co., Denver County; and Summit Brick & Tile Co., Pueblo County.

Western Aggregates Inc., a subsidiary of Inco United States (an operating unit of Inco Ltd., Canada), operated a lightweight aggregate plant near Boulder, Boulder County. The 382,300-cubic-meter-per-year (500,000-cubic-yard-per-year) quarry and plant began production in 1991. Reserves at the quarry are believed to be adequate for 60 years of production. About 50% of production is expected to be used in concrete block masonry, with the rest in precast, prestressed, and ready-mixed concrete.

Two companies produced fire clay for production of firebrick block and shapes: Adlence-BMI/Cold Refractories Division and G. W. Parfet Estate Inc.

Gypsum.—Two companies continued to produce gypsum in Colorado. Both production and value of crude gypsum increased more than 30% from 1991 levels. Colorado Lien Co. produced crude gypsum in Larimer County, and Eagle Gypsum Products produced crude gypsum at a mine in Eagle County.

Eagle Gypsum produced wallboard at a plant opened in 1990 in Eagle, about 4.8 kilometers (3 miles) from the company mine. Some coarse gypsum from the mine is shipped by rail to cement plants in the State.

BLM issued patents for seven 20-acre mining claims to Eagle Gypsum during 1992 under provisions of the 1872 Mining Law during 1992. The mine has about a 400,000-short tons-per-year capacity and is expected to operate for about 25 years. The company's 105 employees have a $3 million payroll.

In the United States and other industrialized nations the major use of gypsum is making gypsum wallboard products.

Lime.—Production of lime increased about 2% while value increased more than 15% in 1992. Western Sugar Co. produced quicklime in Morgan and Weld Counties for use in its sugar beet processing facilities. Calco Inc. produced quicklime in Chaffee County from high-grade chemical limestone.

Lime is used in sugar beet refining to raise the pH of the product stream, precipitating colloidal impurities. The lime is subsequently removed by reaction with carbon dioxide to precipitate calcium carbonate.

USBM statistics show that about 367 short tons of quicklime and 97 short tons of hydrated lime shipments had destinations in Colorado in 1992.

TABLE 2

COLORADO: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	4,493	$18,852	$4.20
Plaster and gunite sands	26	181	6.96
Concrete products (blocks, brick, pipe, decorative, etc.)	458	2,060	4.50
Asphaltic concrete aggregates and other bituminous mixtures	2,891	11,620	4.02
Road base and coverings[1]	6,171	17,365	2.81
Fill	1,447	2,995	2.07
Snow and ice control	216	892	4.13
Railroad ballast	W	W	4.32
Other miscellaneous uses	142	528	3.72
Unspecified:[2]			
Actual	8,727	33,179	3.80
Estimated	4,884	17,610	3.61
Total	29,455	[3]105,281	3.57
Total[4 5]	26,721	105,281	3.94

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data do not add to total shown because of independent rounding.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

Potential new markets for lime products could result from recent EPA decisions on requirements for protection of drinking water and corrosion control in water systems containing lead piping, and treatment methods for municipal sewage sludge.

Peat.—Four companies produced peat in three counties during 1992. Production fell slightly from 1991 levels at the mines in Boulder, El Paso, and Park Counties. Both bulk and packaged peat were marketed by the companies.

Nationwide demand for peat continued to show relatively little growth, a trend seen for several years. Importation of Canadian peat and peat products has contributed to the flat demand for U.S. production of peat. Domestic peat production in 1992 fell 7% while imports rose 11% to capture 50% of the total U.S. peat market.

About 90% of the peat produced in the United States was used for soil improvement, horticultural use, and agricultural use.

Perlite.—Dicaperl Corp., formerly Grefco Inc., mined perlite in New Mexico and expanded it at a processing plant at Antonito, Conejos County. Persolite Products Inc. mined perlite near Rosita, Custer County, and operated an expansion plant near Florence, Fremont County. Production in 1992 fell slightly below 1991 levels. Sales were to the filter, plaster, concrete aggregate, low-temperature and cavity-fill insulation, horticulture aggregate, and filler industries.

Sand and Gravel.—Construction.—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only: data for odd-numbered years are based on annual company estimates. This chapter contains estimated data for 1991 and actual data for 1990 and 1992.

Reported construction sand and gravel production in 1992 was about 22% higher than that reported in 1990. Construction activities at the new Denver International Airport are expected to be reflected in increased production figures in 1993 as well.

Colorado construction sand and gravel statistics are compiled according to geographical districts as depicted on the State map. Most of the production was from District 4, which includes the major population centers of metro Denver and Boulder.

Counties with more than 1 million short ton of production were Adams, Boulder, El Paso, Jefferson, Larimer, Mesa, Montezuma, Pueblo, and Weld. The major producers were Western Mobile Inc. (Redland PLC), Cooley Gravel Co. (ECC Construction Materials), and Albert Frei & Sons Inc. These three companies operated 40 pits to produced more than 11 million short tons of sand and gravel or nearly 40% of the total production.

Major uses, shown in table 2, were for road base, concrete aggregate, and asphaltic concrete. Unit values for the end uses ranged from $2.07 for road fill to $6.96 for plaster and gunite sands. Table 3 presents the end-use data for the State's six construction sand and gravel districts.

During 1992, ECC Group PLC agreed to acquire the sand and gravel reserves of Walt Flanagan & Co. The $20.5 million purchase added about 22 million short tons of reserves to Cooley Gravel Co., ECC's Denver-based subsidiary. Six ready-mix plants in the Denver area were included in the purchase.

Colorado aggregate producers continued to encounter strong opposition to planned expansions and even stronger opposition to any plans for new sand and gravel operations. Several new sand and gravel pits proposed in Jefferson County were facing long permitting processes during the year, and one major proposed operation was defeated. Numerous permits for expansions of existing pits were denied by counties throughout the State while some counties approved expansion for some existing quarries.

TABLE 3

COLORADO: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[1]	303	1,238	670	2,581	185	521
Asphaltic concrete aggregates and other bituminous mixtures	1,092	5,221	330	2,027	W	W
Road base and coverings[2]	1,787	5,007	1,113	2,634	542	1,089
Fill	471	913	59	97	W	W
Snow and ice control	56	153	(3)	1	W	W
Railroad ballast	—	—	—	—	—	—
Other miscellaneous uses	—	—	—	—	99	295
Unspecified:[4]						
Actual	974	3,598	1,950	7,832	—	—
Estimated	966	3,467	1,192	4,252	16	70
Total[5]	5,650	19,597	5,313	19,424	842	1,976
Total[6 7]	5,126	19,597	4,820	19,424	764	1,976

	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[1]	2,657	11,688	886	3,488	275	1,576
Asphaltic concrete aggregates and other bituminous mixtures	W	W	203	490	251	966
Road base and coverings[2]	1,028	3,106	628	1,669	1,074	3,860
Fill	679	1,589	232	371	W	W
Snow and ice control	95	503	34	112	W	W
Railroad ballast	—	—	W	W	W	W
Other miscellaneous uses	948	2,832	91	243	56	222
Unspecified:[4]						
Actual	4,288	16,356	1,514	5,392	—	—
Estimated	1,876	7,008	166	587	669	2,225
Total[5]	11,570	43,083	3,755	12,352	2,324	8,849
Total[6 7]	10,496	43,083	3,406	12,352	2,108	8,849

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes plaster and gunite sands.
[2]Includes road and other stabilization (cement and lime).
[3]Less than 1/2 unit.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value in thousand metric tons and thousand dollars.

Industrial.—Three firms continued to produce industrial sand in Arapahoe, El Paso, and Larimer Counties. Production and value both increased slightly from 1991 figures.

Colorado Lien Co. produced silica sand for containers, sand blasting, and silica flour. Cherry Creek Sand Specialities produced sand for sandblasting, filtration, and roofing granules. Colorado Silica Sand Inc. produced sand for unspecified uses.

Most of the industrial sand produced during 1992 was used for containers, such as glass, and for sandblasting. Coors Brewing Co. announced plans to build a $4.5 million glass recycling plant to handle the growing volume of recycled beverage containers in the State. Recycling of glass containers has grown so rapidly in Colorado that existing glass recycling facilities cannot handle the volume.

Sodium Compounds.—In March, NaTec Resources Inc. of Houston began production in northwestern Colorado at the world's only nahcolite mining and processing operation in Rio Blanco County. The $20 million plant has an annual production capacity of 113,400 metric tons (125,000 short tons) and processes naturally occurring sodium bicarbonate. Production during 1992 was 18,144 metric tons (20,000 short tons); 1993 production was projected to be 54,432 metric tons (60,000 short tons).[12]

The company uses in situ solution mining to recover nahcolite. The product

is sold for use to reduce stack emissions of sulfur dioxide at coal-burning powerplants, including Public Service Co. of Colorado's Cherokee plant in Denver. NaTec holds Federal leases to about 3,320 hectares (8,200 acres) with more than 77 million metric tons (85 million short tons) of proven reserves of nahcolite. NaTec formed a joint venture sharing 50% of the mine with North American Chemical Co. (part of D. George Harris & Associates Inc.). The joint venture hopes to increase production to 453,600 metric tons (500,000 short tons) per year by 1995 or 1996. The joint-venture company is known as the White River Nahcolite Minerals Ltd. Liability Co.

New demand created by passage of the Clean Air Act prompted development of the mine. Nahcolite is used by powerplants to reduce emissions from smokestacks. Nahcolite combines with sulfur dioxide gases to form a sodium sulfate solid that can be captured before escaping the stack.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only: data for even-numbered years are based on annual company estimates. This report contains actual data for 1991 and estimated data for 1990 and 1992.

Crushed.—Estimated crushed stone production in 1992 rose more than 30% from the last surveyed year, 1991, and value increased almost $20 million, or about 47%, from 1991 figures. Construction activities at the new Denver airport and highway construction projects accounted for the increases in production and value.

The four leading counties, in terms of production in 1991 (the last year of actual data), were Boulder, El Paso, Jefferson, and Larimer. Major producers were Western Mobile, Cooley Gravel, and Continental Materials Corp. Most of the production was used for concrete aggregate and concrete manufacturing. Crushed stone production included granite, limestone, marble, quartzite, sandstone, and volcanic scoria.

Dimension.—Three firms quarried granite, marble, or sandstone in 1992; Colorado Watertown Corp., Colorado Yule Marble Co., and Loukonen Brothers Stone Co. Production continued to rise as demand for construction increased. Stone was quarried in Boulder, Gunnison, and Larimer Counties.

The historic Yule Marble Quarry, in Gunnison County, was operated during the year with a staff of 15. About 1,000 cubic meters (35,314 cubic feet) of marble was shipped from the mine during 1992.[13]

At full production the quarry will produce about 7,080 cubic meters (250,000 cubic feet) of white marble annually. Six grades of marble were mined and trucked 67.6 kilometers (42 miles) to Glenwood Springs to a railroad siding. At the present rate of mining, reserves at the quarry could last 300 years. Marble from the quarry has been used at the Tomb of the Unknown Soldier, Lincoln Memorial, and the Colorado State Capital Building. The quarry had been closed since 1941.

Plans to mine a black marble deposit along Conundrum Creek, in the Maroon Bells-Snowmass Wilderness, near Aspen in Pitkin County, continued to draw opposition from many groups. The mining claims cover about 190 hectares (472 acres) and were quarried from the early 1900's to the 1940's. The Forest Service was trying to determine jurisdiction over the operation. Last year, the Forest Service had determined that an Environmental Impact Statement would be required and a special-use permit must be approved before mining could start. If the Forest Service does not have jurisdiction, the county or State may be in control of what happens at the proposed quarry site.

Other Industrial Minerals.—Several industrial minerals mined in other States or countries were shipped to Colorado for processing into higher value products or to be used in the manufacturing of other consumer products.

Nitrotec produced Grade-A helium at its plant near Burlington, Kit Carson County, but did not produce liquefied helium. Production and value were up slightly from 1991. Conoco Inc. produced sulfur as a byproduct of petroleum refining in Adams County. U.S. Zeolites processed zeolites mined in Wyoming at a plant near Fort Collins, Larimer County.

Although Larimer County Commissioners issued a special review permit to Diamond Company N.L. for diamond exploration work in the county, no production has been reported to date. The company estimated that about 90,700 metric tons of diamond-bearing kimberlites will be processed during a 2-year program. Kimberlites on the Colorado side of the State Line district have reportedly yielded about 0.2 carat per ton.

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[1]Mining engineer, U.S. Bureau of Mines, Denver, CO. She has 17 years of mineral-related work with the government.

[2]Chief, Minerals and Mineral Fuels, Colorado Geological Survey, Department of Natural Resources, Denver, CO.

[3]Rocky Mountain Construction. Jan. 6, 1993.

[4]———. Oct. 5, 1992.

[5]Cappa, J. A. Colorado—State Activites 1992. Min. Eng. May 1993, pp. 466-468.

[6]Work cited in footnote 5.

[7]Petroleum Institute. 1992 Resume.

[8]Mining Engineer. Sept. 1992

[9]Cappa, J. A. Colorado—State Activites 1991. Min. Eng. May 1992, p. 430.

[10]Work cited in footnote 5.

[11]Work cited in footnote 5.

[12]Work cited in footnote 5.

[13]Work cited in footnote 5.

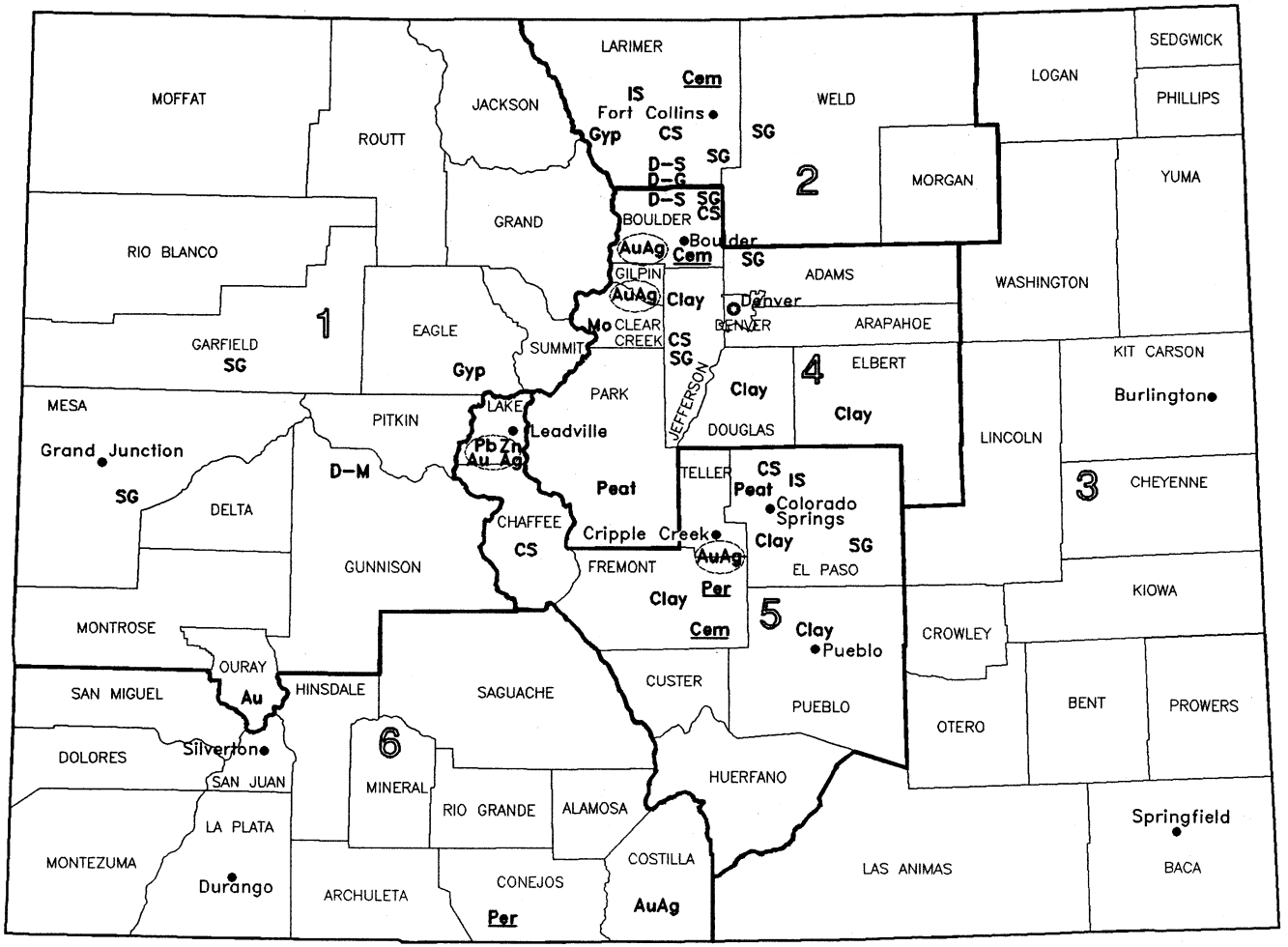
COLORADO

LEGEND

- State boundary
- County boundary
- O Capital
- • City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

AuAg	Gold–Silver
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
D–G	Dimension Granite
D–M	Dimension Marble
D–S	Dimension Sandstone
Gyp	Gypsum
IS	Industrial Sand
Mo	Molybdenum
Pb	Lead
Peat	Peat
Per	Perlite plant
SG	Sand and Gravel
Zn	Zinc
⬭	Concentration of mineral operations



Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Holnam Inc.[1] Ideal Div. (Holerbank Group)	Box 8789 750 17th St. Denver, CO 80201	Plants	Fremont and Larimer.
Southwestern Portland Cement Co.[1] (Southdown Inc.)	1111 South Colorado Blvd. Denver, CO 80222	Plant	Boulder.
Clays:			
General Refractories Co.	600 Grant St., Room 3000 Pittsburgh, PA 15219	Pits	Pueblo.
Lakewood Brick & Tile Co.	1325 Jay St. Lakewood, CO 80214	Pits and plant	Fremont and Jefferson.
G. W. Parfet Estate Inc.	1213-1/2 Washington Ave. Golden, CO 80401	Pits	Jefferson.
Robinson Brick Co.	Box 5243 Denver, CO 80217	Pits and plant	Douglas, Elbert, El Paso, Jefferson.
Gold:			
ASARCO Inc.[2]	Box 936 Leadville, CO 80461	Mine and mill	Lake.
Battle Mountain Gold Co.	Box 310 San Luis, CO 81152	do.	Costilla.
Cripple Creek & Victor Gold Mining Co.[3]	Box 191 Victor, CO 80860	Mine dump heap leaching	Teller.
Summitville Consolidated Mining Co. Inc., a subsidiary of Galactic Resources Inc.[3]	Box 2G Del Norte, CO 81132	Open pit, vat leaching, carbon-pulp plant	Rio Grande.
Gypsum:			
Eagle Gypsum Products	Box 980 Gypsum, CO 81637	Mine and plant	Eagle.
Lime:			
Calco Inc.	Box 1044 Salida, CO 81201	do.	Chaffee.
The Western Sugar Co., a subsidiary of Tate and Lyle PC	555 17th St. Denver, CO 80202	Plants	Morgan and Weld.
Molybdenum:			
Climax Molybdenum Co. (a subsidiary of AMAX Inc.)	1707 Cole Blvd. Golden, CO 80401	Mines and mills	Clear Creek, Grant, Lake.
Peat:			
Hyponex Corp.	Box 586 Fountain, CO 80817	Bog and plant	El Paso.
Universal Peat Sand & Gravel Inc.	1557 South Ingalls St. Lakewood, CO 80226	Bog	Park.
Perlite:			
Dicaperl Corp.	Box 308 Antonito, CO 81120	Plant	Conejos.
Persolite Products Inc.	Box 105 Florence, CO 81226	Mine and plant	Custer and Fremont.
Sand and gravel:			
Construction:			
Cooley Gravel Co. (ECC Construction Materials)[1]	Box 5485 Terminal Annex Denver, CO 80217	Pits and plants	Adams, El Paso, Jefferson.
Elam Construction Co. Inc.	1225 South 7th St. Grand Junction, CO 81501	do.	Mesa, Moffat, Pitkin, Routt.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued:			
Construction—Continued:			
Albert Frei & Sons Inc.	11521 Brighton Rd. Henderson, CO 80640	Pits and plants	Adams, Clear Creek, Garfield, Weld.
Western-Mobile Inc.[1] (Redland PLC)	Box 5183TA Denver, CO 80217	do.	Boulder, El Paso, Jefferson, Larimer, Pueblo, Weld, and others.
Industrial:			
Colorado Lien Co.	Box 1961 Fort Collins, CO 80522	Pit and plant	Larimer.
Colorado Silica Sand Inc.	Box 15615 Colorado Springs, CO 80935	do.	El Paso.
Stone:			
Crushed:			
Castle Concrete Co., a subsidiary of Continental Materials Corp.	Box 2379 Colorado Springs, CO 80901	Pits and plants	Do.
Dimension:			
Colorado Yule Marble Co.	1101 Village Road Suite 2A Carbondale, CO 81623	Quarry	Gunnison.

[1]Also crushed stone.
[2]Also copper, lead, silver, and zinc.
[3]Also silver.

THE MINERAL INDUSTRY OF CONNECTICUT

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the State Geological and Natural History Survey of Connecticut, Department of Environmental Protection, for collecting information on all nonfuel minerals.

By Donald K. Harrison[1] and Robert J. Altamura[2]

The value of nonfuel mineral production in 1992 was $97.2 million, a $6.4 million increase over that of 1991. This increase was largely attributable to an increase in output of construction sand and gravel over the 1991 estimate. Estimated output of crushed stone, the State's leading mineral commodity produced, in terms of value, remained essentially the same as that of 1991. Other mineral commodities produced included clays, industrial sand, and dimension stone.

TRENDS AND DEVELOPMENTS

In 1992, the average annual value of total construction contracts was down 4% from that of 1991. The 1992 value was also 42% lower than the peak building year of 1988. The largest declines in construction contracts were recorded in 1989 and 1990. The modest 4% drop in 1992, compared with that of the past few years, indicated that the industry was showing some signs of recovery. In 1992, the value of residential construction contracts, which had not risen since 1987, was up by 15% over that of 1991. This was offset, however, by declines in the value of nonbuilding contracts (down 31%) and nonresidential contracts (down 3%). Because the aggregate industry (crushed stone and sand and gravel) is highly dependent on the State's construction industry, the modest decline in 1992 actually helped to at least stabilize this industry. Continuing infrastructure improvements to the State's roads, bridges, sewers, and water systems also have benefited this industry.

In August, the Associated General Contractors of Connecticut (AGC) agreed to affiliate with the Connecticut Construction Industries Association (CCIA). The AGC chapter became a division of CCIA. This was the second recent affiliation of a major organization in the State with the CCIA. The Utility Contractors Association of Connecticut affiliated with the CCIA in 1991 to become a new division of CCIA. The newest affiliation makes the CCIA, a nonprofit trade association, the State's leading construction industry organization, which represents all aspects and disciplines of the industry. CCIA will now have seven divisions, including the Connecticut Road Builders Association; Connecticut Ready-Mixed Concrete Association; Connecticut In-Plant Operators Association; and the Connecticut Equipment Dealers Div. The association also includes the State's bituminous plant operators, crushed stone and sand and gravel operators, excavators, and a wide variety of associate members involved in the construction industry.

TABLE 1
NONFUEL MINERAL PRODUCTION IN CONNECTICUT[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$2	NA	$62	NA	$5
Sand and gravel (construction)	thousand short tons	r8,416	r37,387	e5,400	e24,800	6,025	30,107
Stone:							
Crushed[2]	do.	e10,200	e70,600	5,873	52,701	e5,900	e54,500
Dimension	short tons	r e 4,156	r e 7,113	r16,545	1,739	W	W
Combined value of clays (common), feldspar (1990-91), mica [scrap (1990-91)], sand and gravel (industrial), stone [crushed dolomite and other (1991-92), crushed granite (1990)], and values indicated by symbol W		XX	r7,165	XX	11,531	XX	12,580
Total		XX	r122,267	XX	90,833	XX	97,192

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain stones; kind and value included with "Combined value" data.

EMPLOYMENT

In 1992, the average number of workers employed in the minerals extractive industries in Connecticut was 744.[3] This included 251 workers at sand and gravel operations, 272 at stone operations, and 2 workers at other nonmetal mines. In addition, 219 employees worked at mineral-related mills and preparation plants in the State.[4]

Since the end of 1988, Connecticut's construction and mining industries suffered the worst during the recent recession with a 41.4% decrease in jobs. Connecticut's manufacturing industry also lost a significant number of jobs. In statistics released by the State Department of Labor, stone, clay, and glass manufacturing lost 27.5% of its jobs, down 1,400 from 5,100 at the end of 1988 to 3,700 in the beginning of 1992. The primary metals industry, which includes those industries that produce metal extracted from ores, natural brines, or ocean water or ingot cast from reduced and/or refined metal, lost 2,800 jobs or 22%, dropping from 12,700 to 9,000 in the same period. Likewise, the fabricated metals industry lost 21.8% of its jobs, from 43,200 to 33,800.

LEGISLATION AND GOVERNMENT PROGRAMS

Several bills that would affect mineral producers were introduced in the 1992 State legislative session. House bill (H.R.) 5611 would require quarry owners or operators to conduct a preblast survey. H.R. 5230 would give the local fire marshall the authority to stop any excavation, demolition, or discharge of explosives. Both of these bills died in committee. Another bill, which never made it out of committee, was Raised House Bill 5699, "An Act Adopting the Model Surface Use and Mineral Development Accommodation Act." The purpose of the bill was to establish mineral development standards to protect surface owners from physical damage to their land from exploration through development.

In 1992, the Connecticut Legislature approved construction bonds totaling $867 million. Bond authorizations included: transportation projects, $244.1 million; clean water fund, $60 million; Long Island Sound cleanup, $50 million; public works projects, $483.5 million; and capital improvements, $30 million.

Connecticut's local chambers of commerce began working in conjunction with the State Department of Environmental Protection (DEP) in setting up regional-business recycling councils to help private enterprise establish individual recycling programs. The councils, which serve as information clearinghouses, are concerned primarily with recycling nine items mandated by law. That list includes metal food and beverage containers, scrap metal, and lead-acid batteries. Under State law, Connecticut businesses and certain residential areas were to begin recycling those items in January 1991. The local chambers of commerce are acting as a communications link to businesses and do not have enforcement authority. The individual towns where the recycling occurs have enforcement authority.[5]

The Connecticut Geological & Natural History Survey (CGNHS), as the research arm of the parent agency, the Natural Resources Center of the State Department of Environmental Protection, continued programs on the collection, interpretation, and dissemination of information on the State's natural resources. Major efforts for the year included topographic, bedrock, glacial geological mapmaking, soil mapmaking, a continued geophysical investigation of Long Island Sound, and a continued study of the distribution of radon in Connecticut. An effort was made for the continuation of work on Statewide digital data sets of natural resource significance for the office's Geographic Information System. During the year, the Natural Resources Center made contributions in the areas of water resources basic data collection, aquifer modeling and protection, endangered species, and natural heritage identification. In addition, the Center developed a public library of basic resource data on Long Island Sound at its satellite office at Avery Point in Groton as part of the center's continuing Connecticut marine geology emphasis. A volume of the Journal of Coastal Research was published during the year devoted to Connecticut marine geology with papers written by State Survey staff, researchers at Wesleyan University and institutions and agencies outside the State. A full-color map entitled, "The Surficial Materials Map of Connecticut," a cooperative effort on the part of the CGNHS and the U.S. Geological Survey (USGS), was published by the USGS.[6] Work on a companion map, the Quarternary Geological Map of Connecticut, continued. An evaluation of the volume of existing sand and gravel deposits in the State, not necessarily that available for excavation, was under way as part of a project initiated by the New England Governors' Conference. A scientific and economic investigation on a giant hydrothermal silica ore deposit, a source of industrial sand and gravel in the southeastern part of the State, also was being conducted.[7]

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Calcium Metal.—Mineral Technologies Inc. (MTI) produced calcium metal at a plant in Canaan, Litchfield County. The company used the Pidgeon process in which high-purity calcium oxide and aluminum powder are compacted into briquettes and heated in vacuum retorts where the calcium metal is vaporized and collected in a water-cooled condenser.

In October, MTI was officially spun off from Pfizer Inc. MTI is a new company composed substantially of all of the net assets of what were formerly the specialty minerals business of Pfizer, which included the company's specialty minerals operations in Canaan. The spinoff was the result of a decision by Pfizer to focus on health care, although Pfizer retained a 40% interest in MTI.

Clays.—Two companies mined

common clay and shale for use in manufacturing common and face brick. K-F Brick Co., a subsidiary of the Susquehanna Corp., mined Pleistocene glacial lake clay near South Windsor and Jurassic age shale near Suffield, both in Hartford County. The Michael Kane Brick Co. reported production from an open pit mine into glacial lake clay in Middlesex County.

Feldspar.—As of the first of the year, The Feldspar Corp. officially ceased excavation at its open pit quarries in Middletown and Portland.[8] Miners had excavated granitic pegmatite from rock bodies within the Middletown Pegmatite District. This shutdown represented the closing of the last operations in this historic feldspar mining district. The company's feldspar refining plant at Middletown also ceased operation, and reclamation of mined land was begun. In addition to feldspar, the company also recovered byproduct mica and industrial sand. Several months prior to the closure, the Inland Wetlands and Waterways Agency (IWWA) had approved a plan from The Feldspar Corp. to hoist approximately 700 tons of pegmatite feldspar out of a wetlands area adjacent to the mine. The boulders had fallen the wrong way when a blast went awry at the mining operations. However, in early 1992, the company sought an amendment to the permit indicating that it could not get the boulders out of the wetlands without doing more damage. In February, the IWWA approved the modification of the plan and agreed that the material should be left in place rather than to cause additional environmental damage.

Gemstones.—The Strickland-Cramer pegmatite mines near Portland, perhaps the most scientifically studied geologic site in the State, had produced feldspar and mica when it was commercially active. The abandoned mines, which had for many years provided educational and gemstone specimens from its mine spoils, were being developed as a golf course by a private landowner. The Strickland site, as well as other sites in the Middletown Pegmatite District, had been investigated as a source of beryllium by the USGS[9] and the U.S. Bureau of Mines (USBM).[10]

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Construction sand and gravel was Connecticut's second most valuable mineral commodity and accounted for almost one-third of the State's mineral production value. In 1992, 55 companies, 8 less than that of 1990 when the last USBM canvass was undertaken, mined construction sand and gravel from 61 pits. Leading counties, in order of output, were Hartford, New Haven, Windham, and Fairfield. The majority of the construction sand and gravel was used for concrete and asphaltic aggregates.

Near yearend, the Prospect Planning and Zoning Commission was considering passage of an ordinance that would ban all new sand and gravel mining operations in residential areas. Existing mining operations were expected to be grandfathered into the regulations. In October, the commission rejected a proposal by O&G Industries of Torrington to mine gravel from water company land primarily because of concerns of increased truck traffic. Local residents also had raised questions about the effect the mining would have on a nearby reservoir and wetlands.

Industrial.—U.S. Silica Co. of Connecticut was the only producer of industrial sand in the State in 1992. The Feldspar Corp., which produced byproduct industrial sand in 1991 at its Middletown feldspar operations, officially shut down its operations as of the first of the year. Uses for the industrial sand produced by U.S. Silica included blasting, scouring, and filtration.

Stone.—Crushed stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—Crushed stone was the State's leading mineral commodity and accounted for 56% of the State's total mineral value. Estimated crushed stone production (predominantly basalt, which is commonly called traprock) remained about the same as that of 1991. Other quarried rock types included marble and granite. The majority of the crushed stone was used for roadbuilding and for making concrete.

After 18 months of being under a cease and desist order stopping most operations at the Midwood Quarry in Tolland, the Burgundy Hills Associates, the owners of the quarry, were told in June by the Inland Wetlands Commission (IWC) that they may resume excavation. However, the owners must adhere to 17 conditions set by the IWC. Earlier in the year, a Superior Court judge upheld a 1991 zoning board decision that limited excavation at the quarry to 10.5 acres. The quarry owners had sued the zoning board in March 1991, arguing that 42 acres of the 142-acre property should be eligible for excavation because those acres had been mined before 1957, the year that local zoning regulations were enacted. In the judge's decision, he said that the quarry owners had been given a "full and fair hearing" by the board. The company is appealing the decision.

In December, E. Aiudi & Sons filed a third lawsuit against the Plainville Planning and Zoning Commission over its denial of a zone-change request to rezone 30 acres the company owns. The company, which owns a cement plant in the town, wanted to rezone the 30 acres at the existing quarry from residential to quarry/industrial use. The centerpiece of the lawsuit contends that the commision's ruling renders the land worthless to the company. The suit also argues that the quarry received site grading approval 13 years ago. Although the designation then did not permit quarrying, the suit asserts that the town allowed the company to

TABLE 2

CONNECTICUT: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	1,034	$6,192	$5.99
Plaster and gunite sands	10	100	10.00
Concrete products (blocks, bricks, pipe, decorative, etc.)	W	W	5.02
Asphaltic concrete aggregates and other bituminous mixtures	1,189	4,521	3.80
Road base and coverings	341	1,302	3.82
Fill	314	1,046	3.33
Snow and ice control	183	797	4.36
Other miscellaneous uses[1]	110	684	6.22
Unspecified:[2]			
Actual	986	3,591	3.64
Estimated	1,857	11,872	6.39
Total[3]	6,025	30,107	5.00
Total[4 5]	5,466	30,107	5.51

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes filtration.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data may not add to totals shown because of independent rounding.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

continue quarrying the site since then because it raised no objections during that time.

In November, the Woodbury Zoning Commission renewed O&G Industries Inc.'s earth excavation permit for its Stiles Road Quarry, but added a number of stipulations for the protection of neighboring property owners. About 20 neighbors of the property had appeared before the commission to complain about blasting, dust, and other inconveniences caused by the quarrying activity.

Many of the 19 conditions imposed on the company addressed residents' concerns. Several of the conditions addressed the noise issue. O&G must keep copies of reports on complaints of blasts from neighboring property owners and submit them to the commission quarterly. In addition, the zoning commission ruled that O&G must attempt to schedule blasting on days when air shock is likely to be at a minimum and try to avoid days when it is likely to be too high. The company must also attempt to notify neighboring property owners and others who ask for notification of blasting in advance of each blast. Other conditions set by the commission dealt with tree clearing, dust reduction, and imposing speed limits on the roads owned by the company.[11]

Dimension.—Dimension granite was quarried in Hartford, Litchfield, New Haven, and Windham Counties, and dimension quartzite was quarried in Middlesex and Tolland Counties. The stone was sold as irregular-shaped stone, rough blocks, and cut stone.

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[1]Regional Minerals Specialist, U.S. Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related experience and has covered the mineral activities in Connecticut for the past 8 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Geologist, State Geological and Natural History Survey of Connecticut, Department of Environmental Protection, Hartford, CT. Also at the Department of Geosciences, The Pennsylvania State University, University Park, PA.

[3]"Average number of workers" is a summary of the average number of persons working at individual mining establishments during periods (not necessarily continuous) of active operations.

[4]U.S. Depart of Labor, Mine Safety and Health Administration. Mine Injuries and Worktime Quarterly, Jan.-Dec. 1992, 32 pp.

[5]American Metal Market. Recycling Gets Push in Connecticut. V. 100, No. 14, Jan. 22, 1992.

[6]Stone, J., P. Shafer, E. London, and W. Thompson. Surficial Materials Map of Connecticut: U.S. Geological Survey Map, 1:125,000 scale, 1992, 2 sheets.

[7]Altamura, R. J., and D. P. Gold. The Lantern Hill Giant Quartz Lode, North Stonington, CT: A Nonmetallic Ore Deposit in the Northern Appalachians. Geological Society of America Abstracts With Programs, v. 25, 1993, No. 2., p. 2.

———. Wall-Rock Alteration and the Genesis of the Lantern Hill Giant Quartz Lode, Southeastern Connecticut. Geological Society of America Abstracts With Programs, v. 25, No. 2, 1993, p. 2.

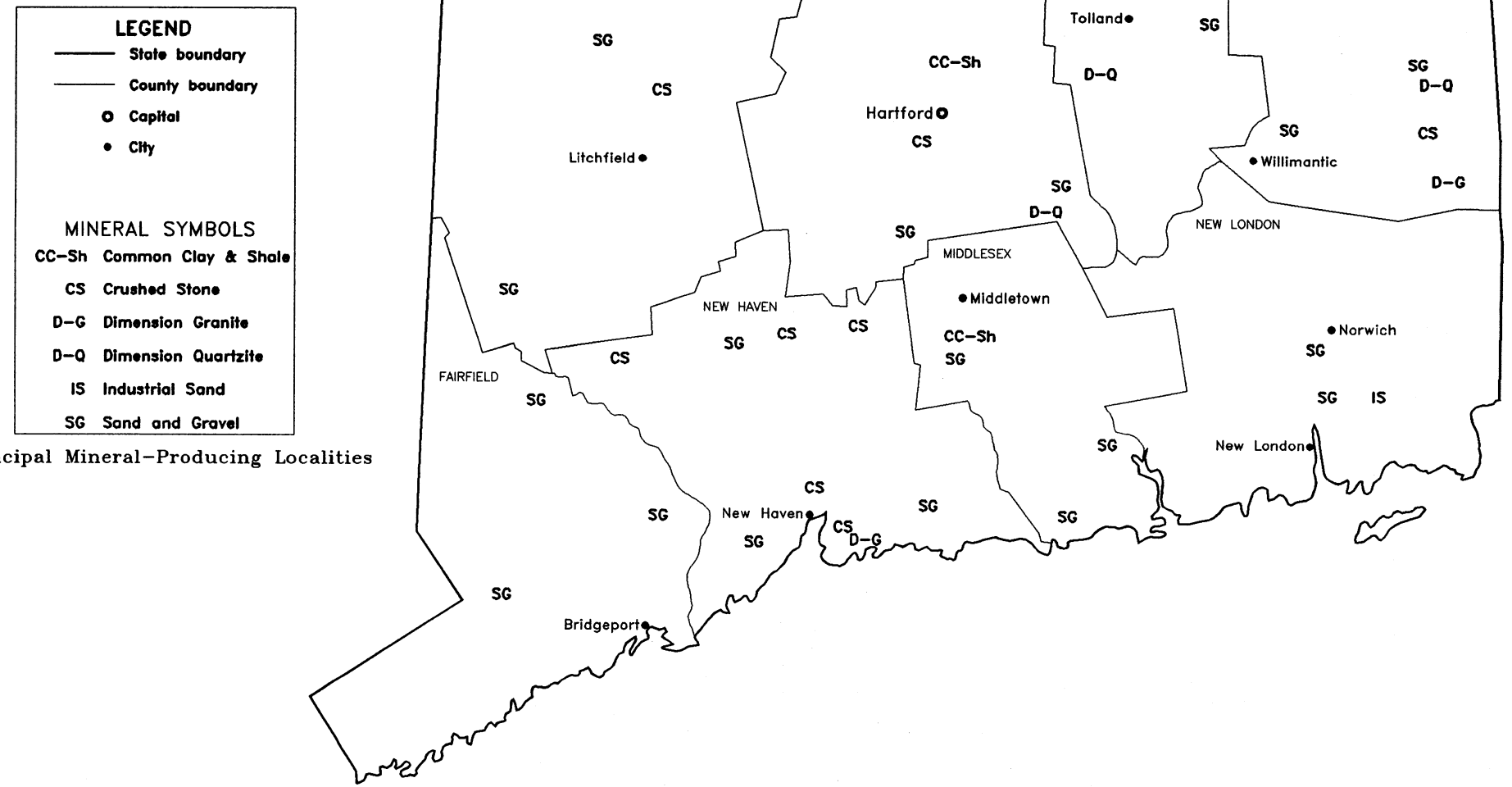
[8]Altamura, R. J. Bedrock Mines and Quarries of Connecticut: Connecticut Geological and Natural History Survey Natural Resources Map, 1:125,000 scale with 41-page booklet, 1987.

[9]Cameron, E. N., et al. Pegmatite Investigations 1942-45, New England. U.S. Geol. Surv. Professional Paper 255, 1954, 352 pp. plus maps.

[10]Barton, W. R., and C. E. Goldsmith. New England Beryllium Investigations. BuMines RI 7070, 1968, 117 pp.

[11]Republican-American (Waterbury, CT). Panel Puts Restrictions on Blasting Due to Noise. Nov. 25, 1992.

CONNECTICUT



Principal Mineral–Producing Localities

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Clays:			
The Michael Kane Brick Co.	654 Newfield St. Middletown, CT 06457	Pit and plant	Middlesex.
K-F Brick Co.	Box 375 East Windsor Hill, CT 06028	do.	Hartford.
Sand and gravel:			
Construction:			
The Balf Co.[1]	301 Hartford Ave. Newington, CT 06111	Pit	Do.
O&G Industries Inc.[1]	23 Casson Ave. Box 907 Torrington, CT 06790	Pit	New Haven.
R. A. Rawson Sand & Gravel Inc.	R.F.D. 1 Putnam, CT 06260	Pits and plant	Windham.
Roncari Industries Inc.[1]	1776 South Main St. East Granby, CT 06026	Pit	Hartford.
Valley Sand & Gravel Corp.	Box 217 North Haven, CT 06473	Pit	New Haven.
Industrial:			
U.S. Silica Co. of Connecticut	Box 187 Berkeley Springs, WV 25411	Quarry and plant	New London.
Stone:			
Crushed:			
Allyndale Corp.	Box 265 East Canaan, CT 06024	Quarry	Litchfield.
The Balf Co.	301 Hartford Ave. Newington, CT 06111	do.	Hartford.
O&G Industries Inc.	23 Casson Ave. Box 907 Torrington, CT 06790	Quarries	Litchfield and New Haven.
Tilcon Connecticut Inc.	Box 67 909 Foxen Rd. North Branford, CT 06471	do.	Hartford, New Haven, Windham.
York Hill Trap Rock Quarry Co.	Westfield Rd. Meriden, CT 06450	Quarry	New Haven.
Dimension:			
Castellucci Stone Inc.	99 Quarry Rd. Stony Creek, CT 06405	do.	Do.
R. B. Marriott & Sons Co.	Box 67 Oneco, CT 06373	do.	Windham.
Wayne C. Williams General Construction Inc.	110 Conklin Rd. Stafford Springs, CT 06076	do.	Tolland.

[1]Also crushed stone.

THE MINERAL INDUSTRY OF DELAWARE

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Delaware Geological Survey for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.[1]

Construction sand and gravel and magnesium compounds were produced in Delaware in 1992. The value of sand and gravel output, based on reports received by the U.S. Bureau of Mines, was about $8.6 million.

TRENDS AND DEVELOPMENTS

Construction began for an advanced materials research and development facility near the University of Delaware at Newark. The Delaware Technology Park was expected to become an international center for development of composite materials technology. Certain composite materials such as fiber-filled ceramics and metal-matrix composites are expected to provide longer life cycles for products that must perform under high-temperature conditions and have a myriad of potential applications in the transportation, energy, environmental, and aerospace areas.

In 1990, worldwide, about 33 million pounds of advanced polymer composites was consumed. About 60% of that total, valued at $2.4 billion, was consumed in the United States. The expanding role of composites and other advanced materials was analyzed in a U.S. Bureau of Mines report, "Toward A New Materials Paradigm."[2]

Also during the year, plans were initiated for the sale of fluorspar stockpiled at the Port of Wilmington since the 1940's. The Department of Defense, through the Defense Logistics Agency, requested from the U.S. Congress permission to dispose of portions of the National Defense Stockpile, including the entire fluorspar stockpile. About 260,000 short dry tons of acid-grade fluorspar is stored at the port.

EMPLOYMENT

In 1992, Delaware employed about 344,000 workers in nonagricultural industries, according to the Delaware Department of Labor. About 75% of the jobs was in the service-producing sector. Manufacturing accounted for about 20% of the employment; construction, about 5%.

In 1992, manufacturing employment dropped by 4% to approximately 67,600 workers compared with 1991 totals. The biggest drop in manufacturing was from the chemical industries, which declined by about 10% to 30,500 employees. Construction employment improved slightly from 18,100 workers in 1991 to 18,300 workers in 1992. Since 1985, the State's nonagricultural work force has increased by about 17%. During the same time, employment in manufacturing and construction, however, has declined by about 4%.

LEGISLATION AND GOVERNMENT PROGRAMS

During the year, the Delaware Department of Natural Resources and Environmental Control reassigned the responsibility for developing extractive use regulations to the Division of Soil and Water Conservation. The regulations were required by enactment of House bill 368 in 1990 and were to protect the waters of the State from adverse environmental impacts relating to extractive use operations. The regulations were expected to be finalized in early 1993 and will apply statewide to the mining of clay, gravel, rock (stone), sand, and silt.

Offshore sand resources were the subject of a cooperative study by the Delaware Geological Survey (DGS), Maryland Geological Survey, and the Minerals Management Service (MMS) of the Department of the Interior. The loss of beach sands, with the potential for a

TABLE 1
NONFUEL MINERAL PRODUCTION IN DELAWARE[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$1	NA	$1	NA	$1
Sand and gravel (construction)	thousand short tons	r2,953	r9,831	e1,600	e5,100	2,488	8,574
Total[2]		XX	r9,832	XX	5,101	XX	8,575

eEstimated. rRevised. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Partial total, excludes values that must be concealed to avoid disclosing company proprietary data.

TABLE 2
DELAWARE: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates and concrete products[1]	966	$3,817	$3.95
Other miscellaneous uses[2]	454	1,370	3.02
Unspecified:[3]			
Actual	776	2,592	3.34
Estimated	291	795	2.73
Total	[4]2,488	8,574	3.45
Total[5 6]	2,257	8,574	3.80

[1]Includes plaster and gunite sands, asphaltic concrete aggregates and other bituminous mixtures, and road base and coverings.
[2]Includes fill, filtration, and snow and ice control.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

loss of beach areas, would diminish tourism, a major industry in Delaware. The study was expected to provide information on the cost and feasibility of replacing sand lost by erosion.

Other ongoing programs at the DGS included annual review of mineral statistics with the U.S. Bureau of Mines, advisement of the State and county extractive use regulations, and evaluation of petroleum potential of mid-Atlantic continental margin. The DGS also was involved in the establishment of an Atlantic Outer Continental Shelf Core and Well Repository, in cooperation with the MMS, and continued geologic mapping projects with the U.S. Geological Survey.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Magnesium Compounds.—Barcroft Co., a subsidiary of Rorer Group Inc., extracted magnesium compounds from seawater near Lewes. These compounds were processed for use in antacids, laxatives, and other pharmaceutical products. Delaware was one of six States that produced magnesium compounds.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

In 1992, about 2.5 million short tons of sand and gravel, valued at $8.6 million, was produced in Delaware. That information was reported to the U.S. Bureau of Mines by 7 companies operating 10 pits.

According to the Delaware Department of Transportation, about 5.9 million short tons (8.8 million cubic yards) of "borrow/soil" was produced from 18 pits for use in construction of State Route 1. This production was in addition to the 2.5 million tons of sand and gravel reported to the U.S. Bureau of Mines. Delaware also received shipments of aggregates from other States including Maryland, New Jersey, and Pennsylvania for use in State highway construction projects.

Metals

Reclaimed Metals and Materials.—The Delaware Solid Waste Authority, through a contract with Raytheon Service Co., operated a resource recovery plant at Pigeon Point, New Castle County. The plant has been in operation for 10 years. During the year, about 231,000 short tons of municipal solid waste was processed at the facility. Recovered materials included about 8,400 tons of ferrous metals and 800 tons of nonferrous metals (primarily aluminum). Also, about 55,600 tons of humus was recovered for use in agricultural applications.

Steel.—CitiSteel USA Inc. operated the State's only steel mill at Claymont. The firm produced approximately 275,000 short tons of carbon-plate steel in 1992. Markets were primarily in the mid-Atlantic and Midwest regions. The steel was used in the manufacture of bridges, tankers, barges, and earth-moving equipment.

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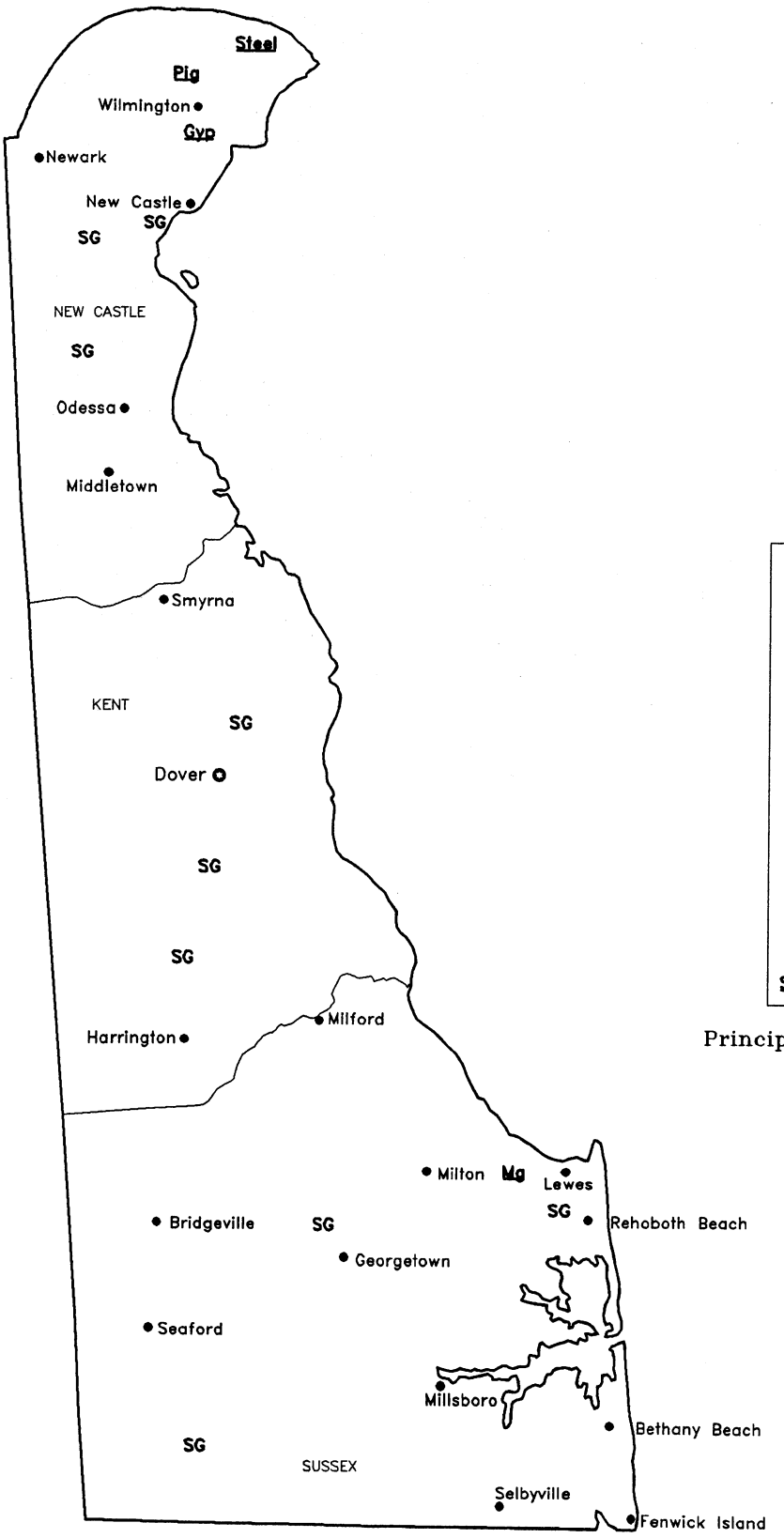
[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related and government experience and has covered the mineral activities in Delaware for 8 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Sousa, L. J. Toward A New Materials Paradigm. BuMines Analytical Series, Dec. 1992, 20 pp.

DELAWARE



LEGEND

State boundary

County boundary

Capital

City

MINERAL SYMBOLS

Gyp Gypsum plant

Mg Magnesium metal plant

Pig Titanium Dioxide pigments

SG Sand and Gravel

Steel Iron and Steel plant

Principal Mineral-Producing Localities

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Gypsum (calcined):			
Georgia-Pacific Corp., Gypsum Div.	Wilmington Marine Terminal Box 310 Wilmington, DE 19899	Plant	New Castle.
Magnesium compounds:			
Barcroft Co.	40 Cape Henlopen Dr. Lewes, DE 19958	do.	Sussex.
Sand and gravel (construction):			
Contractors Sand & Gravel Co. Inc.	Box 2630 Wilmington, DE 19805	Pit	New Castle.
David G. Horsey & Sons Sand Co.	Route 1, Box 140 Laurel, DE 19956	Pit	Sussex.
George & Lynch Inc. (Dover Equipment & Machine Co.)	113 West 6th St. New Castle, DE 19720	Dredge and pit	Kent.
Parkway Gravel Inc.	4048 New Castle Ave. New Castle, DE 19720	Pits	New Castle.
Staytons Sand & Gravel Inc.	Box P Felton, DE 19943	Pit	Kent.
Tilcon Inc.	Box 858 Dover, DE 19903	Pit	Do.
Steel:			
CitiSteel USA Inc.	4001 Philadelphia Pike Claymont, DE 19703	Mill (plate)	New Castle.
Sulfur (recovered):			
Star Enterprise	2000 Wrangle Hill Rd. Delaware City, DE 19706	Refinery (petroleum)	Do.
Titanium dioxide:			
E. I. du Pont de Nemours & Co. Inc.	4600 Hay Rd. Edgemoor, DE 19809	Plant (chemical)	Do.

THE MINERAL INDUSTRY OF FLORIDA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Florida Geological Survey for collecting information on all nonfuel minerals.

By Doss H. White, Jr.,[1] Walter Schmidt,[2] and Steve Spencer[3]

In 1992, Florida's nonfuel mineral value was $1.439 billion, an increase over the $1.396 billion reported in 1991. An increase in sales was reported for the major industrial minerals produced in the State—cement, phosphate rock, construction sand and gravel, and stone. Sales of these four commodities increased about $60 million above the value reported for the previous year. Florida's mineral sales ranked the State fifth nationally, and the State's mineral value was 4.5% of the Nation's total.

TRENDS AND DEVELOPMENTS

For most of the 20th century, phosphate rock has been the leading mineral, valuewise, mined in Florida. More than 95% of Florida's phosphate rock production is used by the fertilizer industry, and the phosphate industry produces approximately 80% of the Nation's fertilizer needs and 30% of the world's demand. Historically, sales of fertilizer and phosphoric acid have exceeded 50% of the State's mineral value. The annual rise or decline in the value of Florida's mineral output has been governed by both fertilizer and phosphoric acid demand and sales to the domestic and world's phosphate fertilizer market.

In past years, the former U.S.S.R. purchased a significant tonnage of Florida's phosphate fertilizer. With the breakup of the U.S.S.R., a major market disappeared, and some former Soviet countries were selling phosphate fertilizer stockpiles to raise cash. China and India, both phosphate fertilizer importers, purchased less than in past years, which further depressed the phosphate market. India cut fertilizer subsidies for its farmers, reducing their ability to purchase fertilizer.

On the domestic scene, about 45% of fertilizer sales are to corn producers. Unseasonably wet weather across much of the Midwestern Corn Belt lowered fertilizer demand because farmers had difficulty harvesting the crop and had less time to apply fertilizer. Fertilizer dealer

TABLE 1
NONFUEL MINERAL PRODUCTION IN FLORIDA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	442	$27,777	e214	e$13,482	342	$22,424
Portland	do.	3,954	186,404	e3,023	e142,081	3,195	161,969
Clays[2]	metric tons	391,334	39,625	363,253	39,150	367,133	37,201
Gemstones		NA	W	NA	6	NA	1
Peat	thousand short tons	252	4,381	244	3,991	211	3,158
Sand and gravel:							
Construction	do.	r20,680	r66,401	e16,000	e51,400	23,266	66,141
Industrial	do.	520	7,024	551	5,989	477	5,167
Stone (crushed)	do.	e74,000	e317,400	[3]59,132	[3]260,901	e[3]59,300	e[3]266,900
Combined value of clays (common), magnesium compounds, phosphate rock, rare-earth metal concentrates, staurolite, stone [crushed marl (1991-92)], titanium concentrates (ilmenite and rutile), zircon concentrates, and value indicated by symbol W		XX	924,788	XX	879,164	XX	876,799
Total		XX	r1,573,800	XX	1,396,164	XX	1,439,760

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX. Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" data.
[3]Excludes certain stones; kind and value included with "Combined value" data.

inventories remained high, and orders to replenish stocks were down.

The decline in phosphate fertilizer purchases by the Commonwealth of Independent States, China, India, and domestic users was cited as the reason for several mine and plant closings. Occidental Chemical Corp. closed its Suwannee River Mine in May; 300 jobs were affected. In June, IMC Fertilizer Inc., the State's largest producer, closed six mines in a three-county area for 18 days, leaving hundreds of workers without pay. Also in June, Piney Point Phosphates Inc. closed its fertilizer plant, affecting 130 jobs, and filed for chapter 11 bankruptcy protection. The action was taken, in part, because of the depressed phosphate market. Early in the fall, Occidental laid off 425 workers at its Hamilton County operation. The Hamilton County plant and mines were for sale, but no definite sales agreement had been reached by yearend. Mobil Mining and Minerals Co. closed its remaining Polk County phosphate mine near Mulberry in December, affecting about 100 employees. At yearend, Florida's two top producers were discussing a merger to cut costs and survive the poor market conditions.

By yearend, diammonium phosphate prices were about $115 per ton in central Florida. This was a decline of more than 20% from January, and the selling price was approaching the production costs of the larger phosphate fertilizer companies. Producers, unable to raise prices, were trying to trim costs. Unfortunately, this equated to a loss of jobs.

Most mineral industry developments were phosphate-related. Mulberry Phosphates Inc. sold its Port of Tampa chemical terminal and pipeline facilities to C-F Industries Inc. Consolidated Minerals Inc. abandoned plans to build a $1 billion industrial complex and phosphate mine in De Soto County, but maintained plans to develop the mine. Despite the low fertilizer prices, Mobil Mining and Minerals Co. announced plans to develop a new phosphate mine in southern Polk and northern Hardee Counties in late 1994 or early 1995. On the agricultural scene, Florida scientists determined that clay-settling ponds associated with phosphate beneficiation plants are fertile grounds for a variety of crops.

Approximately 40% of Florida's crushed stone production is mined in Dade County in an area between Miami and the Everglades National Park. Dade County crushed stone producers have proposed a plan to halt urban sprawl into the Everglades while guaranteeing the county and the Florida east coast area adequate supplies of crushed stone through the year 2050. The plan is discussed below in the Environmental Issues section.

E. I. du Pont de Nemours & Co. Inc., the world's largest producer of titanium dioxide, completed a multimillion dollar project to expand its northeast Florida heavy-minerals operation. A new dredge and associated wet concentrator plant went into operation.

ENVIRONMENTAL ISSUES

Much of the crushed stone used along Florida's eastern coast is mined from a narrow, degraded wetlands belt between Miami and the Everglades. More than 20 million metric tons of stone is mined in Dade County each year; much is used in-county, and unit trains annually transport several million metric tons of crushed stone as far north as Jacksonville. Miami's westward expansion is threatening both the Everglades and the principal well field that supplies Miami's drinking water. Miami-area stone producers, concerned with the expansion problems and possible wetland legislation that could hamper or terminate stone removal, formed a coalition of aggregate mining firms to work with government agencies to determine the best use for the degraded wetlands. More than 50% of the study area is owned by the stone companies.

After several months of study, the South Florida Limestone Mining Coalition issued a report calling for the creation of a 93-hectare (23,000-acre) belt of freshwater lakes within the degraded wetland area. The lakes, created by limestone removal, would bypass the well field and isolate it from urban expansion and runoff. The lakes would be used for both recreational purposes and for water storage for Dade County's future needs.

In the lake-belt area is one of the largest stand of an Australian tree species in Dade County, and it threatens to expand into and compete with the Everglades flora and fauna. If the lake-belt plan is approved by county, State, and Federal agencies, the majority of the trees will be removed at no cost to the county or State. At yearend, the proposal was under review by the various government agencies.

Officials in the Department of Environmental Protection (DEP) believe that, for environmental considerations, new powerplants should be fueled by natural gas rather than coal. Two measures that would expedite the construction of natural gas pipelines by establishing a one-stop permitting process were introduced in the 1992 Florida legislative session; these were H.R. 2097 and S. 1950. The bills were supported by DEP and approved by all committees of reference, but they died on the calendar because of opposition from rural electric authorities and railroads.

The U.S. Environmental Protection Agency (EPA) eased restrictions on the use of radioactive phosphogypsum. The Agency ruled that the phosphogypsum, resulting from processing of phosphate rock into fertilizer, can be applied as a soil conditioner and tested in research projects. The phosphogypsum can be used for other projects on a "case-by-case" basis, provided the EPA first determines the proposed use poses no public health threat.[4]

LEGISLATION AND GOVERNMENT PROGRAMS

Several bills were passed during the 1992 Florida legislative session that were of interest to the State's mineral industry.[5]

Mining in Wetlands, S. 2122, revised the permitting requirements for mining activities in wetlands. Wetlands reclamation performed in accordance with

DEP reclamation requirements must be accepted by DEP as mitigation if certain conditions are met.

Clean Air Act, S. 2122, allows the State to implement new permitting requirements of the Federal Clean Air Act. The bill authorized the establishment of significantly higher application fees for air permits.

Storage Tanks, H.R. 2477, made several significant changes to the cleanup program for leaking storage tanks. Most owners of leaking tanks must complete site restoration to seek State reimbursement; only certain small businesses will remain entitled to State-conducted cleanup. State reimbursement for cleanup for most industries will be phased out. The excise tax on fuel and other pollutants was raised to increase funds for the cleanup program. The bill requires the registration of certain storage tanks that were not under the former DEP registration program.

The first $10 million collected in mineral severance tax is earmarked for the Conservation and Recreation Lands Trust Fund. The fund is used by the State to purchase environmentally sensitive lands. Remaining funds are divided among the Nonmandatory Lands Reclamation Trust Fund, the State's general revenue fund, the mining counties, and the Florida Institute of Phosphate Research. The latter is a part of the Florida University system. In 1992, $61.9 million in severance taxes was collected.

The Florida Geological Survey, the principal State agency involved with research into the State's geology and the identification of mineral resources within Florida, conducted several studies of interest to the mineral industry. These were published in full or abstract form or placed in an open file report at the Survey's research library. Included were studies of the heavy-mineral resources of Columbia, Hamilton, and Suwannee Counties; a directory of the industrial minerals operations in Florida; and a compilation of marine mining and oil and gas regulations.

Ongoing resource studies included uranium associated with Florida peat deposits and a mineral resource study for Escambia County. In addition, the Survey, via the U.S. Minerals Management Service, funded a research study of phosphate resources of the west Florida shelf region.

A Teacher Training Workshop was held at the University of Florida in Gainesville. The workshop was sponsored by Florida Ag in the Classroom Inc. and supported by the Florida Farm Bureau Federation, Florida Department of Agriculture and Consumer Services, and other Florida agriculture and agriculture-related organizations. The teachers were instructed on using agriculture topics to demonstrate aspects of science, social sciences, math, and other subjects. Field trips were included in the study; the group toured Occidental Chemical Corp.'s phosphate mining and refining operation at White Springs, where it visited a "four-story" dragline.[6]

Personnel with the U.S. Bureau of Mines Research Center, Department of the Interior, Tuscaloosa, AL, installed 21 monitoring wells on an inactive gypsum stack. The wells were to document any heavy-metal migration through the stack. Other personnel conducted continuous froth flotation studies in an attempt to improve coarse phosphate recovery. More than 1 million metric tons of phosphate is lost each year in flotation tailings during processing. The recovery of any part of this tonnage would extend the U.S. phosphate reserve base.

The U.S. Bureau of Land Management, Department of the Interior, conducted a public hearing in October on a "Resource Management Plan" and an environmental impact statement for a part of Florida. The plan will guide the Agency's mineral leasing and permitting responsibilities on approximately 109,300 hectares (270,000 acres) of land where the mineral estate, including phosphate and oil and gas reserves, is owned by the Federal Government.[7]

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Cement.—The State ranked seventh in portland cement and second behind Indiana in masonry cement production. Cement sales, both portland and masonry, accounted for 13% of Florida's total mineral value. In 1991, cement sales accounted for 11% of the value.

Portland cement output, 2.9 million metric tons (3.2 million short tons) valued at $162 million, increased over the 2.7 million metric tons (3.0 million short tons) valued at $142 million estimated in 1991. Masonry cement demand paralleled that of portland cement. Production, 310,000 metric tons (342,000 short tons), was valued at $22 million.

The Florida cement industry consisted of six firms operating six plants in Bradenton, Brooksville, Fort Pierce, Hialeah, Miami, and Tampa. All plants produced portland cement, and three produced masonry cement. The six plants operated eight kilns—five dry process and three wet. The plants ground both domestic and imported clinker in the cement manufacturing process.

Clays.—Clay sales were a minor but important part of Florida's mineral value, accounting for 2.5% of the 1992 value. Common clay, fuller's earth, and kaolin were mined; production was higher than that in 1991, but value fell below the previous year's level. Common clay output and value were concealed because there were only two producers. Production and value were the same as those reported in 1991. Kaolin production, 34,700 metric tons (38,200 short tons), rose above the 1991 level of 30,800 metric tons.

Fuller's earth production, 332,500 metric tons (366,500 short tons) valued at $33.8 million, exceeded the 332,400 metric tons but fell below the $35.6 million reported in 1991.

Common clay was produced by the Florida Solite Corp. from pits in Clay County and by Coddings Sand and Soil Inc. from pits in Lake County. Sales were to firms producing concrete block, structural concrete, and asphalt emulsions.

Fuller's earth was produced by Engelhard Corp., Floridin Co., and Milwhite Co. Inc. from pits in Gadsden

TABLE 2
FLORIDA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	7,454	$25,455	$3.41
Plaster and gunite sands	294	1,096	3.73
Concrete products (blocks, brick, pipe, decorative, etc.)	809	2,722	3.36
Asphaltic concrete aggregates and other bituminous	380	1,755	4.62
Road base and coverings	611	1,902	3.11
Fill	5,578	8,467	1.52
Other miscellaneous uses[1]	489	1,405	2.87
Unspecified:[2]			
Actual	2,721	10,296	3.78
Estimated	4,931	13,043	2.65
Total	[3]23,266	66,141	2.84
Total[4 5]	21,107	66,141	3.13

[1]Includes filtration.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data do not add to total shown because of independent rounding.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

County and by Mid-Florida Mining Co. from pits in Marion County. The top three end uses, which accounted for more than 66% of the tonnage mined, were (1) pet waste absorbents, (2) pesticide carriers and related products, and (3) oil and grease adsorbents.

Kaolin was recovered during industrial sand dredging by the Feldspar Corp. at an operation in Putnam County. Major sales were to the electric porcelain, sanitaryware, and china manufacturing industries. These three accounted for more than 51% of the kaolin recovered.

Magnesia.—Seawater was the raw material for magnesia extraction at a facility at Port St. Joe, on the northern Gulf of Mexico. The plant, southeast of Panama City, was operated by Premier Refractories & Chemical Corp. and produced caustic calcined magnesia, magnesium hydroxide slurry, and a dead-burned magnesia.

Peat.—The State advanced to first place among the 20 peat-producing States. Production and value were 211,000 metric tons valued at $3.2 million. Ten firms harvested peat from bogs in Highlands, Hillsborough, Lake, Putnam, and Sumter Counties. Lake, Highland, and Sumter Counties accounted for 88% of the production. Both reed-sedge and humus peat were harvested and sold for horticultural uses.

Phosphate Rock.—The State continued as the leading domestic phosphate producer and accounted for about 30% of the world's total. Phosphate rock sales accounted for more than 50% of the State's total mineral value. Production in 1992, as determined by the Florida Phosphate Institute, totaled 36.2 million metric tons (39.9 million short tons), the same as in 1991. In 1992, nine companies operated phosphate rock mines in central and northern Florida.

The phosphate market was flat due primarily to a twofold problem with foreign demand, the breakup of the U.S.S.R. and resulting economic difficulties, and the cutting of fertilizer subsidies by the Indian Government. A wet summer in the United States also added to the fertilizer demand problem.

Sand and Gravel.—Sales of construction and industrial sand and gravel totaled $71 million, an increase over the $57 million reported in 1991. Output, 21.5 million metric tons (23.7 million short tons), increased 6.4 million metric tons (7.1 million short tons) over the 15.1 million metric tons (16.6 million short tons) mined in 1991. Value of construction and industrial sand and gravel sales ranked fourth among the mineral commodities produced in Florida and accounted for about 5% of the 1992 value.

Construction.—The production of construction sand and gravel is surveyed by the U.S. Bureau of Mines for even numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimated data for 1991.

The State ranked 14th in tonnage and 18th in value among the 49 States with a construction sand and gravel industry. Florida's construction sand and gravel industry produced 21.1 million metric tons (23.3 million short tons) valued at $66.1 million. This was a significant

TABLE 3
FLORIDA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[1]	1,325	4,302	5,569	19,194	1,379	4,762	283	1,015
Asphaltic concrete aggregates and road base materials[2]	129	958	1,566	2,265	1,661	3,699	3,114	5,201
Other miscellaneous uses[3]	—	—	67	254	422	1,151	—	—
Unspecified:[4]								
Actual	51	127	875	3,561	1,763	6,521	31	87
Estimated	755	2,292	1,446	3,730	2,730	7,020	—	—
Total[5]	2,359	7,679	9,523	29,004	7,956	23,154	3,428	6,304
Total[6 7]	2,140	7,679	8,639	29,004	7,217	23,154	3,110	6,304

[1]Includes plaster and gunite sands.
[2]Includes fill.
[3]Includes filtration.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value in thousand metric tons and thousand dollars.

increase over the 14.5 million metric tons (16 million short tons) mined in 1991. An increase in construction activity accounted for the increased output.

Production was reported by 44 companies operating 67 pits in 27 counties. The three leading counties, Lake, Polk, and Sarasota, accounted for 46% of the State's total.

Industrial.—Florida ranked 20th in value and 23d in production of industrial sand and gravel. Output totaled 433,000 metric tons (477,000 short tons) valued at $5.2 million. Five firms operated six pits in six counties. Included were Clarke Sand Co. Inc. (Escambia County), E. R. Jahna Industries Inc. (Glades and Lake Counties), Standard Sand & Silica Co. (Marion and Polk Counties), and Florida Rock Industries Inc. and The Feldspar Corp. (Putnam County).

Staurolite.—E. I. du Pont de Nemours & Co. Inc. produced a staurolite concentrate, a byproduct of mineral sands processing, at an operation in Clay County. Principal sales were to the foundry, sandblasting, and cement industries.

Stone.—The production of stone is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Florida ranked fourth in production and value of crushed stone, according to the 1992 U.S. Bureau of Mines estimate. Stone value ranked second in the State's 1992 total mineral value and accounted for about 18% of the total. Production and value, excluding marl, were estimated at 53.8 million metric tons (59.3 million short tons) valued at $266.9 million. This was slightly higher than the 53.5 million metric tons (59 million short tons) and $261 million reported in 1991.

Florida's crushed stone industry produced limestone and dolomite, shell, and marl. In the last year that a full industry canvass was received, limestone accounted for more than 95% of the stone mined. In that year, 71 firms operated 105 quarries in 25 counties. Limestone and dolomite were mined in 22 counties, shell in 4, and marl in 2. The five leading counties, in decreasing tonnage, were (1) Dade, (2) Broward, (3) Hernando, (4) Lee, and (5) Citrus. These five accounted for approximately 70% of the production. Stone from Dade and Broward were transported by unit train as far north as Jacksonville. Stone was imported into the State through the Ports of Tampa and Jacksonville. Principal markets/end uses reported in the 1991 industry canvass included road aggregate and base, stone sand, poultry grit, and agricultural limestone.

Sulfur (Recovered).—Exxon Corp. operated Florida's only natural gas processing plant that removed sulfur. The Santa Rosa facility recovered 46,900 metric tons (51,700 short tons) from gas piped from the Jay and Blackjack Fields.

Other Industrial Minerals.—Several mineral commodities were shipped into the State and used as a raw material in a processing step or processed into a higher value product. Some were recovered from other substances. These minerals, not listed in table 1, included fluosilicic acid, gypsum, nitrogen used in ammonia and nitric acid production, perlite, and vermiculite.

Metals

Iron and Steel.—Tampa and Jacksonville were the sites of Florida Steel Corp.'s two minimills. The two mills had an aggregate annual capacity of 547,000 metric tons (603,000 short tons).

Mineral Sands.—RGC (USA) Minerals Sand Inc. and Du Pont recovered mineral sands by dredging properties at Green Cove Springs and Trail Ridge. The dredges and associated wet mills produced a concentrate that was trucked to the dry mills for the recovery of monazite, titanium, and zirconium concentrates.

Du Pont began operating its new 1,905-metric-ton-per-hour (2,100-short-ton-per-hour) "Sandpiper" dredge manufactured by Ellicott Machine Corp. of Baltimore. It is the largest cutter suction dredge in use for mining in North America. The new dredge, in operation near Maxwell, will increase production by 50% and extend mine life to the year 2010.

Rare Earths.—RGC recovered rare earth as a byproduct of monazite during processing for titanium and zirconium minerals. The company was one of three in the United States that produced rare earths in 1992. Production declined 57% from that of 1991.[8]

Titanium Concentrates.—RGC and Du Pont recovered mineral sand concentrates containing rutile, ilmenite, and leucoxene. The concentrates were marketed to producers of titanium dioxide pigments and synthetic rutile.

Zirconia Concentrates.—Both mineral sand producers recovered a zircon concentrate from their dredging operations. The product, sold to grinding plants for processing, was used by the ceramic, refractory, and foundry industries.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 33 years of mineral-related industry and government experience and has covered the mineral activities in Florida since 1989. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

[2]State geologist and chief, Florida Geological Survey, Tallahassee, FL.

[3]Geologist, Florida Geological Survey, Tallahassee, FL.

[4]The Ledger. EPA Eases Rules on Gypsum Use. June 4, 1992.

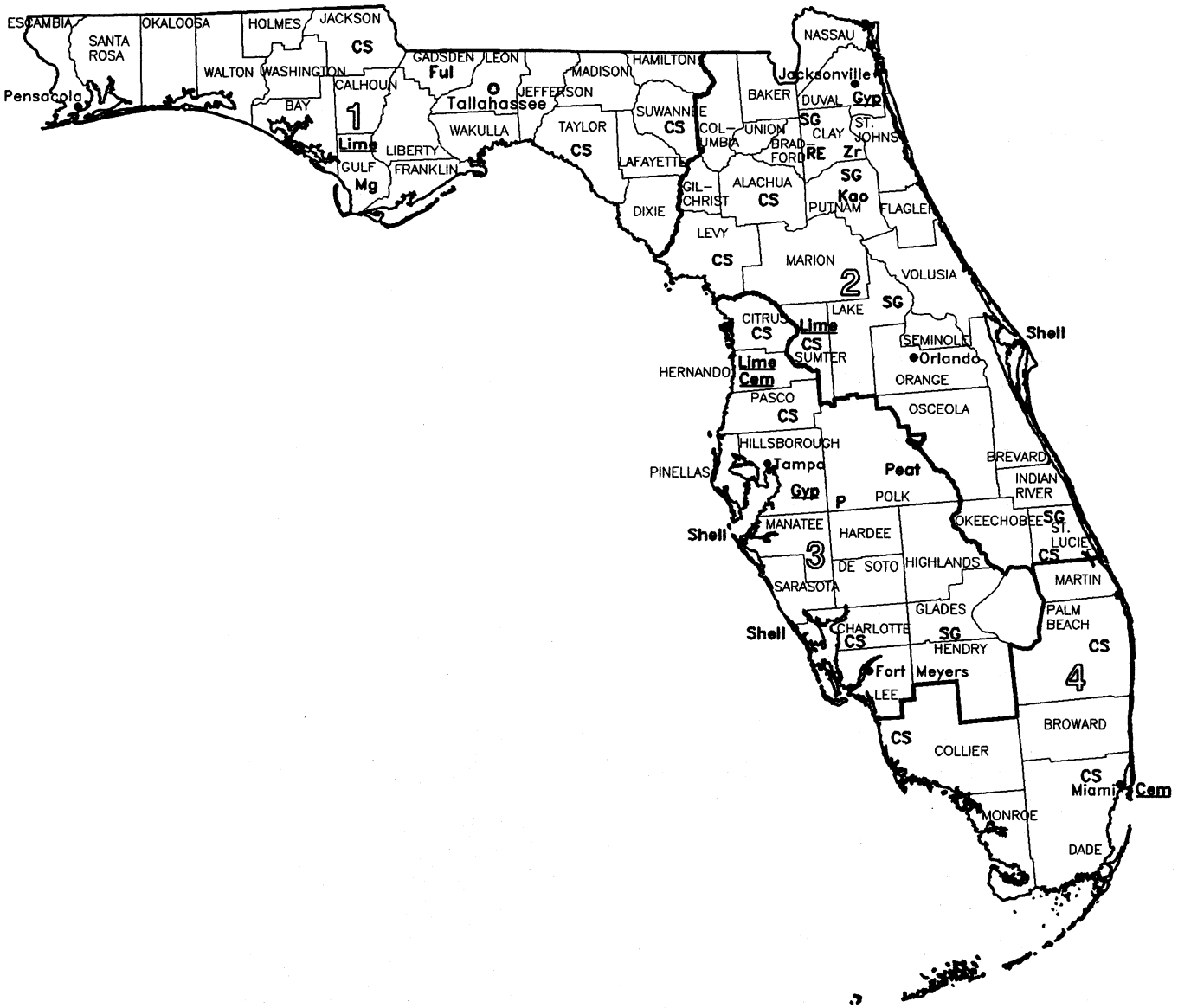
[5]Florida Environments. Several Enviro Bills Passed This Session, Some Pending. Apr. 1992.

[6]Florida Agriculture. Getting Out of the Classroom and Into Agriculture. Aug. 1, 1992.

[7]The Lake Wales Highlander. Federal Land Hearing Set in Polk County. Oct. 1, 1992.

[8]Mining engineering. Industrial Minerals 1992—Rare Earths. June 1993, p. 582.

FLORIDA



LEGEND

- State boundary
- County boundary
- O Capital
- • City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

- Cem Cement plant
- CS Crushed Stone
- Ful Fuller's earth
- Gyp Gypsum plant
- Kao Kaolin
- Lime Lime plant
- Mg Magnesium
- P Phosphate rock
- Peat Peat
- RE Rare-earths
- SG Sand and Gravel
- Shell Shell
- Zr Zircon
- Concentration of mineral operations

Principal Mineral-Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Lafarge Corp.	Box 223481 Tampa, FL 33622	Plants	Hillsborough.
Moore McCormack Resources Inc.	Box 23965 Tampa, FL 33630	Plant	Hernando.
National Portland Cement Co.	Route 1 Port Manatee Palmetto, FL 34221	do.	Manatee.
Rinker Portland Cement Corp.	Drawer K Palm Beach, FL 33416	do.	Dade.
Tarmac Florida Inc.	Box 122035 Hialeah, FL 33012	do.	Do.
Clays:			
The Feldspar Corp., EPK Div.[1]	Box 8 Edgar, FL 32049	Mines and plant	Putnam.
Floridin Co.	5380 Capitol Cr., NW Tallahassee, FL 32303	do.	Gadsden.
Mid-Florida Mining Co.	Suite 152 3300 Southwest 34th Ave. Ocala, FL 32674	do.	Marion.
Gypsum (calcined):			
Jim Walter Corp.	Box 135 Jacksonville, FL 32226	Plant	Duval.
National Gypsum Co.	4100 First International Bldg. Dallas, TX 57270	do.	Hillsborough.
USG Corp.	101 South Wacker Dr. Chicago, IL 60606	do.	Duval.
Peat:			
Hyponex Corp.	14111 Scottslawn Rd. Marysville, OH 43041	do.	Lake.
Reliable Peat	Box 217 Winter Garden, FL 32787	do.	Do.
TU-CO Peat	9601 Bear Rd. Sebring, FL 33870	do.	Highlands.
Perlite (expanded):			
Armstrong World Industries Inc.	Box 1991 Pensacola, FL 35289	do.	Escambia.
Chemrock Corp.	End of Osage St. Nashville, TN 37208	do.	Duval.
Harborlite Corp.	P.O. Box 461209 Escondido, CA 92046	do.	Gadsden.
Phosphate rock:			
Agrico Mining Co.	Box 1110 Mulberry, FL 33860	Mine(s) and plant complex	Polk.
IMC Fertilizer Inc.	Box 867 Bartow, FL 33830	do.	Do.
Occidental Chemical Agricultural Products Inc.	White Springs, FL 32096	do.	Hamilton.
Sand and gravel:			
Construction:			
Florida Rock Industries Inc., Shands & Baker.	Box 4667 Jacksonville, FL 32201	Pits and plant	Clay, Glades, Lake, Marion, Polk, Putnam.

See footnotes at end of table.

TABLE 4—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued:			
Construction—Continued:			
E. R. Jahna Industries Inc., Ortona Sand Co. Div.	102 East Tillman Ave. Lake Wales, FL 33853	Pits and plant	Glades, Lake, Polk.
Tarmac Florida Inc., Center Sand Div. of Tarmac America	16375 Hartwood Marsh Rd. Clermont, FL 34711	do.	Lake.
Industrial:			
The Feldspar Corp.	Box 8 Edgar, FL 32049	Pit and plant	Putnam.
E. R. Jahna Industries Inc., Ortona Sand Co. Div.	102 East Tillman Ave. Lake Wales, FL 33853	do.	Glades and Lake.
Standard Sand & Silica Co.	Box 35 Davenport, FL 33832	Pit and plant	Polk and Marion.
Stone:			
Florida Rock Industries Inc.	Box 4667 Jacksonville, FL 32201	Quarries and plant	Alachua, Collier, Dade, Hernando, Lee, St. Levy, St. Lucie.
Rinker Southeastern Materials Inc.	Box 5230 Hialeah, FL 33014	do.	Dade.
Tarmac Florida Inc.	Box 8648 Deerfield Beach, FL 33441	Quarry and plant	Dade and Monroe.
Vecellio & Grogan Inc.[1]	Box 15065 West Palm Beach, FL 33416	do.	Dade.
Vulcan Materials Co.	Box 7497 Birmingham, AL 35253	Quarries and plant	Broward and Dade.
Titanium concentrates:			
RGC (USA) Mineral Sands Inc.	Box 1307 Green Cove Springs, FL 32043	Mine and plant	Clay.
E. I. du Pont de Nemours & Co. Inc.[2]	Du Pont Bldg. D-10084 Wilmington, DE 19898	Mines and plants	Do.

[1]Also construction and industrial sand and gravel.
[2]Also staurolite.

THE MINERAL INDUSTRY OF GEORGIA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Georgia Geologic Survey, Environmental Protection Division, Georgia Department of Natural Resources, for collecting information on all nonfuel minerals.

By Steve W. Sikich[1] and Bruce J. O'Connor[2]

Statistics released by the U.S. Bureau of Mines (USBM), Department of the Interior, indicate that the value of nonfuel minerals produced in Georgia in 1992 increased 3.1% from a revised[3] $1.31 billion in 1991 to $1.35 billion. The increase marked the 11th time in 12 years that Georgia's mineral production was greater than that in the previous year. The only year in which a decrease occurred was 1991. However, the mineral value in 1992 was 10.5% less than the alltime record high achieved in 1990.[4]

The State's two leading commodities, clays and crushed stone, accounted for more than 90% of the total value of minerals produced. Both increased in value from those in 1991 as follows: clay by 2.2%, from $949.7 million to 970.9 million, and crushed stone by 9.6%, from $222.9 million to $244.2 million. Other mineral commodities that increased in value in 1992 were gemstones, construction sand and gravel, and four commodities for which data were withheld to protect company proprietary information. The only minerals decreasing in value from 1991 to 1992 were dimension stone and two commodities for which data were withheld.

Despite the increase in its mineral production, Georgia dropped from sixth in 1991 to eighth in the total value of minerals produced, but retained its ranking of third in industrial minerals. The State accounted for 4.21% of the total value of minerals produced in the country in 1992. Georgia continued to lead the Nation in the quantity and value of total clays mined, as well as three specific types of clays—kaolin, fire clay, and fuller's earth. The State also led in the quantity of granite dimension stone quarried and regained its number one ranking in the value of barite mined. Georgia ranked second in the production of natural iron oxide pigments sold. Except for the recreational panning of gold, no metals were mined in Georgia in 1992.

TABLE 1
NONFUEL MINERAL PRODUCTION IN GEORGIA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	9,855,248	$1,060,539	9,518,026	$949,737	[2]8,962,374	[2]$970,905
Gemstones		NA	20	NA	10	NA	645
Sand and gravel:							
Construction	thousand short tons	r4,827	r15,577	e4,700	e14,500	4,860	15,581
Industrial	do.	W	W	W	W	588	8,783
Stone:							
Crushed	do.	e53,000	e317,300	[3]41,339	[3]222,900	[3]e44,000	[3]e244,200
Dimension[2]	short tons	re200,531	re20,451	r216,938	r21,282	e159,093	e13,138
Combined value of barite, bauxite (1991-92), cement, clays [fire (1992)], feldspar, iron oxide pigments (crude), mica (scrap), peat (1990), stone [crushed marl, marble and other (1991-92), dimension marble], talc and pyrophyllite (1990), and values indicated by symbol W		XX	e90,164	XX	97,307	XX	93,002
Total		XX	r1,504,051	XX	r1,305,736	XX	1,346,254

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

[3]Excludes certain stones; kind and value included with "Combined value" data.

TRENDS AND DEVELOPMENTS

The increase in the value of Georgia's mineral economy from 1991 to 1992 suggests a recovery from the recession that impacted the State. However, its failure to rebound to anywhere near the record level of 1990 suggests the recovery was constrained and that full recovery may take several years. Georgia experienced an 11% growth in construction spending in 1992. Permits for building construction totaled $6.7 billion, which included $4.3 billion in new residential construction, including hotels; $1.2 billion in new nonresidential construction; and $1.2 billion in additions and alterations.

Revenue at Georgia's ports continued to increased to record-high levels. The Port of Savannah set a new record for total containerized cargo in fiscal year 1992, handling 3.8 million short tons, while the container volume of 20-foot equivalent units rose to 498,432. Total exports from Georgia were valued at $8.1 billion. To accommodate the newest and largest vessels now afloat or planned, the Georgia Ports Authority plans to spend more than $300 million during the decade of the 1990's to upgrade and expand the ports' facilities. The upgrading and expansion began with two projects that have been completed. A new bridge, completed in 1991, was constructed across the Savannah River to raise the vertical clearance to 185 feet. In 1992, a 5.6-mile stretch of the Savannah River channel was widened from 400 feet to 500 feet. Work on deepening the channel was scheduled to begin in early 1993.

The Governors of Alabama, Florida, and Georgia opened 1992 by signing an agreement on January 3 that established a partnership to study interstate water issues. The States have been in disagreement since 1990 when Georgia announced plans to divert water from the Coosa and Chattahoochee Rivers to serve the growing Atlanta area. Alabama filed suit in U.S. District Court to prevent the U.S. Army Corps of Engineers (Corps) from guaranteeing Georgia right to the water. The agreement calls for a $3 million study funded by the three States and the Corps to study the States' shared water resources, specifically the Alabama-Coosa-Tallapoosa and the Apalachicola-Chattahoochee-Flint river basins. The Corps will terminate a plan to divert water from rivers flowing into Alabama and Florida to meet the needs of Atlanta and north Georgia. Alabama will ask the Federal court to stop all action on its lawsuit. States, cities, and businesses will continue to use water at current rates and will notify the other States if an increase is needed. Finally, the three States and the Corps will continue negotiating and exchanging information about the region's water needs.

Construction-material industry officials expect large-scale acquisitions by foreign companies, such as the Hanson PLC purchase of Beazer PLC in 1991, to slacken in the remainder of the decade. Divestitures of some of the acquisitions made in the 1980's and early 1990's can be expected as the construction industry continues to endure a slow-growth market. Smaller companies will continue to be available for acquisition as the result of costs and time required for compliance with government regulations, decreasing availability of permitted reserves, expected slow-growth of the economy, and decreased opportunities for internal or family selling alternatives. Companies in rural areas are expected to consolidate to lessen competition and increase profits.

The aforementioned expectations appeared to be supported in Georgia as the rate of major corporate changes and takeovers that highlighted mineral industry activity for the past decade slackened in 1992. However, several relatively small transactions did occur. Coggins Granite Inc., Elberton, was acquired by Swenson Granite Co., Concord, NH. Kemira Inc., the Savannah-based subsidiary of Finland's Kemira Oy, signed a letter of intent to purchase a 20% interest in Nord Kaolin Co. based in Jeffersonville, Twiggs County. New plants and plant expansions also occurred at a slower pace. Kemira announced plans to construct an $18 million research and development center at its Savannah plant. Expansions were completed by Albion Kaolin Co., Hephzibah; ECC International Inc., Sandersville; and Southern Granite Co. Inc., Elberton.

EMPLOYMENT

Based upon statistics supplied by the U.S. Department of Labor,[5] employment in Georgia's mining sector decreased from 7,700 in 1991 to 7,500 in 1992, a drop of 2.6%. The Mine Safety and Health Administration reported[6] a somewhat lower total number of workers (7,296) employed in the mining industry in 1992, of which 53 were employed in an underground crushed stone mine, 3,965 in nonmetal surface mines, and 5,274 in mills and preparation plants. One fatal minerals-related accident occurred in a preparation plant in Georgia in 1992.

The average salary of mine workers in Georgia increased 6.8%, from $31,466 in 1991 to $33,606. The 1992 salary averaged 23.6% less than the national average of $41,535 for mine workers, but was 37.1% higher than the average pay of $24,517 for nonfarm workers in Georgia. The only Georgia workers with a higher average pay were transportation, communications, and public utility workers who averaged $35,819 annually and wholesale trade workers who averaged $34,759.

ENVIRONMENTAL ISSUES

The Hazardous Waste Management Program of the Georgia Environmental Protection Division (EPD) was split from the Land Protection Branch, effective February 1. The new Hazardous Waste Management Branch will be responsible for the following programs: Generator Compliance, Facilities Compliance, Corrective Action, and Criminal Investigation. On July 1, responsibility for portions of the Erosion and Sedimentation Control Program were transferred from the Land Protection Branch to the Water Protection Branch. Duties related to issuing permits and

reviewing local programs transferred to Water Protection. Inspection and enforcement functions remained in Land Protection.

A new 10-year plan proposed by the Georgia Geologic Survey (GGS) emphasized a shift from mineral and academic studies to environmental technical investigations and regulatory support. The Accelerated Economic Minerals Program was terminated, and other geologic mapping and mineral studies were canceled.

GGS received an $800,000 grant from the U.S. Department of Energy to assess tritium pollution in ground water. Tritium had been detected in several Coastal Plain wells in Georgia across the Savannah River from the Savannah River Site. GGS will assess the occurrences and attempt to determine the extent of tritium pollution, present and future health risks, and the possible pathway the tritium may have followed to the State's ground water.

In July, the U.S. Environmental Protection Agency (EPA) proposed a 300-picocurie-per-liter (1-millionth of 1-millionth of a curie) limit on radon in public water systems to reduce radon in homes. Although the radon contained in the water is considered safe to drink, radon is released into the air when the water is agitated. State officials estimated that 98% of Georgia's 1,400 water systems exceed the proposed limit and suggested a 1,000-picocurie limit would be more reasonable. Small water systems that are unable to borrow money or do not qualify for grant and loan programs will be hard pressed to meet the requirement. They cannot afford radon removal systems nor the cost of the power to run them or to test for the gas.

An administrative law judge with the Department of Natural Resources (DNR) issued an order overturning a decision by the EPD to deny a mining permit based on the historical significance of an adjoining property. The judge ruled that DNR misinterpreted the law when it ruled that the mined land use plan was not compatible with land use in the area. In the order, he stated that the land use consistency requirement is applicable only to postmining activities.

In April, NL Industries agreed to pay EPA $42,000 of the $88,000 the Government agency spent on overseeing the cleanup of the National Smelting and Refining Superfund site in Atlanta. NL spent more than $500,000 to remove process chemicals and lead-contaminated soil from the site.

New legislation requiring scrap recyclers to keep records of all purchases of nonferrous metals was enacted in April. The legislation was designed to reduce the theft of metal that ranges from brass fittings and copper wire to aluminum bridge railings and stocks of used beverage cans. Among the most common victims are scrap metal dealers and processors, utilities, municipalities, and private companies such as building contractors and mining companies. The inability to identify the material as stolen is a major problem police face in combating metal thefts.

GNB Inc., St. Paul, MN, announced plans for a new secondary lead smelter in Waynesboro, Burke County, GA. Company officials declared that the smelter, expected to be completed in early 1994, will offer an environmentally acceptable alternative to the incineration of lead-acid batteries. They also criticized EPA's 1989 decision to drop its ban on incinerating batteries, contending that smelting batteries is an environmentally superior method of disposing of the batteries and has the added advantage of recovering the lead. The new plant is designed to recycle 9 million batteries annually. GNB's existing smelter at Columbus will be phased out when the Waynesboro smelter becomes operational. However, new batteries will continue to be manufactured at the Columbus site.

The Georgia Mining Association sponsored an environmental workshop in August. In the keynote address, the director of EPD complimented Georgia's mining industry on the positive role it had played in improving the State's environmental welfare and noted that EPD had received only three mining-related complaints the previous year. The workshop offered sessions on hydrogeology and well placement, sediment basin construction and design, and an update on wetlands legislative issues. Also discussed were the Hazardous Site Response Act, the Comprehensive Solid Waste Management Act, landfill siting and permitting, and Clean Air Act issues.

EXPLORATION ACTIVITIES

Exploration for gold and other minerals continued to be severely restricted because of low prices and/or oversupply and production capacity. Some development activity was reported at the Franklin-Creighton Gold Mine in Cherokee County. E. I. du Pont de Nemours & Co. purchased 15,400 acres in Charlton County from Union Camp Corp. The site forms an extension to Du Pont's new heavy-mineral sands operation north of Highland in adjoining Florida. Du Pont produces the titanium minerals, ilmenite and leucoxene; the iron-aluminum silicate, staurolite; and the zirconium silicate, zircon, in Florida. After purchasing the property, Du Pont began studies to assess whether or not the minerals can be extracted in an environmentally acceptable manner. The environmental studies are expected to take several years to complete.

The U.S. Geological Survey (USGS) published an open file report on a preliminary geochemical evaluation of potential for platinum deposits in the crystalline rocks of Georgia. The 89-page report, prepared in cooperation with GGS, contains 14 1:100,000 scale maps.

LEGISLATION AND GOVERNMENT PROGRAMS

Funding for the first phase of the Georgia Ports Authority's $319 million FOCUS 2000 Savannah River channel deepening and landside ports improvements program was approved by the Georgia General Assembly. The $88 million first phase of FOCUS 2000 includes funds for deepening the Port of Savannah channel from 38 feet to 42 feet, completion of an existing container berth,

additional warehousing and storage areas, a container crane upgrade program, and improvements to the Port of Brunswick's Mayor's Point Terminal. The $43 million channel deepening will allow the port to accommodate the next generation of container ships. Federal reimbursement will be available for part of the project.

The shift in emphasis from economic mineral and academic studies to environmental technical studies and regulatory support was emphasized by the Georgia State Geologist in his annual report to the Association of American State Geologists. He noted that the mission of GGS when it was founded in 1836 was to complete a geological survey of the entire State. The current mission of GGS is to conduct and foster investigations of the State's geologic and hydrologic resources and to make these investigations available to the public. GGS provides technical expertise to other branches of Georgia's EPD by reviewing hydrological assessments of hazardous and municipal waste sites, locating public water supply wells to maximize yield and minimize impact on aquifers, designing aquifers tests to evaluate industrial sites, and assisting with localized ground water contamination problems. GGS also provides technical expertise to other State agencies, such as the Department of Community Affairs, to promote industrial development. In addition, GGS regulates exploration for oil and natural gas, regulates injection wells, administers the Ground Water Management Plan for Georgia, and oversees compliance with the Water Well Standards Act.

Following the reorganization of GGS in 1991, the survey was separated into two programs, Regulatory Support and Technical Assistance. In 1992, the survey employed 33 full-time staff members, of which 28 were geologists. In cooperative programs with USGS, GGS maintained a statewide network of stream gauging stations and observation wells equipped with continuous water-level recorders. GGS also published studies by USGS on the hydrogeology of Georgia.

Engineers from the Tuscaloosa Research Center, USBM, published studies discussing the modeling of capillary suction time of kaolin slurry based upon Georgia kaolin samples. The model also showed that chemometrics can be used as a tool for prediction of dewatering characteristics.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Georgia ranked third nationally both in the value of industrial mineral production and in the variety of industrial mineral commodities mined. Fourteen industrial mineral commodities were mined in 1992; at least eight others were produced from raw materials mined within the State or shipped in. All of the nonfuel mineral commodities produced in Georgia were industrial minerals.

Barite.—Georgia regained its ranking as the leading State in the value of barite produced after losing it to Nevada in 1991. Georgia continued to rank second to Nevada in the quantity of barite mined. Barite was produced near Cartersville, Bartow County, by two companies—Cyprus Industrial Minerals Co. (CIM) and New Riverside Ochre Co. All of the barite mined in 1992 was used by the chemical and the industrial filler and pigments industries.

CIM's barite operations at Cartersville were reported to be for sale at yearend. CIM was once a leading international producer of industrial minerals that included barite, calcium carbonate, kaolin and ball clay, crushed stone, and talc. However, in the past 5 years, CIM's parent, Cyprus Minerals Co., has sold all of its subsidiary's industrial minerals operations with the exception of the Cartersville barite operation. Georgia operations formerly owned by CIM included a kaolin operation at Sandersville, Washington County, that was sold to Kentucky-Tennessee Clay Co. in 1987 and a calcium carbonate processing facility at Cartersville that was sold to ECC International in 1988.

Bauxite.—Bauxite production increased significantly over that reported in 1991, but overall output continued to be relatively small. Georgia continued to rank second, behind Alabama, as one of the two States in which bauxite was mined in 1992. Production data were withheld because bauxite was mined by only one company in Sumter County, Mullite Co. of America (Mulcoa), a subsidiary of France's Imetal. The bauxite was blended with bauxitic kaolin to manufacture Mulcoa's highest grade of synthetic mullite, "Mulcoa 70," which has an alumina content of 70%. Georgia was the Nation's leader in the manufacture of synthetic mullite, accounting for 89% of the quantity produced and 65% of its associated value in 1992.

Cement.—Georgia ranked 10th in the quantity of masonry cement manufactured in 1992 and 9th in its attendant value. In the manufacture of portland cement, its respective rankings were 22d in quantity and 24th in value. In 1991, Georgia ranked 11th in quantity and 10th in value of masonry cement and 19th in quantity and 20th in value of portland cement. Masonry cement was produced in 36 States, and portland cement was produced in 39 States. Blue Circle Inc. in Atlanta and Medusa Cement Co. in Clinchfield, Houston County, produced both masonry and portland cement.

Clays.—Clay production in Georgia totaled 8.96 million metric tons, a decrease of 5.8% from that of 1991. The value of clays produced showed an increase of 2.2% to $970.9 million. The principal factor causing the reduction in quantity and the modest increase in price was the reclassification of certain types of kaolin to fire clay. The kaolin was included in the published clay data in 1991, but the fire clay was excluded from the published clay totals in 1992. Georgia once again led the Nation in both the volume and the value of clays produced. Four types of clays, common clay, fire clay, fuller's earth, and kaolin, were mined in 17 of Georgia's 159

TABLE 2
GEORGIA: FULLER'S EARTH SOLD OR USED BY PRODUCERS, BY KIND

(Thousand metric tons and thousand dollars)

State	Attapulgite		Montmorillonite		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1989	894	85,052	988	80,643	1,882	165,695
1990	745	95,171	1,563	128,475	2,308	223,646
1991	r509	r63,273	r108	r13,134	r617	r76,407
1992	591	76,665	(1)	(1)	591	76,665

rRevised.
[1]Included under attapulgite.

TABLE 3
GEORGIA: KAOLIN SOLD OR USED BY PRODUCERS, BY COUNTY

(Thousand metric tons and thousand dollars)

County	1992		
	No. of mines	Quantity	Value
Richmond[1]	7	345	10,179
Twiggs	15	1,806	253,300
Washington	10	1,244	159,165
Wilkinson	10	850	119,967
Other[2]	52	2,643	336,317
Total	94	6,888	878,928

[1]Includes Jefferson County.
[2]Includes Columbia, Houston, Sumter, Various, and Warren County.

counties. There was no production of ball clay or bentonite reported to the USBM.

Common Clay and/or Shale.—The value of common clays reported to the USBM increased 46.3% to $15.3 million in 1992. This followed a 49.2% increase to $10.5 million in 1991. Common clay was valued at $7 million in 1990. The principal reason for the phenomenal increase was a reported increase in the value of common clay used for brick manufacture by a Bibb County producer, from $4.63 per short ton in 1990 to $45.59 per ton in 1991 to $67.98 per ton in 1992. Production increased 7.4%, from 1.38 million metric tons in 1991 to 1.48 million tons in 1992. As a result of the changes, Georgia's national ranking rose from fourth in 1990 to third in 1991 to first in 1992 in value of common clays produced. The corresponding rankings in quantity produced dropped from fourth in 1990 to eighth in 1991 and then rose to sixth in 1992.

Common clay production was reported by 8 companies from 12 operations and 12 pits in 7 counties. It was used in common and face brick; portland cement; flue linings; floor, wall, and ceramic tile; and quarry tile. The leading producers, in order of volume, were Boral Bricks Inc., Bibb and Richmond Counties; Blue Circle Inc., Douglas and Fulton Counties; Bickerstaff Clay Products Co., Columbus and Floyd Counties; General Shale Products Corp., Floyd and Fulton Counties; and Cherokee Brick and Tile Co., Bibb County.

Fire Clay.—Fire clay production was reported for the first time in Georgia in 1992. This resulted from the reclassification of kaolin produced by two companies to the fire clay category based on mineralogy and end-use applications. Fire clay production was reported by Mulcoa in Sumter County for calcine and by Georgia Vitrified Brick and Clay Co. Ltd. in Harlem, Richmond County for fire brick and flue lining.

Fuller's Earth.—Clays included in the fuller's earth category included attapulgite mined by Engelhard Corp. and Milwhite Co. Inc. in Decatur County and by Oil Dri Corp. of America and Waverly Minerals Products Co. in Thomas County. Clays classified as montmorillonite were mined by the Georgia-Tennessee Mining and Chemical Co. in Jefferson County, Medusa Cement Co. in Houston County, and by Floridan Co. and Waverly in Thomas County.

The volume of fuller's earth produced decreased from a revised total of 617,000 metric tons in 1991 to 591,000 tons in 1992, although the value increased from $76.4 million to $76.7 million. Georgia's share of all the fuller's earth produced in the United States increased from 22.5% in 1991 to 24.5% in 1992. The corresponding value increased from 28.3% to 31.7%.

Principal uses of fuller's earth, which accounted for more than 80% of the volume produced, were in the manufacturing of pet waste absorbents, oil and grease absorbents, and pesticide carriers. Other uses included fertilizers; drilling mud; cement; paint; filtering, clarifying, and decolorizing agents; and as a catalyst in oil refining.

Kaolin.—Georgia continued to rank as the principal producer of high-grade kaolin products both domestically and worldwide. In 1992, the State accounted for 85.4% of national production and more than 32% of the world's estimated production. The State's kaolin production dropped 8.4%, from 7.52 million metric tons in 1991 to 6.89 million tons in 1992. The value of kaolin increased 1.9%, from $862.9 million in 1991 to $878.9 million in 1992, as the result of a unit value increase from $123.93 per metric ton in 1991 to $127.61 per ton in 1992.

Kaolin production was reported by 14 companies at 89 pits in 9 counties. Table

TABLE 4

GEORGIA: KAOLIN SOLD OR USED BY PRODUCERS, BY USE

(Thousand metric tons)

Use	1991				1992			
	Air-float	Unprocessed[1]	Water-washed[2]	Total[3]	Air-float	Unprocessed[1]	Water-washed[2]	Total[3]
Domestic:								
Adhesives	W	—	26	26	30	—	28	58
Aluminum sulfate and other chemicals	—	W	—	W	—	W	—	W
Asphalt tile and linoleum	W	W	—	W	W	W	—	W
Catalysts (oil-refining)	W	—	35	35	W	—	45	45
Face brick	—	4	—	4	—	4	—	4
Fiberglass and mineral wool	223	—	W	223	259	W	W	259
Fine china and dinnerware; crockery and earthenware	W	—	W	W	W	—	W	W
Firebrick, blocks and shapes	W	9	—	9	W	—	—	W
Grogs and calcines, refractory	W	W	W	W	W	—	W	W
Medical, pharmaceutical, cosmetic	W	—	W	W	W	—	W	W
Paint	W	—	200	200	W	—	199	199
Paper coating	—	—	2,604	2,604	—	—	2,675	2,675
Paper filling	147	—	905	1,052	W	W	1,059	1,059
Plastics	W	—	50	50	W	—	30	30
Pottery	W	—	—	W	W	—	—	W
Refractories[4]	7	23	8	38	32	8	8	48
Roofing granules	W	W	—	W	W	—	W	W
Rubber	14	—	40	54	25	—	26	51
Sanitaryware	33	—	—	33	W	W	W	W
Miscellaneous, air-float:								
Common brick, fertilizers, gypsum products, pesticides and related products, roofing and structural tile, other uses not specified	247	—	—	247	309	—	—	309
Miscellaneous, unprocessed:								
Fertilizers, pesticides and related products, other uses not specified	—	879	—	879	—	173	—	173
Miscellaneous, water-washed:								
Gypsum products, ink, pesticides and related products, waterproofing and sealing, fertilizers, other uses not specified	—	—	185	185	—	—	218	218
Total[3]	671	915	4,053	5,639	655	185	4,288	5,128
Exports:								
Paint	—	—	W	W	—	—	27	27
Paper coating	—	W	1,321	1,321	—	W	1,358	1,358
Paper filling	—	—	386	386	9	—	191	200
Rubber	—	—	16	16	—	—	17	17
Undistributed	30	44	83	157	20	68	69	157
Total[3]	30	44	1,805	1,879	29	68	1,662	1,759
Grand total[3]	702	959	5,858	7,519	685	253	5,950	6,888

W Withheld to avoid disclosing company proprietary data; included in "Undistributed" and/or "Total."

[1]Includes high-temperature calcined.

[2]Includes low-temperature calcined and delaminated.

[3]Data may not add to totals shown because of independent rounding.

[4]Includes electrical porcelain; floor and wall tile, ceramic; flue linings; glazes, glass, and enamels; high-alumina brick and specialties; kiln furniture; and refractory mortar and cement.

3 summarizes Georgia kaolin sold or used by producers by county. Table 4 contains an abbreviated listing of kaolin sold or used by producers by use. A more complete listing is given in the USBM's 1992 Clays Annual Report, which also contains a breakdown of kaolin exports. Kinds of kaolin sold or used by producers with their quantities produced in metric tons and values in thousand dollars were as follows: water washed, 4,169 tons, $472,008; calcined, 587 tons, $226,935; delaminated, 1,257 tons, $143,031; air-float, 685 tons, $30,001; and unprocessed, 190 tons, $6,953. Both low-temperature filler and high-temperature refractory grades were included in the calcined kaolin. The major kaolin producers, in order of quantity produced, were ECC America Inc., Engelhard Corp., Thiele Kaolin Co., and J. M. Huber and Co.

Albion Kaolin Co., a subsidiary of United Catalysts, Louisville, KY, completed its new kaolin slurry plant at Hephzibah, Richmond County. The fully automated facility increased Albion's production capacity to 300,000 short tons per year for the ceramics, refractories, rubber, and paint markets.

Dry Branch Kaolin Co., owned by Asea Brown Boveri, Zurich, Switzerland, formed a subsidiary, Kaopolite Inc., to develop, manufacture, and market new kaolin-based products. One of the company's first products was a chewing gum designed to whiten teeth and help remove plaque. Although the gum cannot be used to replace regular brushing and flossing, tests show that chewing the gum removed up to 30% of plaque. The American Dental Association is conducting tests to determine if its endorsement of the product would be appropriate.

ECC International Inc., a subsidiary of English China Clays PLC, Cornwall, England, continued the staged expansion of its Sandersville, Washington County, operations. Included in the 1992 expansion was the installation of a laboratory cryofilter high-gradient magnetic separator (HGMS). The HGMS has a powerful 6 Tesla (60 kilogauss) superconducting magnet. All facilities necessary to process clay samples are provided in the unit's compact design. ECC also opened its fifth precipitated calcium carbonate plant in 1992.

Kemira Inc., the Savannah-based subsidiary of Finland's Kemira Oy, signed a letter of intent to purchase a 20% interest in Nord Kaolin Co. based in Jeffersonville, Twiggs County. Closing of the transaction, which was originally scheduled for August 15, was still pending at yearend. The original agreement called for Kemira to retain an option to buy an additional 31% interest in Nord over the next 4 years. Kemira is a producer of titanium oxide pigments with a plant capacity of 145,000 tons of TiO_2 at Savannah. Its interest in Nord is related to the latter's recently developed line of special papermaking pigments, which are essentially composites of kaolin and TiO_2.

According to published reports,[7] Nord produces approximately 300,000 tons of kaolin for the paper industry each year. Products include coating, filler, delaminated, and calcined grades of kaolin, 10% of which is exported mainly to Europe and Japan.

Feldspar.—Georgia ranked fifth of six States in both the quantity and value of feldspar produced in 1992. The State's only feldspar producer, The Feldspar Corp., a wholly owned subsidiary of the Zemex Co., operated a high-sodium feldspar mine near Monticello, Jasper County, and a high-potassium feldspar mine near Siloam, Greene County. Ore from the two mines was blended at a froth-flotation plant in Monticello to produce a concentrate used in the manufacture of glass and ceramic products.

Gemstones.—Georgia's ranking in the value of natural gemstones produced rose from 32d in 1991 to 20th in 1992. Gemstone production was reported from all 50 States. Georgia's rise in national ranking appeared to have resulted from a change in the manner in which pearl and mussel-shell producers reported their production. In past years, the mussel farmers credited all of their production to Tennessee or Arkansas, the States in which they had their major operations. In 1992, they credited their production to the State's from which the mussels were actually harvested.

Iron Oxide Pigments.—Georgia ranked second, behind Missouri, in value and third in the quantity of natural iron oxide pigments produced in 1992. Production was reported from five States. Georgia ranked eighth out of 11 States in both the quantity and value of finished iron oxide pigments manufactured. New Riverside Ochre Co., the State's only producer, mined ochre and umber near Cartersville in Bartow County. Ochre is an orange-yellow mixture of limonite and clay averaging 55% to 65% Fe_2O_3 with less than 2% MnO_2 oxide. The most valuable ochres average 0.5% MnO_2 and have the brightest yellow color. Umber has a chocolate-brown color and may contain up to 5% MnO_2. The deposits occur in residuum developed in the basal part of the Lower Cambrian Shady Dolomite.

Mica.—Nationally, Georgia ranked third in both value and quantity of scrap mica mined in 1992. Scrap mica was produced in five States. Franklin Mineral Products Co. Inc., division of the Mearl Corp., produced flake muscovite from micaceous granite saprolite. It had a mine and wet-grinding plant 1/2 mile west of Hartwell and a second mine 5 miles south of Hartwell, Hart County. Much of the plant's production was used by the parent company to manufacture pearlescent pigments used in plastic coatings and cosmetics.

Sand and Gravel.—Construction.—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Construction sand and gravel production increased 3.4% to 4.86 million short tons, while its corresponding value

TABLE 5
GEORGIA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	2,331	$7,646	$3.28
Plaster and gunite sands	W	W	2.85
Concrete products (blocks, bricks, pipe, decorative, etc.)	95	464	4.88
Asphaltic concrete aggregates and other bituminous mixtures	W	W	2.54
Road base and coverings	24	162	6.75
Fill	W	W	2.17
Unspecified:[1]			
Actual	1,601	4,800	3.00
Estimated	256	1,071	4.18
Total	4,860	15,581	3.21
Total[2 3]	4,409	15,581	3.53

W Withheld to avoid disclosing company proprietary data; included with "Total."
[1]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[2]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[3]Total quantity and total value in thousand metric tons and thousand dollars.

increased 7.5% to $15.6 million. Although increasing significantly, construction sand and gravel production was barely one-half of that produced in the record-high year of 1988, 9.5 million short tons valued at $30.2. Georgia ranked 44th in both the quantity and value of construction sand and gravel mined in 1992. Sand and gravel production was reported from all of the contiguous States and Alaska in 1992.

Construction sand and gravel production was reported by 36 companies with 44 operations and 49 pits in 33 counties. The State's leading counties, in order of quantity produced, were Decatur, Talbot, Montgomery, Taylor, McIntosh, and Richmond.

The State's largest producers, in order of quantity produced in 1992, were Atlanta Sand & Supply Co. in Crawford County; Brown Brothers Sand Co. in Talbot County; Southern Aggregates and McIntosh Sand Co., subsidiaries of CSR Corp., in Richmond and McIntosh Counties; Montgomery Sand Co., a subsidiary of Florida Crushed Stone Co., in Brantley, Montgomery, and Pike Counties; and Brown and Watson Inc. in Taylor (two pits) and Talbot Counties.

Industrial.—Industrial sand and gravel production data were published in 1992 after being withheld in previous years. The quantity produced, 588,000 short tons, was slightly less than that produced in 1991. The value of $8.8 million was essentially unchanged from the 1991 value. Of the 39 States producing industrial sand and gravel, Georgia ranked 17th (up from 18th in 1991) in quantity and 18th in its corresponding value in 1992.

Industrial sand and gravel production was reported by five companies in 1992. The Morie Co. Inc., the Nation's third largest industrial sand and gravel producer, mined sand near Junction City, Marion County. It operated one pit and a plant producing sand for glass containers, blasting, filtration, traction, molding, and core facing.

Atlanta Sand and Supply Co., operating under the name of Crawford County Mining Co., produced sand for blasting, ground fillers, roofing granules, filtration, traction, and golf courses. It mined from two pits south and southeast of Gaillard, Crawford County. The company also produced construction sand and gravel at the same location. Approximately 6% of its total production was industrial sand and gravel.

The Granite Panelwall Co., a division of Florida Crushed Stone Co., produced sand for blasting, golf courses, and traction from a Quaternary alluvial sand deposit 1 mile west of Mount Vernon, Montgomery County. The company, under the name Montgomery Sand Co., also produced construction sand and gravel at the same location.

Savannah Abrasives Inc. reported minor production from Chatham County. Sales of byproduct industrial sand from a mica operation in Hart County also were reported.

Major uses of industrial sand and gravel in 1991 were glass containers, flat glass, blasting sand, foundry sand, ground fillers, and filtration sand. The six products accounted for the end use of 90% of the sand produced in Georgia. Flat glass was manufactured using industrial sand as the principal ingredient by PPG Industries at Perry. Glass containers were manufactured by Anchor Glass Co. Inc., Warner Robbins, and Owens-Brockway Inc. and Smith Container Corp., both in Atlanta. Industrial sand was also used in the manufacture of fiber-optic cable by the Fitel Corp., a joint venture of Penn Central Corp. and Furukawa Electric of Japan, at its plant in Carrollton.

Fused silica was produced by Harbison-

TABLE 6

GEORGIA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1[1]		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[2]	—	—	500	2,092	2,238	6,906
Asphaltic concrete aggregates and other bituminous mixtures	—	—	(3)	(3)	(3)	(3)
Road base and coverings	—	—	—	—	24	162
Fill	—	—	(3)	(3)	(3)	(3)
Unspecified:[4]						
Actual	—	—	181	582	1,419	4,217
Estimated	—	—	256	1,071	—	—
Total	—	—	952	3,808	3,908	11,773
Total[5 6]	—	—	864	3,808	3,545	11,773

[1]Withheld to avoid disclosing company proprietary data; included with District 2.
[2]Includes plaster and gunite sands.
[3]Withheld to avoid disclosing company proprietary data; included with "Total."
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

Walker Refractories Co., a subsidiary of Dresser Industries Inc., at Calhoun and by Leco Corp. at Lawrenceville. Fused or vitreous silica is manufactured by the fusion of very high-grade silica sand in various electric arc and electrical resistance furnace configurations.

Stone.—**Crushed.**—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed stone was the second most valuable mineral commodity produced in Georgia again in 1992. Estimated production of crushed stone in Georgia increased 6.4% to 44 million short tons valued at $244.2 million, a 9.6% increase. Georgia ranked 11th out of 49 States in the quantity and 9th in the value of crushed stone produced in 1992.

The Mine Safety and Health Administration inspected 78 crushed stone quarries operated by 25 companies in 48 of Georgia's 159 counties in 1992. There were 51 granite quarries, 16 limestone quarries, 10 marble quarries, and 2 sandstone quarries. Counties with multiple quarries included Gilmer with seven, Pickens with five, and Whitfield with four. Five counties had three quarries each and seven had two each.

Companies with the most quarries were Vulcan Materials Co. with 15, Hanson PLC (Davidson Mineral Properties and Stoneman Inc.) with 11, Georgia Marble Co. with 8, Martin-Marietta Aggregates Inc. with 8, Blue Circle Inc. with 7, and Florida Rock Industries Inc. with 6.

EPD granted mining permits to Vulcan Materials Co. and Florida Rock Industries for planned crushed stone quarries in Bartow County. The quarries will provide stone for the new Atlanta outer-belt perimeter highway that will be built through the area. Florida Rock also applied for a permit for a quarry, asphalt plant, and cement batch plant in Jefferson, Jackson County.

Granite was crushed to produce roofing granules by Georgia Stone Quarries from its Banks County quarry and by Blue Circle Aggregates Inc. from quarries at Lithonia, DeKalb County, and Douglasville, Douglas County.

Dimension.—Estimated dimension stone production declined sharply in 1992 after posting large gains in 1990 and 1991. The quantity produced dropped 26.7%, from a revised figure of 216,938 short tons in 1991 to 159,093 tons in 1992. Correspondingly, the value dropped 38.3%, from $21.3 million to $13.1 million. Data for marble dimension stone were not included in the published totals because only one company, Georgia Marble Co., quarried dimension marble.

Georgia continued to lead the Nation in the value of marble dimension stone and in the volume of granite dimension stone quarried. Overall, it ranked second in the volume and third in the value of all dimension stone produced.

The Elberton granite district retained its position as the world's leading producer of granite monuments. In 1992, 101 firms, 33 of which operated quarries, were members of the Elberton Granite Association (EGA).

Southern Granite Co. Inc. completed a 6,000-square-foot expansion of its Elberton finishing plant. Featured in the expansion was the installation of a computer operated, fully automatic milling, grinding, and polishing system capable of producing monuments continuously on a 24-hour schedule, even during overnight hours when no one is working in the plant.

The assets of Coggins Granite Inc. were

acquired by Royalty Granite Corp., a subsidiary of Swenson Granite Co., Concord, NH. Swenson also owns one of the world's largest granite quarrying operations, the Rock of Ages quarry in Barre, Vermont. Coggins was a 72-year-old, family owned granite quarrying operation composed of 12 properties covering 2,800 acres in Elbert, Madison, and Oglethorpe Counties; a quarry in South Carolina; and another in Oklahoma. Included in the Georgia quarries were the Royalty Blue, the Berkeley Blue, the Millstone, and nine idle quarries. A few of the idle quarries may be reopened, but Swenson officials indicated they have no plans to build or purchase a finishing plant in Georgia. Any finishing of blocks quarried in Georgia would be subcontracted to existing processing plants in the Elberton area because the cost of shipping the blocks to Swenson's plants in New England would be prohibitive.

Coggins was founded in 1919 as the Georgia Granite Corp. and grew into a multidimensional producer employing as many as 500 people. Operations included monumental and/or structural granite quarries and plants in Georgia, the Dakotas, Oklahoma, the Carolinas, and Virginia. The company was a leader in the introduction of innovative technology in both quarrying and processing operations. It pioneered the use of explosives to free large quarry blocks and diamond sawing techniques.

Other Industrial Minerals.—Several industrial mineral commodities were processed into added-value products from raw materials not mined by the processing company. Although these commodities are not included in table 1, they play a significant role in the overall mineral industry in Georgia.

Kemira Inc. used several industrial minerals at its titanium dioxide pigment plant in Savannah. The plant is one of two in the United States that uses both the chloride and the sulfate processes to produce TiO_2. In addition to the TiO_2 pigments, gypsum was produced as a byproduct. The byproduct gypsum, along with imported crude gypsum, was used by Domtar Inc. to manufacture wallboard at its plant in Savannah. Wallboard was also manufactured by the Gypsum Div. of Georgia-Pacific Corp. near Brunswick in Glynn County and Gold Bond Building Products Div. of National Gypsum Corp. in Garden City, Chatham County. Georgia-Pacific also operated a gypsum-plaster plant in Marietta, Cobb County. All four plants calcined crude gypsum imported principally from Nova Scotia. Georgia led the Nation in the quantity of byproduct gypsum produced and ranked second in its attendant value, after ranking first in both categories in 1991. The State also ranked 10th in quantity and 12th in the value of calcined gypsum produced in 1992.

The Specialty Products Div. of Franklin Industrial Minerals Co. ground calcined gypsum for use in flame and smoke suppressants at its Dalton plant. Alumina trihydrates, brucite, calcium carbonate, and calcium sulfate also were ground and blended at the plant for use in fire retardant materials and reinforced plastics. Other companies grinding similar materials and producing comparable products were Custom Grinders Sales Inc. and Filler Products Co., Chatsworth, Murray County; Dalton Alumina Chemical Co., Dalton; and Solem Div., J. M. Huber Corp., Fairmount, Gordon County.

Arsenic trioxide was converted to arsenic acid for use in the production of arsenical wood preservatives by Hickson Corp., a subsidiary of Hickson International PLC, Castleford, England, in Conley, De Kalb County.

Bentonite from Wyoming was used by Clem Environmental Corp. to manufacture geocomposite clay liners for the water, waste, mining, and petrochemical industries.

Celestite was imported from Mexico by Chemical Products Co. of Cartersville to be manufactured into strontium chemicals. The major product was strontium carbonate used in the manufacture of color television and video screens.

Various iodine chemicals were produced by Ajay Chemicals Inc. at Powder Springs, Cobb County; Diversey Wyanndotte Corp. at Tucker, De Kalb County; and Natrochem Inc. at Savannah, Chatham County.

A significant increase in both the quantity of expanded perlite produced and its associated value improved Georgia's national ranking to third and fifth, respectively. In 1991, Georgia ranked fifth in quantity and sixth in value. Perlite was expanded in 34 States in 1992. Armstrong World Industries Inc., which imported perlite from Greece for use in the manufacture of acoustic tile at its plant in Macon, Bibb County, was one of two producers in Georgia. Perlite also was expanded by Calcilite Insulation Products, Brunswick, Glynn County, for the manufacture of insulated block.

Florida Favorite Fertilizer Inc., Quitman, Brooks County, a manufacturer, processor, and distributor of fertilizer and other agricultural products, formed a partnership with its potash supplier, Potash Corp. of Saskatchewan Inc.

Salt was used to produce chlorine by Brunswick Pulp and Paper Co., Brunswick, Glynn County, and Olin Corp., Augusta, Richmond County. Brunswick was one of several companies that used a variety of industrial minerals to manufacture paper products. The others included Augusta Newsprint Co., Augusta; Federal Paper and Board Co., Augusta; Fort Howard Corp., Rincon, Effingham County; Gilman Paper Co., St. Marys, Camden County; and Southeast Paper Manufacturing Co., Dublin, Laurens County.

Georgia ranked 16th in value and 17th in the amount of iron and steel slag produced in 1992. Slag from Atlantic Steel Co. plants in Atlanta and Cartersville was sold as construction aggregate by International Mill Service Corp.

Production of exfoliated vermiculite was not reported to the USBM in 1992. Exfoliated vermiculite was used by Anitox Corp. at Buford, Gwinnett County. It was sold primarily to the agriculture market as a horticultural medium and fertilizer carrier. A minor amount was sold for fireproofing purposes.

Metals

There has been no metal production reported from Georgia since the last brown iron ore mine closed in early 1977. Numerous mines producing metals such as copper, gold, iron ore (goethite, limonite, and hematite), lead, manganese, pyrite, and silver had been mined, but closed because reserves were depleted or mining the low-grade ore was not economically feasible. However, metal products are commonly manufactured in the State from metallic ore or concentrates shipped into the State or from recycled metals.

Southwire Co., Carrollton, Carroll County, is one of the Nation's leading producers of aluminum and copper cable, rods, and castings. Southwire and Kaiser Chemical and Aluminum Corp. signed a letter of intent for Southwire to purchase the Kaiser's Georgia Wire Products Div. located in Macon. Georgia Wire is a manufacturer of aluminum alloy wire and screw machine stock for the transportation, construction, and consumer markets. Prior to the acquisition announcement, a U.S. Court of Appeals ruled in favor of Southwire in a dumping and countervailing duty suit filed against imports of electrically conductive aluminum redraw rod from Venezuela.

Aluminum ingots were produced by Alcan Recycling from aluminum scrap at Greensboro, Greene County. A variety of extruded aluminum products were produced by Alcan Extrusions USA, Rome, Floyd County; William L. Bonnell Co. Inc., Newnan, Coweta County; General Extrusions, Union City, Fulton County; Hoover Group Inc., Franklin, Heard County; Indal Extrusion and Macklanburg-Duncan Co., Gainesville, Hall County; and Tifton Aluminum Co. Inc., Tift County.

Atlantic Steel Co. produced hot-rolled steel bars, rods, shapes, and wire from electric arc minimills in Atlanta and Cartersville. The Atlanta plant continued to operate pending completion of work to consolidate operations in Cartersville.

Bliss and Laughlin (B&L), owner of a cold-finished steel bar plant in Cartersville, Bartow County, announced earnings of almost $300,000 in 1992 following a loss of $2.4 million loss in 1991. B&L instituted layoffs, froze wages, and applied other operating cost cuts that, combined with an 8% increase in sales, resulted in the reversal in earnings. B&L's Cartersville operation, which opened in 1990, is expected to grow as both foreign and domestic firms continue to build manufacturing facilities in the south.

Southern Zinc Co., Atlanta, produced zinc dust, zinc oxide, and zinc slabs from its smelter and refining operation at East Point, Fulton County.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 34 years of mineral-related industry and government experience and has covered the mineral activities in Georgia since 1989. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

[2]Supervisory geologist, Georgia Geologic Survey, Environmental Protection Div., Georgia Department of Natural Resources.

[3]Total 1991 mineral value revised from $1,298,621,000 to $1,305,736,000.

[4]Total mineral value for 1990 was revised from $1,495,124,000 to $1,505,051,000.

[5]U.S. Department of Labor. Employment and Earnings. V. 40, No. 5, May 1993, p. 159.

[6]———. Mine Injuries and Worktime, Quarterly. Jan.-Dec. 1992, preliminary, p. 9.

[7]Industrial Minerals (London, United Kingdom). Kemira Buys Into Nord Kaolin. No. 298, July 1992, p. 18.

GEORGIA

Principal Mineral-Producing Localities

LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Au	Gold	D-M	Dimension Marble	Mica	Mica
Ba	Barite	D-Q	Dimension Quartzite	Per	Perlite plant
Cem	Cement plant	Fel	Feldspar	SG	Sand and Gravel
Clay	Clay	FePg	Iron Oxide pigments	Steel	Iron and Steel plant
CS	Crushed Stone	Ful	Fuller's earth	II	Titanium plant
Cu	Copper smelter	Gyp	Gypsum plant		Concentration of mineral operations
D-G	Dimension Granite	Kao	Kaolin		

TABLE 7
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Barite:			
Cyprus Industrial Minerals Co.	Box 130 Cartersville, GA 30120	Open pit mine and mill	Bartow.
New Riverside Ochre Co.[1]	Box 387 Cartersville, GA 30120	do.	Do.
Bauxite:			
Mullite Co. of America	Box 37 Andersonville, GA 31711	Open pit mines and mill	Macon and Sumter.
Cement:			
Blue Circle Inc.[2]	2520 Paul Ave., NW Atlanta, GA 30318	Plant	Fulton.
Medusa Cement Co.[2]	Box 120 Clinchfield, OH 31013	do.	Houston.
Clays:			
Common:			
Bickerstaff Clay Products Co.	Box 1178 Columbus, GA 31993	Open pit mines	Columbus and Floyd.
Boral Bricks Inc.	Box 1957 Augusta, GA 30903	Open pit mines and plants	Bibb and Richmond.
Chattahoochee Brick Co., a subsidiary of General Shale Products Corp.	Box 813250 Smyrna, GA 30081	do.	Floyd and Fulton.
Fuller's earth:			
Englehard Corp.	Box 222 Attapulgus, GA 31715	do.	Decatur.
Oil Dri Corp. of America	Box 200A Ochlocknee, GA 31773	do.	Thomas.
Waverly Mineral Products Co.	Box 106 Meigs, GA 31765	do.	Do.
Kaolin:			
ECC International Inc.	Box 471 Sandersville, GA 31082	do.	Various.
Engelhard Corp.	Box 37 Gordon, GA 31031	do.	Decatur, Washington Wilkinson.
J. M. Huber Corp.	Route 4 Huber, GA 31298	do.	Various.
Feldspar:			
The Feldspar Corp.	Mine Rd. Monticello, GA 31064	Open pit mines and plant.	Greene and Jasper.
Gypsum:			
Byproduct:			
Kemira Inc.	Box 368 Savannah, GA 31402	Plant	Chatham.
Calcined:			
Georgia-Pacific Corp., Gypsum Div.	Box 1397 Brunswick, GA 31520	do.	Glynn.
Gold Bond Building Products, a subsidiary of National Gypsum Corp.	Box 7016 Garden City, GA 31408	do.	Chatham.
Domtar Gypsum, division of Domtar Inc.	Box 1526 Savannah, GA 31498	do.	Do.
Mica:			
Franklin Mineral Products Co. Inc., division of The Mearl Corp.	Drawer 390 Hartwell, GA 30643	do.	Hart.

See footnotes at the end of table.

TABLE 7—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Construction:			
Atlas Sand and Gravel Co.	Box 249 Eden, GA 31307	Open pit mines	Effingham.
Brown Brothers Sand Co.	Route 1 Roberta, GA 31087	do.	Talbot.
Southern Aggregates Co.	Box 4510 Augusta, GA 30907	do.	Richmond.
Industrial:			
Atlanta Sand & Supply Co.[3]	Route 1 Roberta, GA 31078	Open pit mine and plant	Crawford.
Montgomery Sand Co., a subsidiary of Florida Crushed Stone Co.[3]	Box 255 Mount Vernon, GA 39445	do.	Montgomery.
The Morie Co. Inc., Georgia Silica Div.[3]	1201 North High St. Millville, NJ 08332	do.	Marion.
Stone:			
Crushed:			
Davidson Minerals Properties Inc. and The Stoneman Inc., subsidiaries of Hanson PLC	Box 486 Lithonia, GA 30058	Quarries and plants	Various
Martin Marietta Aggregates Co.	Box 4380 Augusta, GA 30917	do.	Do.
Vulcan Materials Co.	Box 80730 Atlanta, GA 30366	do.	Do.
Dimension:			
Granite:			
Keystone Granite Co.	Box 516 Elberton, GA 30635	do.	Oglethorpe.
Royalty Granite Corp.	Box 39 Carlton, GA 30627	Quarries	Madison and Oglethorpe.
T & C Quarries Inc.	Box 119 Elberton, GA 30635	do.	Elbert and Oglethorpe.
Marble:			
Georgia Marble Co.	Building 100 1201 Roberts Blvd. Kennesaw, GA 30144	do.	Pickens.

[1]Also produced crude iron oxide pigments.
[2]Also produced common clay and limestone.
[3]Also construction sand and gravel.

THE MINERAL INDUSTRY OF HAWAII

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Department of Land and Natural Resources of the State of Hawaii for collecting information on all nonfuel minerals.

By Fred V. Carrillo[1] and Marguerite Roberto[2]

Hawaii's nonfuel mineral production value in 1992 was reported to be $148 million, an increase of 5% from that of 1991. This reflected a similar increase in production of construction materials for the State's continuing construction spending. According to the Bank of Hawaii, gross State product for Hawaii has increased more than 1% since 1991, with the most rapid real growth occurring in the past 3 years. During 1992, the national economic recovery that began in mid-1991 gradually accelerated from quarterly growth of rates of about 1.5% on an annual basis in the last two quarters of 1991 to about 2.5% in the first two quarters of 1992. Hawaii ranked 39th nationally in the value of 1992 nonfuel mineral production.

TRENDS AND DEVELOPMENTS

The U.S. Department of Labor reported that, reflecting the slowdown in Hawaii's overall economy, total employment growth slipped from an average 4.2% in 1991 to 0.4% in the second and third quarters of 1992. Although the number of persons employed continued to rise in the latter quarters of 1991 and during 1992, the year-over-year increase sank to less than 1% for much of 1992. Average annual pay was about $25,000. The Bank of Hawaii reported 1992 construction completed (construction put in place) was down 7.6% from that of 1991 to $3.8 billion. Mineral production in Hawaii was used principally for local construction. Most mining in Hawaii is for sand and gravel and stone.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Cement.—Hawaiian finished portland cement production was estimated to have increased to 573,000 short tons and was valued at more than $53 million during 1992, up 4.8% and 12.8%, respectively, from that of 1991. Masonry cement production decreased 17% to 8,000 short tons, valued at $1,421,000.

The principal producer of finished portland cement in Hawaii was the Lone Star plant at Barbers Point, Oahu. Portland cement was used by building material dealers, concrete product manufacturers, ready-mix companies, and highway and building contractors. Raw materials consumed at the plant included gypsum, limestone, sand, and volcanic ash.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains estimates for 1991. Data for 1992 collected by the U.S. Bureau of Mines, have been withheld to avoid disclosing company proprietary data. According to the Bank of Hawaii annual report, total

TABLE 1
NONFUEL MINERAL PRODUCTION IN HAWAII[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	12	$1,870	e10	e$600	8	$1,421
Portland	do.	532	46,311	e547	e47,589	573	53,936
Gemstones		NA	55	NA	60	NA	W
Sand and gravel (construction)	thousand short tons	438	2,459	e400	e2,300	W	W
Stone (crushed)	do.	e7,000	e55,400	[2]10,486	[2]90,563	e[2]10,500	e[2]93,500
Total[3]		XX	106,095	XX	141,112	XX	148,857

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain stones; data excluded to avoid disclosing company proprietary data.
[3]Partial total, excludes values that must be concealed to avoid disclosing company proprietary data.

construction put in place in Hawaii during 1992 remained near the record $4.1 and $4.3 billion levels of the two preceding years. At just under $4 billion for the year, the 1992 total marks the third year in which the industry stood an average one-third above historical patterns for the State. The construction job count, which has tended to accurately reflect real changes in construction activity over the years, likewise remained at record levels throughout 1992 and into 1993. These levels of activity have come as a result of a resurgence in government construction that partially offset a slowing in private activity. In light of the slowing in private construction anticipated for 1993, the probable slowing in public construction will ensure a larger decline in total construction than had initially been forecast.

Private construction permits in 1992 declined, as anticipated from the 1990-91 peaks of $2.1 and $2.2 billion.

Grove Farm Rock Co., Inc. completed expansion of its aggregate facility on the Island of Kauai. Additional screening and conveyor capacity was installed to complement the increased crusher capacity expansion begun in 1989 at its basalt quarry.

Stone (Crushed).—Crushed stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

The crushed stone production of 10.5 million short tons in 1992 was about 0.1% higher than that reported in 1990.

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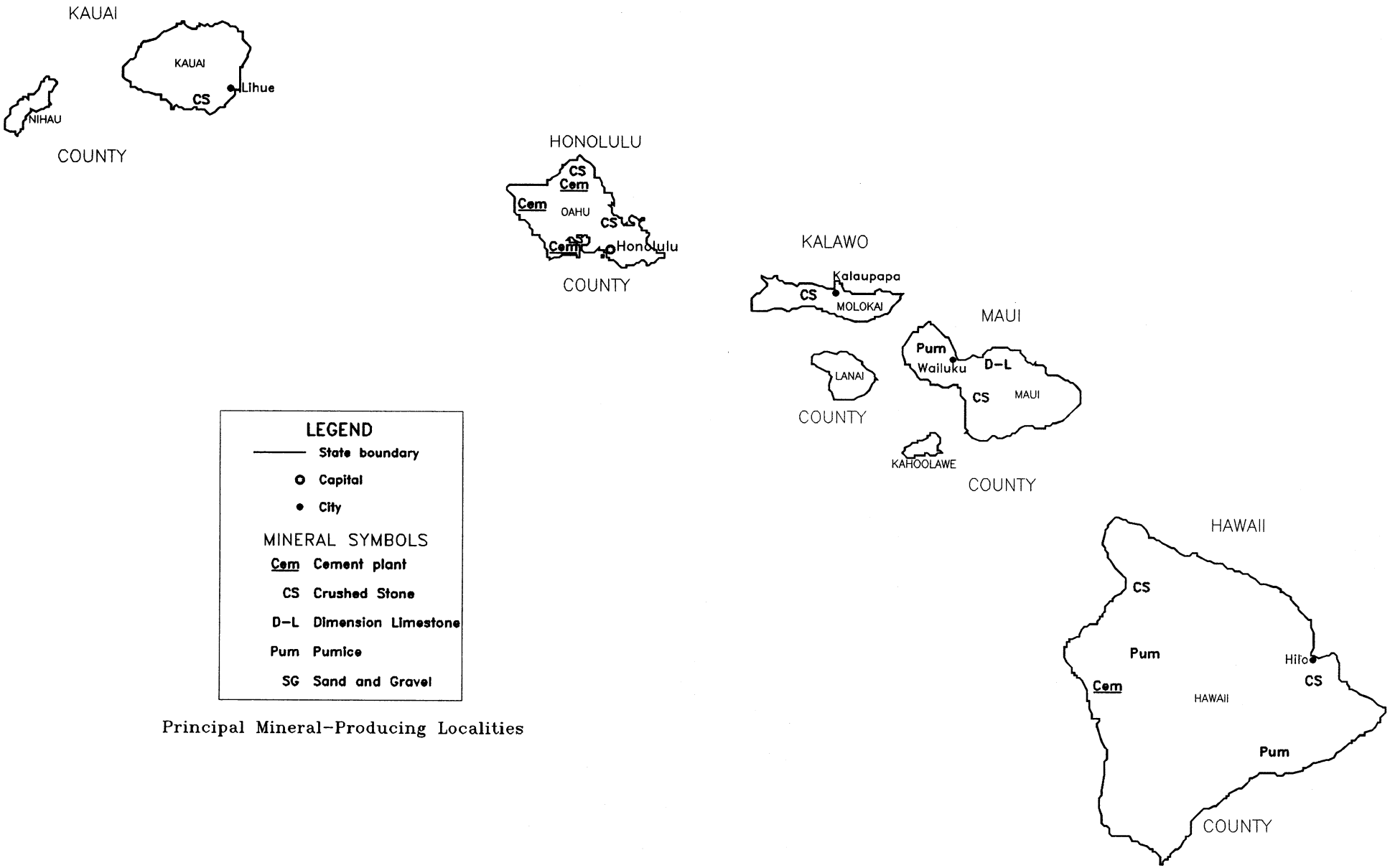
[1]State Mineral Officer, U.S. Bureau of Mines, Reno, NV. He has 27 years of mineral-related government experience and has covered the mineral activities in Hawaii for 10 years.

[2]Program assistant, U.S. Bureau of Mines, Reno, NV, State Activities Office.

HAWAII



Principal Mineral-Producing Localities

TABLE 2
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Hawaiian Cement	Barbers Point Plant 91-044 Kaomi Loop Ewa Beach, HI 96706	Cement plant	Oahu.
Sand and gravel (construction):			
Amelco Corp., Maui Concrete	Box 488 Kuhului, HI 96732	Plant and pit	Maui.
Kauai Sand & Gravel Inc.	4247 Kapaia Rd. Lihue, HI 96766	do.	Kauai.
Stone (crushed):			
Allied Aggregates Corp.	761 Keaa St. Hilo, HI 96720	Quarries	Hawaii.
Ameron Honolulu Construction & Drayage Ltd.	Box 29968 Honolulu, HI 96820	do.	Oahu and Maui.
Grace Pacific Corp., Concrete & Rock Div.	91-220 Farrington Hwy. Ewa Beach, HI 96707	do.	Do.
Grove Farm Rock Co., Inc.	Puhi Rural Station Lihue, HI 96776	do.	Kauai.
Herbert Tanaka Co.	87-1748 Farrington Hwy. Waianae, HI 96792	Quarry	Oahu.
Kuwaye Bros. Inc.	160 Keaa St. Hilo, HI 96720	do.	Hawaii.
Lone Star Hawaii Rock Products	11555 Dublin Canyon Rd. Pleasanton, CA 94566	do.	Oahu.

THE MINERAL INDUSTRY OF IDAHO

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Idaho Geological Survey for collecting information on all nonfuel minerals.

By R. J. Minarik[1] and V. S. Gillerman[2]

Nonfuel mineral production for Idaho in 1992 was valued at $306 million, an increase of 3% from that of 1991, according to the U.S. Bureau of Mines. Increased production values for molybdenum, construction sand and gravel, industrial sand and gravel, crushed stone, and vanadium more than offset a drop in the value for lead and silver.

Phosphate rock continued to be the leading mineral commodity in terms of value, followed in order by construction sand and gravel, gold, silver, molybdenum, and crushed stone. Industrial minerals, led by phosphate rock, accounted for 58% of the State's nonfuel mineral production value, compared with 56% in 1991 and 36% in 1990. The aggregate value of the metallic minerals—antimony, copper, gold, lead, molybdenum, silver, vanadium, and zinc—decreased slightly from that reported in 1991.

Idaho ranked 33d nationally for total mineral production value, unchanged from 1991. The State was the Nation's sole producer of antimony and vanadium, ranked first in quantity of garnet produced, third in phosphate, lead, and silver, and fifth in perlite.

TRENDS AND DEVELOPMENTS

The value of Idaho's industrial minerals rose 6% from that of 1991. Aggregate production—construction sand and gravel, and crushed stone—led the way with the largest increase in absolute value. Although the value of phosphate production dropped slightly, it was still more than twice the value of construction sand and gravel, Idaho's second highest valued commodity.

Idaho's metal production did not fare as well as the industrial minerals, with

TABLE 1
NONFUEL MINERAL PRODUCTION IN IDAHO[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	W	W	[2]967	W	W	W
Gemstones		NA	$320	NA	$426	NA	390
Gold[3]	kilograms	W	W	3,348	39,107	3,177	35,241
Lime	thousand short tons	W	W	150	9,124	W	W
Phosphate rock	thousand metric tons	4,380	67,978	5,921	86,328	5,208	84,000
Pumice	metric tons	31,333	220	36,868	267	55,525	401
Sand and gravel:							
Construction	thousand short tons	r8,563	r22,842	e11,600	e31,300	14,906	40,728
Industrial	do.	552	6,234	W	W	802	9,214
Silver[3]	metric tons	442	68,418	337	43,807	254	32,131
Stone:							
Crushed	thousand short tons	e4,300	e12,900	3,230	15,057	e4,000	e19,200
Dimension	short tons	r e7,121	r e749	r10,883	r970	W	W
Combined value of antimony, cement (portland), clays, [common, kaolin (1990-91)], copper, feldspar, garnet (abrasive), lead, molybdenum, perlite, vanadium ore, zinc, and values indicated by symbol W		XX	r195,657	XX	r71,147	XX	84,756
Total		XX	r375,318	XX	r297,533	XX	306,061

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" figure.
[3]Recoverable content of ores, etc.

the aggregated value declining slightly. Except for a small increase in the value of zinc, the value of the State's base and precious metals showed a general decline. In the Coeur d'Alene Mining District, another mine was put on a care-and-maintenance basis, making a total of four major metal mines closed to date; two others have cut back exploration and development, and reduced production. Idaho's ferroalloys—molybdenum and vanadium—both had increases in quantity and value of production. At yearend, the State's only molybdenum mine was temporarily shut down and placed on care-and-maintenance status. Vanadium was recovered from ferrophosphorus slag, a waste product generated in the production of elemental phosphorus.

EMPLOYMENT

Idaho's mining sector employment dropped for the second consecutive year. According to the Research and Analysis Bureau of the Idaho Department of Employment, overall mining employment averaged 2,604 employees, a decrease of more than 15% from that of 1991 and about one-third from that of 1990. The average number of metal mining employees declined 27% to 1,449 in 1992, almost one-half that in 1990.

The average hourly wage for mining in 1992, which included premium pay for overtime and late shift work as well as changes in basic hourly and incentive wages, was $14.03. Average weekly earnings were $563, essentially unchanged from that of 1991; the average length of the workweek was 40.1 hours compared with 39.6 hours in 1991.

ENVIRONMENTAL ISSUES

At the Yellow Pine Mine, east of McCall, Hecla Mining Co. used cyanide-eating bacteria to neutralize and detoxify its heap-leach pads. According to the company, the new method was successful. The bacteria ate the cyanide and broke it down into carbon dioxide, water, and nitrogen. The heap was nearly neutralized after 5 months of application compared with the 2 years it would take with a traditional chemical neutralization process. Also, extra nutrients added to the heaps for the bacteria complement the overall reclamation effort. Hecla received the Pacific Northwest Pollution Control Association's 1992 Industrial Pollution Control Award for Idaho for pioneering the innovative bioneutralization process.

Cleanup continued within the 54-square-kilometer Bunker Hill Superfund site in the Coeur d'Alene Mining District, Shoshone County. Work included demolition of the mechanic's shop in the smelter complex, the stabilization of toxic copper-dross flue dust and other contaminants, removal of soil from residential yards, planting trees, building erosion control terraces and rock dams, and mitigating dust. The Federal Environmental Protection Agency (EPA) proposed its preferred remedial action plan, which included revegetating and stabilizing hillsides, removing 40 hectares of mine waste, capping a central impoundment area, controlling dust blowing off old mill tailings, preventing ground and surface water contamination, and razing the smelter and zinc plants. Under a separate plan, lead tainted soil from several hundred residential yards would be removed. Companies designated by the EPA as potentially responsible parties (PRP's) to the cleanup included ASARCO Incorporated, Callahan Mining Corp. (now part of Coeur d'Alene Mines Corp.), Coeur d'Alene Mines, Gulf USA (formerly Gulf Resources and Chemical Corp.), Hecla, Stauffer Chemical Co., Sunshine Precious Metals Inc., and the Union Pacific Railroad.

In late 1991, the National Marine Fisheries Service (NMFS) listed the Snake River sockeye salmon as an endangered species. Then in early 1992, three runs of Chinook Salmon were listed as threatened. The NMFS rulings require any activity on public lands to be analyzed for impact on the anadramous fish population. Consequently, a biological assessment was mandated for all activities on Forest Service land, including mining. As a result, numerous mining projects were delayed and some dropped completely during 1992.

Ash Grove Cement West Inc. received permission from the Idaho Department of Environmental Quality (DEQ) to burn 300,000 to 1 million scrap tires annually to fire kilns at its Inkom cement plant. Approval was given to burn up to 14% of the total fuel burned at the plant. The burning of tires could provide a means of effectively handling a landfill problem. As of January 1993, Idaho no longer permits old tires in landfills, and burning tire-derived fuels (TDF's) may help alleviate the problem. With the 3,000 degree F temperatures in the kiln, tires should be totally disintegrated. According to an Ash Grove engineer, there is no appreciable change in plant emissions—no black smoke or smell of rubber—when tires are burned as fuel. In November, the State awarded Ash Grove a $45,000 grant to help fund the project. The money came from the Waste Tire Grant Account established by the State legislature in 1991; it is funded by a $1 fee collected on the purchase of every new tire.

J. R. Simplot Co. and FMC Corp. hired a consultant to study the extent of pollution at the East Michaud Flat Superfund site northwest of Pocatello. Simplot's fertilizer complex and FMC's elemental phosphorus plant were formally added to the Superfund site in 1991. The 1,022-hectare site, which contains a large part of the Fort Hall Reservation, was contaminated as a result of mining and processing wastes being stored in unlined ponds over many years. Heavy metals detected in soil and water at the site prompted the listing. Both companies are working cooperatively with the EPA, DEQ, and the Shoshone-Bannock Tribe on the cleanup effort, including paying for the remedial studies and cleanup. Assessment of the effects of airborne P_2O_5 emissions on people and how to control those emissions also will be part of the study.

FMC and Simplot were studying small particulate air pollution emitted from their plants. The particulates were suspected of contributing to smog problems in downtown Pocatello and surrounding

areas. The companies were working with DEQ, local government, and EPA to come up with a State implementation plan to meet EPA standards by November 15, 1993. The penalty for noncompliance is the loss of Federal highway funds and service money provided to the local governments. Dust from handling phosphate ore appears to be the biggest industrial offender.

FMC was working with Monsanto Chemical Co. to fund a new study to find what harmful effects, if any, slag from the elemental phosphorous process may have. The EPA will conduct a comprehensive study of the health effects of the rocklike byproduct of the phosphate refining process. Both FMC and Monsanto have stopped selling slag, which has been widely used as an aggregate throughout the area.

A number of mineral-related companies received environmental accolades during 1992. Monsanto received the U.S. Bureau of Land Management's (BLM) Partners in the Public Spirit Award. The company was acknowledged for its reclamation work at the Henry Mine, closed as a result of ore exhaustion. The prestigious award, one of six nationwide, was presented by the Idaho Governor and the Director of the BLM. Monsanto has received numerous awards and citations for reclamation at the 485-hectare site north of Soda Springs.

Coeur d'Alene Mines received another award for its cleanup and reclamation efforts at the Thunder Mountain property, a heap-leach operation that was closed in 1990 and reclaimed in 1991. The company received a "highest habitat certification" from the Wildlife Habitat Council, based in Maryland. The company created wetland, backfilled and recontoured pits, and constructed a hiking trail at the mine site, east of McCall.

Cyprus Minerals Co. and the Yankee Fork Ranger District of the Challis National Forest received a special reclamation award from the Idaho Governor and the State Department of Lands for cleanup and reclamation work, including removal of old mill buildings and ore bins, at the old Scheelite Gem mill on lower Thompson Creek. Cyprus Minerals also reclaimed another tungsten mill on upper Thompson Creek.

EXPLORATION ACTIVITIES

The number of exploration projects in Idaho decreased from 99 in 1990 to 70 in 1991 and 47 in 1992, according to the Idaho Geological Survey (IGS). The IGS "conservatively" estimated total exploration expenditures at $11.8 million in 1992. The bulk of the targets was focused on gold and other precious metals. There were a few projects under way searching for base metals, and a number of firms explored for industrial minerals. Fully permitted development projects, like Idaho Gold Corp.'s Buffalo Gulch near Elk City, FMC Gold Co.'s Beartrack at Leesburg, and Hecla's Grouse Creek project in Custer County, remained on hold owing to low gold prices. Delays caused by rulings on anadromous fish and wetlands hampered some projects. On the plus side, exploration for limestone and phosphate reserves in southern Idaho increased.

Exploration in north Idaho was sparse, especially in the Coeur d'Alene Mining District. As a result of closure or reduced operation at a number of the silver and lead-zinc mines, normal exploration work surrounding the properties was cut back. An exception was the silver discovery by Hecla beneath the old Gold Hunter Mine near Mullan. Hecla announced that it would spend $2 million and hire 29 miners to evaluate the discovery. From a crosscut at the 4050 level of the company's Lucky Friday Mine, an exploration drift was driven, exposing silver and lead mineralization.

Golden Chest Inc., a subsidiary of Viking Investment Corp., continued exploration and development, including confirmation drilling, of the Golden Chest Mine, 2 kilometers east of Murray, Shoshone County. Newmont Mining Co. drilled, then returned the underground property to Golden Chest in 1990.

Following geologic mapping and geophysics, Kennecott Exploration drilled for lead and zinc at the Galena Giant property near Wallace, Shoshone County. The drill site on Tributary Creek is near the former Jack Waite Mine. The project was a joint venture by two Canadian firms, Wealth Resources and Arbor Resources Inc.

Crews from Wilson Exploration Co. conducted helicopter-supported mapping and sampling of a gold-bearing breccia zone at the Shale Mountain anomalous gold discovery in the Kelly-Cayuse (Hoodoo) Roadless Area, north of Lolo Pass, near the Idaho-Montana line. In 1991, a U.S. Bureau of Mines, IGS, and U.S. Geological Survey team reported on the Clearwater County gold mineralization. Wilson staked 368 claims.

In Idaho County, Newmont Exploration Ltd. reclaimed, then dropped, its claims at Newsome and Leggett Creeks near Golden; the company drilled the shear-zone hosted low-grade deposit in 1991. Cominco American Exploration received permission to continue drilling in the Red River/Big Creek area near Dixie, but due in part to delays from the listing of the Sockeye salmon as an endangered species, lost interest. Cominco was marketing the property.

Near Warren, at the Rescue Mine, CSC Mining Co. intersected a gold vein, then drifted along the vein 85 meters. The company stockpiled about 455 metric tons of ore and has proposed the construction of a small gravity mill to recover free gold. The mill would use recycled water and include a small tailings pond. Also near Warren, Unity Gold Mines Inc. continued to retimber and rehabilitate the Unity underground gold mine. The primary target of the drift was the Little Giant vein. Harold McDowell filed an operating plan with the Payette National Forest to explore, including backhoe excavation and sampling, at the Firecreek Mine in the Webfoot Creek drainage.

Idaho Lime Co. did exploratory drilling on a marble deposit on Orofino Creek in hopes of developing an agricultural lime and decorative limestone quarry. The company also drilled at No Business Creek near Slate Creek and on a State lease at Slate Point northeast of Riggins. Adjacent to Idaho Lime's Slate

Point property, Big John Mining Co. also drilled for limestone.

In Lehmi County, exploration activity continued to center around FMC's Beartrack property, albeit less than that of the past few years. Formation Capital Corp. controlled more than 155 square kilometers, including a large part of the northern extension of the Panther Creek Fault. Formation Capital continued surface exploration, some with joint-venture partners, on several projects, including the Bob Cat Gulch, King Solomon, Moose Creek, Morning Glory, and Redrock properties. The Bob Cat Gulch property, a copper porphyry system with associated gold veins, was mapped, sampled, and drilled. Pathfinder Exploration, a wholly owned subsidiary of Compagnie Generale Des Matieres Nucleaires (COGEMA), a French company, explored in the Morning Glory Mine area between Jesse and Wallace Creeks. Pathfinder also leased Formation Capital's claims at the King Solomon Mine on Bob Moore Creek; work included trenching and drilling. Jettra Resources, in a joint venture with Formation Capital and two other property owners, mapped, trenched, and sampled on the Queen of the Hills and Tendoy properties between Wallace Creek and Bob Moore Creek. To the north of Beartrack, Formation Capital identified, drilled, and trenched targets at Comet Ridge and in the Moose Creek Ridge and Sawmill Gulch areas. Formation Capital obtained a lease option on the Blackpine Mine, five kilometers east of the Cobalt Ranger Station on Copper Creek. The property was mined for copper and cobalt during the 1940's and 1950's; gold and silver also are present.

Cominco continued to explore for copper and cobalt on the Jackass claims on the Iron Creek property, south of Salmon. The property was leased from Centurion Gold Ltd. and is on Idaho's cobalt-copper belt, which also includes Formation Capital's Blackpine property and Noranda's Blackbird Mine. At the Blackbird Mine site, Noranda continued to operate a water-treatment plant, and a number of environmental issues were in litigation.

American Gold Resources Corp. (AGR) did infill drilling at its Arnett Creek property, a gold prospect on 69 square kilometers adjacent to and west of Beartrack. The company submitted metallurgical samples to a laboratory for column-leach testing. A more extensive drill program of the former Haidee Mine area of the property was delayed by lack of an archeological clearance needed from the State Historical Preservation Officer.

Newmont acquired rights to mining properties owned by Atlas Precious Metals Corp. Included in the package was Atlas's Musgrove Creek property, encompassing about 52 square kilometers in Lemhi County. Terms of the agreement called for Newmont to acquire a 35-year lease on Atlas's properties, with options for 30 additional years. In addition to extensive surface mapping and sampling, Atlas drilled a number of holes during 1991 and 1992. Also in the Musgrove Creek drainage, an independent miner shipped a 56-metric-ton bulk sample. Atlas leased the property, but allowed the independent to retain mining rights on his vein.

Kennecott Exploration maintained its presence in the Yellow Pine area of Valley County. After intersecting significant gold mineralization in a 1990-91 drill program, the company was looking for a partner for the Moscow Mine in the Moore Creek drainage near Big Creek. Also, Kennecott leased and drilled the combined properties of Thunder Mountain Gold Inc., Dewey Mining Co., and the Sunnyside Consolidated Mining Co. in the Thunder Mountain Mining District. Cambior USA Inc. drilled on a ridge west of Johnson Creek; the Johnson Creek property was returned owing to permitting problems.

In Adams County, Cominco American explored for massive sulfides on claims near Harrington Springs in the Peck Mountain area, northwest of Council. Near Cuprum, Alta Gold Co. did reclamation work at the Red Ledge Mine, a massive sulfide property. Work included installation of bulkheads in two old adits. The reinforced concrete barriers were put in place to prevent acidic water from draining from the former mine.

In Custer County, Western Mining Co. USA drilled near the Ramshorn Mine and at Poverty Flat, both in the Bayhorse district. The company cooperated with the Idaho Parks and Recreation Department to preserve historic buildings and sites in the district. Mont Stocking shipped a test run of ore from the Greer claims on Valley Creek northwest of Stanley. At the former Lucky Boy Mine south of the historic town of Custer, Independence Mining explored, including drilling on patented claims, and submitted a plan of operations to the Challis National Forest; permitting was delayed by the NMFS anadramous fish ruling. About 152 meters of old drift was rehabilitated at the Lost Packer Mine on Loon Lake. The mine, under development by the Lost Packer Mining Co. for several years, has reported minor production.

Curator American Inc., a subsidiary of International Curator Resources Ltd., acquired Westmont Mining Inc.'s DSA property at the head of the North Fork of the Big Lost River in Custer County. Westmont's parent company, Costain Minerals, sold all its base metal assets to Cambior, which then sold the DSA property to Curator. Curator was a partner in the original joint venture that investigated the property in the early 1980's. In addition to evaluating Westmont's 3-year drilling program, Curator did detailed mapping and geochemical studies.

Biomyne Inc. continued gold exploration, including drilling, sampling, and mapping, on the Waldemar-Lingren Watterson claim block in hills along the West Fork of Warm Springs Creek, about 10 kilometers west of Ketchum, Blaine County.

West One Minerals continued efforts to market limestone from a quarry near Leslie Butte, about 32 kilometers north of Arco, Butte County.

In the Weiser area of Washington County in southwest Idaho, Minnova Inc. optioned the Blue Dog hot-springs gold property after a small drilling program by owner Gold Canyon Resources Inc.; this

follows recent leases by Noranda and Gold Fields Mining Co. AMAX Gold Exploration Inc. drilled and prepared a feasibility study at the Idaho-Almaden gold prospect, another epithermal deposit in the Weiser area. The company has an agreement with ICAN Minerals Ltd. in which it can acquire a 65% interest in the former mercury property. J. L. Carroll Mineral Exploration Co. continued drilling on the WD-VAR claims (the old Consolidated Mercury prospect) near the mouth of Crane Creek; the property is owned by Western Epithermal.

Sunshine Mining Co. drilled for gold on its property in Cartwright Canyon in Boise County. In the Boise Basin area, Cactus West Exploration Ltd. drilled at the Gold Hill Mine, near Quartzburg; the company also surveyed and sampled the Century property, which extends from Quartzburg to Alder Creek Summit. Also in the area, Willoughby Shepherd reopened the Dead Dog Mine and Theron Richardson drilled on a State lease at Clear Creek, just south of Placerville. Northeast of Idaho City, Cominco worked on the Elk Creek project.

Northeast of Boise in Elmore County, Atlanta Gold Corp. continued a drill program on the west side of its metallurgically complex gold property near Atlanta. In an effort to reopen the 900 level adit, a National Pollution Discharge Elimination System (NPDES) permit was being prepared. RST Mining drilled along the road that passes over James Creek Summit between Atlanta and Rocky Bar.

In the Owyhee Mountains north of the DeLamar Mine, Nerco did minor drilling at its Twin Peaks project, and Placer Dome drilled then dropped the Black Sheep project in Slaughterhouse Gulch. War Eagle Mining Co. explored its epithermal claims on War Eagle Mountain above Silver City, Owyhee County.

In southeast Idaho, Atlas drilled at its Rock Creek hot springs property south of Hansen, Twin Falls County; Gold Fields drilled north of Malad, Oneida County, and south of the city in the Cherry Creek area; and Placer Dome continued exploration, including drilling and surface geophysics, at its gold prospect near Kilgore, Clark County.

LEGISLATION AND GOVERNMENT PROGRAMS

The Idaho Department of Parks and Recreation opened a new mining interpretive center near Challis, at the intersection of U.S. 93 and State Highway 75; it includes interpretive displays and audiovisual programs on Idaho's mining history. A circle road tour was developed with a number of posted stops, including the historic Yankee Fork gold dredge.

Late in the year, the Interstate Commerce Commission (ICC) voted to authorize the Union Pacific Railroad to abandon its 115-kilometer-long track from Plummer to Mullan that services the Coeur d'Alene Mining District. The company proposed the abandonment in 1991, claiming that the route was unprofitable. Soon after the ICC decision, the railroad announced that it would stop service in February 1993. All ore and other supplies formerly shipped into and out of the district by rail will now have to be trucked. Several appeals have been filed with the ICC to keep the line open.

In 1992, the Mining and Mineral Resources Institute of the University of Idaho, at Moscow, received an allotment of $16,000 from the U.S. Bureau of Mines. The school has received a total of $3.67 million since inception of the Mineral Institute Program in 1978.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Cement.—Both the quantity and value of Idaho's cement production rose slightly from those of 1991. The State's only cement producer was Ash Grove Cement West Inc. at Inkom in Bannock County. The bulk of the cement produced was general-use, moderate-heat Types I and II gray portland cement. Lesser quantities of Type III high-early-strength portland cement and masonry cement also were produced. Users of the finished portland cement included ready-mix concrete companies, highway and other contractors, concrete product manufacturers, and building material dealers. Limestone and quartzite used in the cement production were quarried from just west of the plant.

Clays.—Idaho's reported clay production dropped both in quantity and value from that of 1991. Mutual Materials Co. mined common clay from the Tensed Mine, about 3 kilometers north of Tensed, Benewah County. Clay from this former Interpace Corp. property was trucked to Mutual Materials' brick plant at Mica, WA, where it was mixed with Washington clay to produce desired colors for structural and facing brick. Clayburn Industries reclaimed and reseeded about 2 hectares disturbed by clay mining near Deary in Latah County. During the past few years, Clayburn operated a kiln at the old Simplot clay plant and shipped the calcined clay to the company's refractory brick plant in British Columbia, Canada. Applied Industrial Minerals Corp. (AIMCOR) operated the Ben-Jel bentonite pit near Oreana, Owyhee County, and processed the white clay for use in papermaking at a plant in Caldwell. E. J. Wilson and Sons produced bentonite from the Morning Glory property. Uses included ditch and canal linings to reduce water loss during drought, and for the sealing of fish ponds, basements, and water hazards on golf courses.

Diatomite.—Grefco Inc. continued assessment and development work at its Deep Creek diatomite property in Owyhee County. To do bulk sampling, the company reopened three 76-centimeter-diameter drillholes that were completed in 1989. As part of a validity exam, a BLM geologist was lowered on a chair hoist into the holes ranging in depth from 11 to 21 meters. According to the IGS, the diatomite ore was very pure at about 15 meters below the surface.

Feldspar.—Feldspar production rose slightly in both quantity and value from that of 1991. Unimin Corp. in Emmett, Gem County, was the State's sole producer. In July, Unimin received a patent on five claims totaling 36 hectares, culminating a 2 1/2-year legal process. The company produced a feldspar-silica sand mixture used mainly in glass production, but also for sandblasting and golf courses. Unimin had two drilling projects to define reserves in the active Pearl quarry and to explore additional unpatented claims.

Garnet.—Garnet production rose in quantity but fell in value from that of 1991. The Western Garnet Co., formerly Hawkeye Development Ltd. of Canada, completed its first full year of ownership of the State's only commercial garnet mine near Fernwood, Benewah County, and the Nation's largest garnet producer. The land position included private ground and Federal leases. Emerald Creek Garnet Milling Co. Inc. sold the property to Hawkeye Development in 1991. In addition to gem-quality stones, including star garnets, the mine was one of the world's largest producers of garnets used for industrial abrasives. Using five washing plants, the company mined garnet year-round from two sites on Carpenter Creek and three locations on Emerald Creek. Each of the washing plants can support about 16,000 square meters of placer mining per year. The mine site included a shop, jig plant, and a sizing and bagging plant. The recovered garnet was milled to varying coarseness for use in water filtration, sandblasting, and polishing.

The U.S. Forest Service's public garnet digging area near St. Mary's, Benewah County, sold a record 2,670 permits to visitors. The diggers took out 297 kilograms of garnets; the largest crystal weighed 227 grams. Star garnets, the Idaho State gemstone, can be found at the popular recreational site.

Gemstones.—The value of gemstone production decreased more than 26% from that of 1991. Many of the active gemstone collection areas continued to be in Benewah, Boise, Clark, Clearwater, and Latah Counties. Idaho was one of two places that produce star garnets, the State's gemstone; India was the other. The primary sources of star garnets were the placer deposits on the East Fork of Emerald Creek and its tributary gulches in Benewah County. Various varieties of opals, including blue, common, pink, precious, and yellow, also were major contributors to Idaho's gemstone production value. The Spencer Mine in Clark County, the State's largest opal producer, produced pink and precious varieties. Other gem materials recovered in Idaho included aquamarine, jasper, smoky quartz, topaz, and turquoise.

Lime.—Lime production in Idaho increased 16% in quantity, but dropped more than 13% in value from that of 1991. Three lime plants, operated by Amalgamated Sugar Co. in Canyon, Minidoka, and Twin Falls Counties, accounted for the bulk of the State's 1992 reported lime production. The raw material was shipped by rail from Ash Grove Cement's limestone quarry in Durkee, OR. The quicklime was used in the manufacture of sugar.

Chemstar Lime Co. began production at its new Tenmile lime plant and quarry near Bancroft, Caribou County. The lime was mined from a nearby Mississippian algal-reef limestone deposit and transported by conveyor belt to the plant, which is expected to produce up to 544 metric tons of high-calcium lime daily. A new high-efficiency, 52-meter-high Maerz gas-fired vertical kiln was installed, along with fabric dust filters and automated controls. The plant was expected to be very efficient and environmentally clean. The product was trucked to Bancroft where a new railroad terminal complex was constructed. The lime was used in heap-leach gold operations, as a water purifier, for soil stabilization, and for manufacturing glass, paper, cement, copper, steel, and asphalt.

The Nez Perce Tribe mined limestone from the Mission Creek quarry and sold it to Potlatch Corp.'s paper mill in Lewiston. Treasure Canyon Calcium shipped limestone from its plant and quarry in Franklin County to Simplot's fertilizer plant in Pocatello for use in processing phosphoric acid. The company also produced a small amount of limestone for use as an animal feed supplement. Owyhee Calcium mined an oolitic limestone deposit south of Grand View, Owyhee County, and sold the material for use in animal feed. The company filed an application to patent its claims.

Perlite.—Perlite production decreased both in quantity and value from that of 1991. National Perlite Products Co., a division of Oglebay Norton Co., sold inventory from the Oneida Mine in the Wrights Creek drainage of the Caribou National Forest, about 40 kilometers north of Malad City, Oneida County. The perlite was processed and expanded at the company's plant in Malad City. The expanded product was used for industrial filters, in fireproofing, and as a filter medium. Late in 1991, the plant was closed because of air quality violations. In an effort to control the dust problem, a mitigation plan was submitted to and approved by the Idaho Air Quality Bureau, which included the mining of harder perlite ore, the use of new dust abatement equipment, and road improvement along Wrights Creek. However, the company placed the plant and mining operation on hold.

Phosphate Rock.—Phosphate rock production decreased 12% in quantity and almost 3% in value from that of 1991. Idaho was the Nation's third-ranked producer of marketable phosphate. None of the Idaho phosphate producers marketed phosphate rock as a salable commodity. FMC and Monsanto produced elemental phosphorus; J.R. Simplot Co. and NuWest Industries Inc. made various grades of phosphoric acid; and Rhône-Poulenc Basic Chemicals Co. shipped ore to its elemental phosphorus plant in Montana.

With two operating mines, Simplot was Idaho's top ranked phosphate rock producer in 1991. Simplot mined

phosphate at the Smoky Canyon Mine, near the Idaho-Wyoming border in Caribou County, and was the mining contractor for FMC at the Gay Mine, about 48 kilometers northeast of Pocatello on the Fort Hall Indian Reservation in Bingham County. Simplot shipped rock through a 140-kilometer slurry pipeline from the Smoky Canyon Mine near Afton, WY, to the company's phosphoric acid and fertilizer complex at Pocatello. The pipeline bypassed the company's former calcining plant at Conda. Simplot developed a proprietary filter and digestion process that used uncalcined, organic-bearing ore in the manufacture of agricultural fertilizers, thus enabling the company to shut down its three calciners, making the Conda plant obsolete. At the fertilizer plant, the new process technology was expected to significantly reduce air emissions and energy consumption. With the ore being used directly, it eliminates the need for ore stockpiles, thus reducing dust pollution. At the Smoky Canyon Mine site, Simplot continued work on a new tailings impoundment. To ensure no net loss of wetlands and to receive its 404 (wetlands) permit from the EPA and the U.S. Army Corps of Engineers, the company plans to restore up to 790,000 square meters of former wetlands lost to livestock and other uses.

Owing to dwindling reserves, production at the Gay Mine has nearly ceased, and the property was scheduled for closure in 1993. Mine production was processed by Simplot into phosphoric acid and by FMC into elemental phosphorus at their Pocatello plants. The Gay Mine, a major employer on the reservation, has been a large contributor to the tax base, for Shoshone-bannock Tribe. The tribe has been investigating alternative sources of income, including the production of their own fertilizer in a joint venture with the Ogallalla Tribe in South Dakota. Zeolites from the Ogallala Tribe could be combined with Shoshone-Bannock material to produce a time-release fertilizer.

To replace the production of high-grade ore from the Gay Mine, FMC began operations and was the operator of a new phosphate mine in Dry Valley, about 40 kilometers northeast of Soda Springs, Caribou County. With an estimated mine life of 20 years, plans were for the mine to be in full production by early 1995. A railroad siding was constructed at the mine site to rail-ship the ore to FMC's Pocatello plant. A new precast shop and office at the mine site also was completed. FMC was creating 45 hectares of new wetlands to replace 14 hectares that will be drained. The new wetlands, plus 121 additional hectares, will be given to the Boy Scouts of America for a summer camp. The Boy Scouts have agreed to maintain the wetland into perpetuity. FMC's Pocatello facility is the largest elemental phosphorous plant in the world.

Simplot and EG&G Idaho Inc. continued a research program studying the use of biotechnology in the extraction of phosphate from ore. The process, developed by EG&G, would use microorganisms at the mine site to separate the phosphate from waste rock. It would eliminate the use of sulfuric acid to extract phosphorus from phosphate ore, the current method for fertilizer production. Not only would this eliminate possible problems associated with the acid, but would end the production of phosphogypsum, a waste product that has no use and is produced in large quantities as a result of the current fertilizer manufacturing process.

Rhône-Poulenc, a French government-owned company, continued full production of phosphate ore on its lease at the southern end of Rasmussen Ridge, about 29 kilometers northeast of Soda Springs. The company began production at Rasmussen Ridge after ore was exhausted at the company's Wooley Valley Mine in 1991. Ore was transported on a 6-kilometer haulage road to its mill at the Wooley Valley mine site, washed, then shipped by rail to the company's elemental phosphorous plant in Silver Bow, MT.

Monsanto continued full production at its new Enoch Valley Mine in Caribou County. In 1991, Enoch Valley replaced the company's Henry Mine about 6 kilometers to the west, which was closed as a result of ore exhaustion. The new mine has an estimated 14 years of reserves. The ore is hauled by truck to Monsanto's elemental phosphorous plant at Soda Springs.

NuWest Industries acquired the 50% interest of its former partner in the Conda Partnership, Western Cooperative Fertilizer Ltd. of Calgary, Alberta, Canada, and now owns the entire mining and processing facility. After a 2-month shutdown at the end of 1991, both the mine and plant restarted production in January. The phosphate rock was mined under contract at the Mountain Fuels lease in Dry Valley, Caribou County. The Mountain Fuels lease was nearly exhausted, so the company was expanding into the Champ pit and planning to open new mining operations at the North Maybe Canyon Extension. The ore was beneficiated at the company's calcining plant at Conda, and the calcined product was moved by conveyor to NuWest's phosphate fertilizer complex adjacent to the plant. The fertilizer plant manufactures super phosphoric acid and five different dry products.

NuWest opened a new plant that extracts silica from waste generated in the making of phosphoric acid fertilizer. The pilot plant has an annual capacity of about 900 metric tons of very pure silica. Potential markets include fiber optics and computer chips.

Pumice.—Output of pumice in Idaho increased by more than 50% in both quantity and value from that of 1991. Pumice was produced by two operations in Bonneville County and by one in Oneida County. Hess Pumice Products operated a mine on Wrights Creek, north of Malad City in Oneida County, and an automated pumice processing plant at Malad City. The very pure, fine-grained pumice had a variety of uses, as an abrasive, lightweight aggregate, filler, and highway sanding.

Amcor Inc. quarried pumice from its Sunnyside pit along the west flank of the Blackfoot Mountains, near Ammon in Bonneville County. The material was trucked to Idaho Falls where it was crushed, screened, and used for

TABLE 2
IDAHO: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	2,057	$6,811	$3.31
Plaster and gunite sands	42	192	4.57
Concrete products (blocks, bricks, pipe, decorative, etc.)	58	231	3.98
Asphaltic concrete aggregates and other bituminous mixtures	684	2,635	3.85
Road base and coverings	7,996	20,565	2.57
Fill	700	1,343	1.92
Snow and ice control	40	145	3.63
Railroad ballast	33	140	4.24
Other miscellaneous uses[1]	33	100	3.03
Unspecified:[2]			
Actual	524	1,274	2.43
Estimated	2,739	7,295	2.66
Total[3]	14,906	40,728	2.73
Total[4 5]	13,522	40,728	3.01

[1]Includes filtration.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data may not add to totals shown because of independent rounding.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

lightweight concrete aggregate. Also near Ammon, Producer Pumice, a subsidiary of Builders Masonry Products, sold its Rock Hollow Mine to Joe Smith of Boise. The pumice was shipped by rail to Meridian, where it was crushed, screened, and sold for use as lightweight concrete aggregate.

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains estimates for 1991 and actual data for 1990 and 1992.

The 1992 output of construction sand and gravel in Idaho increased more than 28% in quantity and 30% in value from that estimated in 1991 and nearly two-thirds in quantity and almost 60% in value from production surveyed in 1990. The three major producing counties were Ada, Canyon, and Idaho, accounting for almost 56% of the State's total. Major uses included road base and cover, concrete aggregate, and asphaltic concrete. The bulk of Idaho's construction sand and gravel was transported by truck; much of the remainder was used on-site.

Industrial.—Industrial sand and gravel production more than doubled in quantity and doubled in value from that of 1991. Output came from three pits in three counties: FMC in Power County; Monsanto near Soda Springs, Caribou County; and by Unimin Corp. at the top of Freeze Out Hill east of Emmett, Gem County. Uses for the industrial sand and gravel included glass containers, sandblasting sand, specialty sands, and nonmetallurgical flux (slag) in electric furnaces at elemental phosphorous plants.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains actual data for 1991 and estimates for 1990 and 1992.

Crushed.—The estimated quantity of crushed stone produced in 1992 increased by almost 24% and value rose almost 28% from that reported in 1991. Historically, top producing counties have included Bannock, Benewah, Caribou, Idaho, and Nez Perce. The bulk of the crushed stone produced was limestone and traprock. The top uses for the product included bituminous aggregate, flux stone, graded roadbase, and unpaved road surface.

Dimension.--Idaho Travertine Corp. operated a stone-cutting plant at Idaho Falls, Bonneville County, and a travertine quarry east of the city. The company has two quarries, one at Fall Creek, Bonneville County, where large boulders of travertine were quarried and then shipped to its Idaho Falls plant for slabbing, and another mine on Medicine Lodge Creek, Clark County. Decorative sandstone was quarried at the Table Rock property near Boise, Ada County, by Table Rock Sandstone Inc. Production was shipped to Idaho Travertine's plant for processing, then used in the construction of new buildings at a local college and for repairing the Statehouse in Boise.

A number of companies marketed Oakley Stone from quarries south of Oakley, Cassia County. They included Northern Stone Supply Co., which operated the Rocky Mountain Quartzite quarry and sold slab quartzite for paving and facing applications; and Oakley Valley Stone Co., which mined and sold quartzite from the Valley View Mine. The Rocktile Co. of Boise bought slabbed, roughed quartzite, cut the stone to tile, and sold most of it as a facing stone to both domestic and Japanese markets.

Zeolites.—Teague Mineral Products Co. mined clinoptilolite from the Chrisman Hill pit, near the old townsite of Sheaville, on the Idaho-Oregon border just north of U.S. Highway 95. The company trucked the Owyhee County ore

to its processing plant at Adrian, OR. Along with mine output from deposits in southeastern Oregon, the zeolite was sold for ammonia absorbent in aquarium systems, animal feed supplement, anticaking agents, fungicide carriers, odor control, and wastewater treatments. The company was working on a soil additive product to be used for water retention and as a potting mix.

Steelhead Resources mined zeolites from pits near Succor Creek on the Idaho-Oregon line. The material was crushed then trucked to Calgary, Alberta, Canada.

Metals

Antimony.—Idaho was the only State in the Nation reporting antimony production in 1992. Production increased in both quantity and value from that of 1991. Sunshine Mining recovered antimony as a byproduct from the electrolytic treatment of tetrahedrite, a complex silver-copper-antimony sulfide that is the principal ore mined at the Sunshine Mine near Kellogg, Shoshone County. A new antimony process circuit, developed in-house, was installed and was expected to generate substantial savings.

Copper.—Idaho's copper production dropped 26% in quantity and value from that of 1991. The major copper-producing region in the State continued to be the Coeur d'Alene Mining District, where copper was produced as a byproduct at the following mines: the Galena, Lucky Friday, and Sunshine. All three mines either have reduced output or closed.

Gold.—Gold production in Idaho decreased in both quantity and value from that of 1991. Nerco's DeLamar gold-silver mine, 32 kilometers east of Jordan Valley, OR, in Owyhee County, continued working at its full operating level. The property includes an open pit, a countercurrent decant mill, and a vat-leach plant. A mill expansion, completed in 1991, increased the average throughput in 1992 to about 3,200 metric tons per day. Most of the gold and silver production came from the Glensilver pit, although ore also was mined from the Sommercamp and South Wahl pits. The company detoxified a tailings pond, and a new acidification, volatilization, and reabsorption plant began operation; it allows Nerco to recover and reuse cyanide and prevent it from entering the mine's pond water. Mining properties owned by Nerco, a subsidiary of Pacific Corp., were for sale, including the DeLamar Mine. As a result, development work at the nearby Stone Cabin project was put on hold. Also, the entire DeLamar-based exploration group was laid off at the end of November.

The Stibnite Mine, a seasonal open pit, heap-leach operation 24 kilometers southeast of Yellow Pine, Valley County, was owned and operated by MinVen Gold Corp. Mining was concentrated in two new areas: the Midnight pit at the south end of the nearly exhausted West End pit, and the Northeast pit. The company sought permission from the Payette National Forest to open six new sites: the Broken Hill, Cinamid, Doris K., Garnet Creek, Ridge Top, and Stibnite. Work included the preparation of a draft environmental impact statement (EIS).

Hecla completed processing ore from the oxide portion of the Yellow Pine Mine and continued reclamation of the site. Hecla used a new experimental bacterial process to neutralize and detoxify its leach pads (see Environmental section.) The heap-leach gold mine was adjacent to the Stibnite property, about 72 air-kilometers east of McCall. Barrick Gold Exploration Inc., a subsidiary of American Barrick Resources Corp., signed a letter of intent to explore and develop the refractory sulfide gold deposit on the property; the company had an option to earn a 70% interest in the mine. After drilling more than 3,000 meters of core and reverse circulation holes, American Barrick decided to withdraw from the project.

Idaho Gold Corp. completed mining at its Champagne property 32 kilometers west of Arco, Butte County. Production in 1992 came from the South Zone pit. The company, a subsidiary of Bema Gold Corp., continued secondary leaching of the low-grade ore and initiated its reclamation efforts. Leaching and gold recovery were expected to continue until mid-1993. Detoxification and neutralization of the heap pads and reclamation were expected to continue into 1994, followed by long-term monitoring of the site. The open pit, heap-leach mine is on Idaho Gold's Lava Creek property. The company is 85% owned by BEMA Gold Inc. and 15% owned by Glamis Gold Ltd.

The Yellowjacket Mine, owned and operated by U.S. Antimony Corp. (USAC), is about 24 kilometers southwest of Cobalt, Lehmi County. The surface mine was constructed and the mill opened in a joint venture with BumbleBee Inc., which contributed sufficient funds to acquire a 40% share of the property. The small, open pit gold mine was drilled by Westgold in 1989 and opened by USAC in late 1991. After installing a second grinding mill, production was boosted up to 230 metric tons per day. The mill's flotation circuit processed oxidized ore containing free gold. The concentrates were trucked and further processed at USAC's mill at Preachers Cove on the Yankee Fork. As a result of the crusher being moved to the Yellowjacket mine site, the Preachers Cove mill did not accept any custom orders. Custom milling, including ore from the Lost Packer Mine, could be restarted as early as 1993.

In January, Pegasus Gold Inc. made its first gold pour at the Black Pine Mine, a heap-leach operation about 6 kilometers from the Utah border in Cassia County. Beginning with the Tolman pit, the company plans to mine three separate open pits. Project startup was delayed slightly after Pegasus agreed, for environmental reasons, to use a central valley-fill leach pad as opposed to the original plan of smaller pads at each of the three pits. The open pit, heap-leach mine may have to operate on a seasonal basis (8 to 9 months per year), but leaching was expected to continue uninterrupted throughout the year. The 42-square-kilometer property is centered around the old Tolman Mine in the Black

Pine Mountains of the Sawtooth National Forest, 108 kilometers southeast of Burley.

Other gold producers included NJB Mines Inc., which started a small open pit gold mine and gravity mill near the Red River Ranger Station southeast of Elk City. Because of recovery problems, a flotation circuit may need to be added. American Independence Mines mined ore from the Fourth of July Mine on Logan Creek; a gravity mill was moved on-site. Gold also was produced from Asarco's Galena silver mine, Sunshine's Sunshine silver mine, and Hecla's Lucky Friday lead mine.

According to the IGS, a number of gold placer mines were worked in the State, including Jim Riggans and crew, who ran a 270-metric-ton-per-day placer operation on the North Fork of the Salmon River, below Gibbonsville; George Castle processed material at the Twin Springs placer deposit on the Middle Fork of the Boise River; Arvid Wolfgram placered in the Florence Basin; Mace Ridley at South Boone Creek on the east side of the Targhee National Forest; and several small placer operations, some with dredges, were on the Yuba River near Atlanta. According to the Idaho Department of Water Resources, 518 one-stop permits, required to run small hobby suction dredges, were issued in 1992. Most were in the northern and southwestern parts of the State, with only 40 permits issued in southeast Idaho.

Important gold projects under development included FMC's Beartrack property, Hecla's Grouse Creek deposit, Idaho Gold's Buffalo Gulch and Ericson Reef deposits, and Nerco's Stone Cabin project.

In lieu of a debt payment, Canyon Resources Corp. transferred its 15% ownership holdings in the Beartrack property to Meridian Gold. Co., a wholly owned subsidiary of FMC Gold. As a result of the transfer, FMC Gold owns 86% of the property and Mirex Partners, 14%. Meridian did some surface drilling, mainly for assessment and delineation purposes, and a 38-meter decline was driven in the North zone, which included the removal of a bulk sample for metallurgical testing. The project was put on hold until the advent of more favorable gold prices. Beartrack, reportedly one of the largest gold discoveries in Idaho's history, is approximately 16 kilometers west of Salmon near the historic placer mining town of Leesburg, in the Mackinaw Mining District, Lemhi County. Two large gold deposits have been identified. The deposits, Gold Ridge and North, are on the Panther Creek Fault Zone within the Trans-Challis belt. The proposed 3-square-kilometer mine would include two open pits, a cyanide heap-leach pad, waste rock dumps, and other facilities. The U.S. Forest Service has approved the company's EIS. Production is estimated at 18,700 kilograms over a 7-year life. Additional sulfide tonnage has been identified underneath the shallow leachable oxide reserves.

Hecla continued development of its Grouse Creek gold and silver property, 43 kilometers southwest of Challis on Jordan Creek, in the historic Yankee Fork Mining District, Custer County. As a result of extensive drilling, two mineral targets have been identified—the Grouse Creek deposit and the old Sunbeam Mine. After an active fill-in drilling program in 1992, Hecla announced high-grade gold and silver intercepts from holes drilled on Soapstone Hill and other areas outside the already delineated ore bodies. State and Federal permits have been issued, including the 404 wetlands permit, necessary to begin mining. In the past, the project was hampered by environmental concerns involving the Pinyon Basin wetland. Wetland and riparian mitigation have been thoroughly addressed by Hecla, including offsite restoration of wetlands in the Sawtooth Valley in the upper Stanley basin; a supplemental EIS was being finalized. Operation plans called for a 2,720-metric-ton-per-day mill and a carbon-in-pulp circuit.

Idaho Gold's Buffalo Gulch open pit, heap-leach property and the Ericson Reef prospect are part of the Elk City Gold Belt. Final BLM and Idaho State permits have been issued for Buffalo Gulch, 5 kilometers northwest of Elk City. Startup was dependent on financing and gold prices. The 404 wetlands permit was delayed because of the cyanide used in the proposed heap-leaching process. Final permitting was under way for the Ericson Reef deposit, approximately 13 kilometers north-northwest of Elk City. Plans were to mine Buffalo Gulch and Ericson Reef as one unit; several other nearby deposits would potentially expand the reserves.

The combination of Nerco marketing its metals properties and delays caused by wetland issues has put development of the Stone Cabin project on hold. The new property, on Florida Mountain, is about 8 kilometers east of the DeLamar Mine and would become a satellite operation. The proposed gold and silver operation would include three open pits, with ore processing via conventional milling at DeLamar or on a new heap-leach pad to be constructed on the west slope of Jacob's Gulch.

Lead.—Idaho ranked third nationally in lead production in 1992. Production dropped about one-third in quantity and almost 29% in value from that of 1991. Lead production was predominately from the Coeur d'Alene Mining District in Shoshone County, the location of the State's only primary lead mine.

Hecla's Lucky Friday Mine near Mullan, Shoshone County, was the State's leading lead producer. According to Hecla's 1992 annual report, the Lucky Friday Mine produced 19,350 metric tons of lead, 63,200 kilograms of silver, 3,820 metric tons of zinc, plus small amounts of copper and gold. In February, Hecla laid off 20 workers at the mine site, primarily owing to losses due to low metal prices. The unique Lucky Friday Underhand Longwall Method (LFUL) continued to be used at the mine, particularly in stopes on lower levels, along with a conventional crushing and grinding milling circuit. The LFUL system was designed to enhance safety and improve efficiency by employing more mechanized equipment, including rubber-tired vehicles, a ramp system, and cement sandfill.

Other mines reporting lead production included the Galena Mine, operated by Asarco, and Sunshine's Sunshine Mine. Both mines produced lead as a byproduct of silver.

Molybdenum.—Molybdenum production increased by more than 10% in quantity and more than 17% in value from that of 1991. As a result of continued low prices, a reflection of the depressed market worldwide for molybdenum, Cyprus Minerals Inc. laid off more than 100 workers, about one-third of the work force at its Thompson Creek open pit mine west of Challis. In November, the company announced its intentions to temporarily close the mine until molybdenum prices improved. Plans included retaining a small staff of employees to maintain the facility during shutdown. A number of the laid off employees were hoping to find work nearby at Hecla's Grouse Creek gold project, where the company may begin construction as early as 1993.

Silver.—Silver production dropped almost 25% in quantity and nearly 27% in value from that of 1991. The State ranked third in the Nation in 1992 silver production, after Alaska and Nevada.

Sunshine Precious Metals Inc., a subsidiary of Sunshine Mining Co., was the State's largest producer and the Nation's only vertically integrated silver mining company, operating a silver mine and refinery on Big Creek, Shoshone County, and a mint near Hayden Lake, Kootenai County. In December, Sunshine discontinued fabricating, minting, and marketing precious-metal bullion for retail sale. According to Sunshine's 1992 annual report, the mine produced 77,800 kilograms of silver, 395 metric tons of copper, and 370 metric tons of antimony. Underground exploration focused on the West Chance and Silverline areas of the property.

The Galena Mine was closed and placed on temporary care-and-maintenance status in July, primarily a result of low silver prices, according to Asarco's 1992 annual report. The report also stated that the mine produced 48,900 kilograms of contained silver before closing; minor amounts of copper and gold also were produced. Coeur d'Alene Mines acquired the assets to the Galena Mine when it merged, by stock transfer, with Callahan Mining Corp. in December 1991. The Coeur d'Alene Mines' share of production increased from 50% to 62.5% in June, a result of the company's acquisition of Hecla's 12.5% operating interest. The Shoshone County underground mine was operated by Asarco, which holds a 37.5% operating interest in the production. The mine utilized horizontal cut-and-fill mining and track haulage with battery-powered locomotives. The Galena produced both silver-copper and silver-lead concentrates.

The Coeur Mine, like the Galena, owned by Coeur d'Alene Mines and operated by Asarco, remained on temporary care-and-maintenance status after being closed in early 1991. With its acquisition of Callahan, Coeur d'Alene Mines obtained Callahan's 5% interest in the Coeur Mine and now owns a 50% operating interest in the property; Asarco holds the other 50% interest. Also with the Callahan merger, Coeur d'Alene Mines acquired the Caladay silver exploration project, an ore body immediately east and connected by a tunnel to the Galena Mine. Underground maintenance was being done by Asarco, who used the Caladay shaft for ventilation in the Galena Mine.

Other mines reporting silver production included Hecla's Lucky Friday lead mine in Shoshone County and its Yellow Pine gold mine, Valley County; MinVen's Stibnite gold mine, Valley County; Nerco's DeLamar gold mine, Owyhee County; Bema Gold's Champagne gold mine in Idaho County; and USAC's Yellowjacket gold mine, Custer County.

Vanadium.—Idaho's vanadium production increased by one-third in quantity and value increased 60% from that of 1991. Kerr-McGee Chemical Corp. operated a vanadium recovery plant at Soda Springs, Caribou County. The operation recovered vanadium from ferrophosphorus slag, a waste product generated by Monsanto's elemental phosphorous plant across the road from Kerr-McGee. The plant produced ammonium metavanadate, potassium vanadate, sodium vanadate, and vanadium pentoxide. These products were used to make industrial catalysts and specialty steel.

Zinc.—After dropping significantly in 1991, zinc production increased 24% in quantity and 37% in value. Production was reported as a byproduct from Hecla's Lucky Friday lead and silver mine. Mineral rights at the Bunker Hill Mine were purchased by Placer Mining Co., owned by Robert Hooper of Bellevue, WA. Some work was done during the year to partially restore air and electrical systems in the mine.

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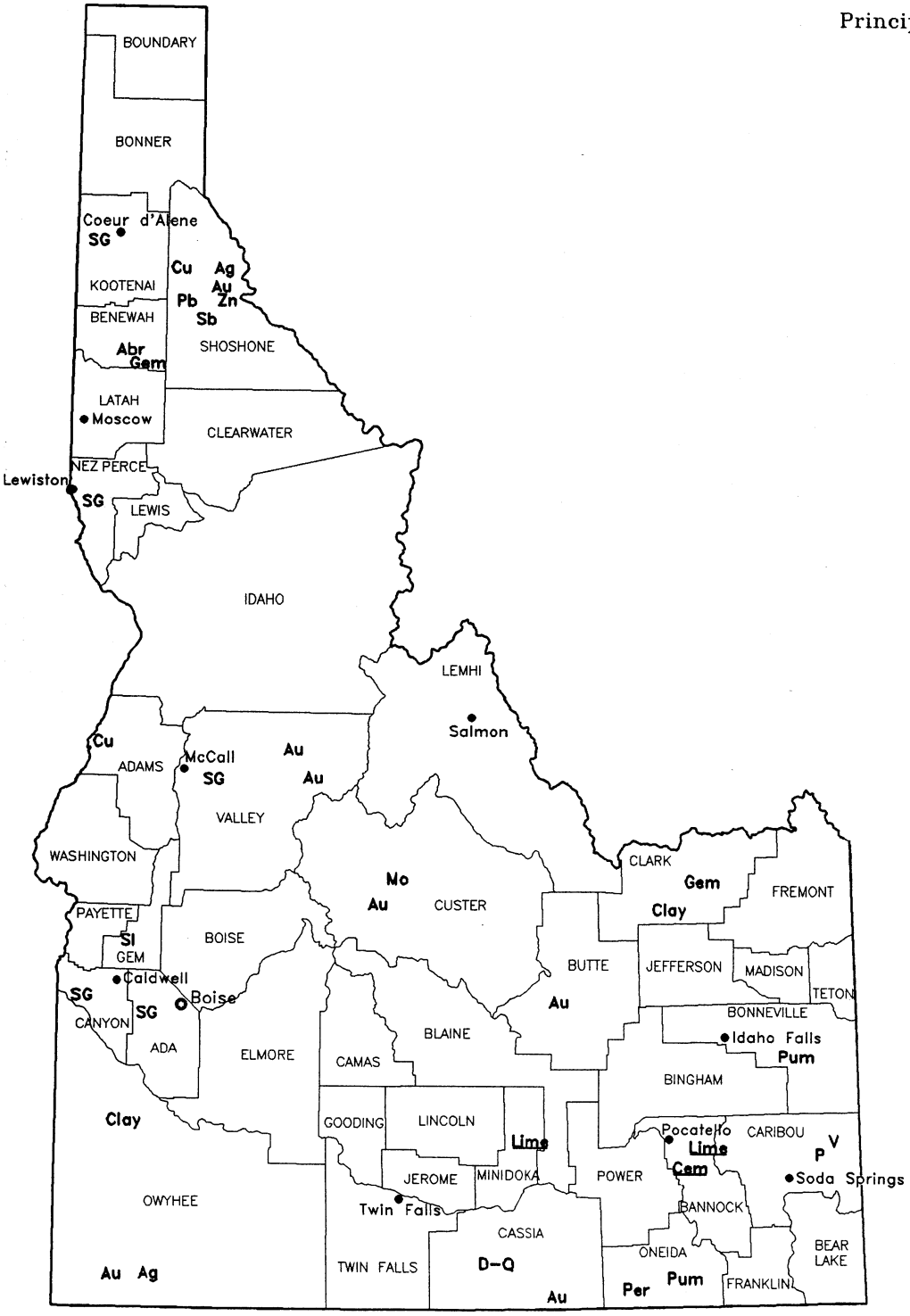
[1]State Mineral Officer, U.S. Bureau of Mines, Spokane, WA. He has 18 years of mineral-related experience in industry and government and has covered the mineral activities in Idaho since 1989. Assistance in preparation of the chapter was given by W. A. Lyons, editorial assistant.

[2]Research economic geologist, Idaho Geological Survey, Boise, ID.

IDAHO

Principal Mineral–Producing Localities



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Abr	Abrasives (natural)
Ag	Silver
Au	Gold
Cem	Cement plant
Clay	Clay
Cu	Copper
D–Q	Dimension Quartzite
Gem	Gemstones
Lime	Lime plant
Mo	Molybdenum
P	Phosphate rock
Pb	Lead
Per	Perlite
Pum	Pumice
Sb	Antimony
SG	Sand and Gravel
Sl	Silica
V	Vanadium
Zn	Zinc

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Antimony:			
Sunshine Precious Metals Inc.	815 Park Blvd. Suite 100 Boise, ID 83712	Mine, mill, plant	Shoshone.
Cement:			
Ash Grove Cement West Inc.	6720 SW Macadam Ave. Suite 300 Portland, OR 97219	Surface mine and plant	Bannock.
Clays:			
Applied Industrial Minerals Corp. (AIMCOR)	520 Blomquist Ave. Caldwell, ID 83605	Pit	Owyhee.
E.J. Wilson & Sons	HC 61 Box 1190 Dubois, ID 83423	Pit	Clark.
Mutual Materials Co.	Box 2009 Bellevue, WA 98009	Pit	Benewah.
Copper:			
ASARCO Incorporated	Box 440 Wallace, ID 83873	Mines and mills	Shoshone.
Sunshine Mining Co.	815 Park Blvd. Suite 100 Boise, ID 83712	Mine, mill, refinery	Do.
Garnet:			
Western Garnet Co.	Route 4, Box 190 Fernwood, ID 83830	Pits and plant	Benewah.
Gold:			
MinVen Gold Corp.	7596 West Jewell Ave. Suite 303 Lakewood, CO 80232	do.	Valley.
NERCO Minerals Co.	Box 52 Jordan Valley, OR 97910	Surface mine, mill, leach plant	Owyhee.
Pegasus Gold Inc.	North 9 Post Suite 400 Spokane, WA 99201	Surface mine and leach plant	Cassia.
Lead:			
Hecla Mining Co.	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	Mine and mill	Shoshone.
Lime:			
Amalgamated Sugar Co.	Box 1520 Ogden, UT 84402	Plants	Various.
Chemstar Lime Co.	Box 88 Bancroft, ID 83217	Mine and plant	Caribou.
Molybdenum:			
Cyprus Minerals Co.	7200 South Alton Way Englewood, CO 80110	Surface mine and mill	Custer.
Phosphate rock:			
FMC Corp.	Box 668 Soda Springs, ID 83276	do.	Caribou.
Monsanto Co.	Box 816 Soda Springs, ID 83276	do.	Do.
NuWest Industries Inc.	3010 Conda Rd. Soda Springs, ID 83276	do.	Do.

TABLE 3—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Phosphate rock—Continued:			
Rhône-Poulenc Basic Chemical Co.	Box 160 Montpelier, ID 83254	Surface mine	Caribou.
J. R. Simplot Co.	Box 912 Pocatello, ID 83204	Surface mine and plant	Bingham and Caribou.
Pumice:			
Amcor Inc.	Box 1411 Idaho Falls, ID 83401	Quarry and plant	Bonneville.
Hess Pumice Products	Box 209 Malad City, ID 83252	do.	Oneida.
Sand and gravel:			
Construction:			
Boise Paving and Asphalt Co.	5400 S. Apple St. Boise, ID 83705	Pit	Ada.
Bryan C. Rambo Crushing Co.	8301 Cherry Lane Nampa, ID 83651	Pit	Canyon.
Rock Contractors Inc.	Box 815 Meridian, ID 83642	Pits	Ada and Canyon.
Seubert Excavators Inc.	Box 57 Cottonwood, ID 83522	do.	Idaho and Valley.
Industrial:			
Unimin Corp.	258 Elm St. New Canaan, CT 06840	Pit	Gem.
Silver:			
ASARCO Incorporated	Box 440 Wallace, ID 83873	Mines and mills	Shoshone.
Hecla Mining Co.	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	Mine and mill	Do.
NERCO Minerals Co.	Box 52 Jordan Valley, OR 97910	Surface mine, mill, leach plant	Owyhee.
Sunshine Mining Co.	815 Park Blvd. Suite 100 Boise, ID 83712	Mine, mill, refinery	Shoshone.
Stone:			
Dimension:			
Idaho Travertine Corp.	3935 N. Yellowstone Hwy. Idaho Falls, ID 83401	Quarry, plant	Bonneville.
Northern Stone Supply Inc.	Box 249 Oakley, ID 83346	Quarry	Cassia.
Oakley Valley Stone Inc.	Box 28 Oakley, ID 83346	do.	Do.
Vanadium:			
Kerr-McGee Chemical Corp.	Box 478 Soda Springs, ID 83276	Plant	Caribou.
Zinc:			
Hecla Mining Co.	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	Mine and mill	Shoshone.

THE MINERAL INDUSTRY OF ILLINOIS

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the State Geological Survey, Illinois Department of Energy and Natural Resources, for collecting information on all nonfuel minerals.

By Steve W. Sikich[1] and John M. Masters[2]

The value of nonfuel mineral production in Illinois increased to a record high for the sixth consecutive year in 1992. The total value of $733.6 million was 9% greater than that of 1991. Crushed stone, the State's leading nonfuel mineral commodity, accounted for 44% of the value of all nonenergy minerals produced in the State, increasing 9.3% to a record high of $322.8 million. Other mineral commodities that were worth more in 1992 than in 1991 included portland cement, gemstones, construction sand and gravel, industrial sand, and several minerals for which data were withheld. Minerals that decreased in value included clays, fluorspar, and dimension stone. Illinois was the leading State in the Nation in both the quantity produced and the value of fluorspar, industrial sand, and tripoli. The State continued to rank 16th nationally in mineral production, accounting for 2.3% of total value of nonenergy minerals mined in 1992.

TRENDS AND DEVELOPMENTS

The 9% increase in the value of Illinois' mineral output mirrored a 9.9% increase in construction spending. Permits for building construction totaled $7.1 billion, which included $3.9 billion in new residential construction, including hotels; $1.3 billion in new nonresidential construction; and $1.8 billion in additions and alterations. Residential construction was 25.2% greater than that in 1991, but nonresidential construction decreased 7.6%. The increase in residential construction resulted from a combination of lower interest rates and increased confidence that the recession impacting the Nation might be ending. The major factors contributing to the decrease in nonresidential construction were a lack of confidence by industry that the recession had indeed ended and an oversupply of office space in metropolitan areas.

The Illinois Coal Development Board reported that by 1995 the State may lose more than one-third of its coal business, 23,000 jobs, $900 million in personal income, and $50 million per year in State tax revenues as a result of economic fallout from amendments to the Federal

TABLE 1
NONFUEL MINERAL PRODUCTION IN ILLINOIS[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland)	thousand short tons	2,842	$116,781	e2,654	e$108,814	2,860	$118,982
Clays	metric tons	2598,479	2$2,516	935,154	38,877	2535,282	2$2,362
Gemstones		NA	W	NA	547	NA	715
Sand and gravel:							
Construction	thousand short tons	r33,118	r$107,013	e26,300	e$90,400	35,695	123,720
Industrial	do.	4,486	62,531	4,146	57,210	4,410	56,741
Stone (crushed)[3]	do.	e62,700	e$283,100	68,586	295,362	e72,700	e$322,800
Combined value of barite, cement (masonry), clays [fuller's earth (1990, 1992)], copper (1990, 1992), fluorspar, lead (1990, 1992), lime, peat, silver (1990, 1992), stone [crushed sandstone (1990), crushed sandstone and limestone (1991-92), dimension], tripoli, zinc, and value indicated by symbol W		XX	95,478	XX	82,081	XX	108,252
Total		XX	r$667,419	XX	673,291	XX	733,572

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" data.

[3]Excludes certain stones; kind and value included with "Combined value" data.

Clean Air Act of 1990. The 182-page report bases its conclusions in part on a survey of 38 out-of-State utilities that consume more than two-thirds of Illinois' coal production. According to the report, 19 have opted to switch to low-sulfur coal while only 11 plan to invest in emission scrubbers that would allow them to continue burning Illinois coal.

Illinois was one of six States that formed the Midwest-Eastern States Coal Coalition, a new organization aimed at addressing coal-related concerns on a regional basis. The other States are Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia.

The continuing recession and a host of economic factors contributed to the continued decline of the iron foundry industry in 1992. Economic factors included downsized automobiles that use 40% to 50% less metal than they did 10 years ago, stricter environmental laws requiring huge expenditures for pollution control equipment, higher energy rates, and overseas competition.

In 1964, there were 5,482 foundries in the United States. The number decreased to 4,006 by 1986 and to only 3,402 at the beginning of 1992. In the six-county Chicago area, the number decreased from 291 in 1964 to 124 at the beginning of 1992. Additional closings of iron and steel production facilities in Illinois during 1992 included the John Deere foundry in Silvis, Rock Island County; Iowa Malleable Iron Co. in Galesburg, Knox County; Thomas Steel Corp. in Lemont, Will County; Laclede Steel Co.'s wire mill in Alton, Madison County; Komatsu Dresser Co. in Libertyville, Lake County; and U.S. Steel Co. in Chicago, Cook County.

In December, the U.S. Commerce Department, acting on claims submitted by National Steel Co. and other American steel companies, issued a preliminary finding of unfair trade practices by steel producers in 12 foreign countries. The department set preliminary duties as high as 90% on steel produced in those countries. A final ruling making the duties permanent was expected in April 1993. The ruling was expected to benefit the beleaguered domestic steel industry by reducing foreign imports. The United States imported $7.89 billion worth of steel in 1992, of which $3.18 billion fell into categories affected by the ruling. Officials of USX Corp., the Nation's largest steelmaker, indicated that orders for steel surged 50% in the fourth quarter of 1992, largely in anticipation of and/or as a result of the ruling. Several American steelmakers also announced price increases scheduled to take place in April 1993.

Despite plant closings and other problems impacting the Illinois iron and steel industry, there were some bright spots. Companies that announced new or expanded facilities included Granite Foundry Corp. in Augusta, Hancock County; Excelsior Foundry Co. in Belleville, St. Clair County; Materials Works Ltd. in Red Bud, Randolph County; and Gremp Steel Co. in Posen and Reynolds Metal Co. in McCook, both in Cook County.

EMPLOYMENT

The Mine Safety and Health Administration reported an average of 4,154 Illinois workers employed in the nonenergy mining industry in 1992. Of these, 152 worked in underground mines, 1,933 in surface mining operations, and 2,069 in preparation plants and mills. Comparable figures for 1991 were as follows: total workers 4,103, underground 152, surface 1,935, and preparation plants and mills 2,016. Although the total number of workers increased by only 1.2%, the value of mineral commodities mined increased by 9%. An additional 8,869 workers were employed in Illinois' coal mining industry in 1992. This represented a 7.3% decrease from the number employed in 1991, although coal production actually rose by 4.9% from 1991 to 1992. There were six mining-related fatal accidents in Illinois in 1992, two in sand and gravel operations, one each in underground coal and crushed stone operations, and one each in surface coal and crushed stone operations. In 1991, there were only two fatalities, both in underground coal mines.

ENVIRONMENTAL ISSUES

In November, the State accepted bids for reclamation work on five abandoned fluorspar mines in Pope and Hardin Counties. This is the final step in the Abandoned Mined Lands Reclamation Council's (AMLRC) ongoing efforts to eliminate the most hazardous mine openings in the two-county area. AMLRC will concentrate future noncoal reclamation efforts on the lead and zinc mining areas of northwestern Illinois. Federal production fees on active coal mines provide funding for the noncoal mine reclamation projects.

The U.S. Office of Surface Mining announced the first awards for outstanding mine reclamation for 1992. Two of the ten awards presented went to reclamation projects in Illinois. Gary Saam Construction Co. of Galena, Jo Daviess County, won an award for innovative reclamation by filling 3 abandoned shafts in Galena and 22 others along the bluffs of the Mississippi River south of Galena with polyurethane foam and capping them with colored reinforced concrete slabs. Illinois Excavators of Pinckneyville, Perry County, won an award for eliminating a source of acid-forming materials by consolidating the refuse and treating it with ground agricultural limestone. About 270 acres of barren land was revegetated, and the pit is being developed into a 32-acre wetland.

The Intermountain Field Operations Center (IFOC) of the U.S. Bureau of Mines, Denver, CO, completed a preliminary study of subsidence problems in the Jonesboro district of the Shawnee National Forest. This part of the forest had been mined extensively for tripoli, and many of the inactive underground mines have subsided. Information from the study is enabling the Forest Service to ensure public safety and to manage the resources of the area with greater efficiency and accuracy. IFOC is currently working with the U.S. Bureau of Mines Denver Research Center to develop geophysical tests that could lead to the development of faster and relatively

safe methods to evaluate undermined areas to determine if they are susceptible to surface subsidence.

The Occupational Safety and Health Administration (OSHA) ruled in May that three nonasbestiform minerals, actinolite, tremolite, and anthophyllite (AT&A), would no longer be treated as a form of asbestos. The decision came after 6 years of challenges from major mining associations. The challenges questioned the scientific basis for a 1986 OSHA ruling that redefined asbestos to include six nonasbestiform minerals, including AT&A. The ruling should have a positive effect on Illinois' construction aggregate producers and producers of several other mineral commodities. Nationally, the National Stone Association estimated that the ruling will save aggregate producers in excess of $7 million annually as a result of the elimination of sampling, monitoring, labeling, and other control measures that would have been required under the asbestos regulations.

The Illinois Environmental Protection Agency (IEPA) cited 41 companies for failing to meet a September 1 deadline for filing toxic air emissions reports. The reports are used to develop toxic chemical release inventories. None of the companies cited were accused of illegally releasing toxic chemicals.

Officials from the Illinois Department of Public Health and IEPA continued their investigation of potentially hazardous contaminants found near the abandoned New Jersey Zinc Co. and Mobil Mining Corp. operations in De Pue, Bureau County. Higher-than-normal concentrations of cadmium were found in random soil samples collected in the area in March. Additional soil sampling and dust and paint sampling from homes near the sites were conducted in December to determine if a long-term health hazard exists.

In January, the Du Page County Board purchased the Elmhurst-Chicago stone quarry for $39.9 million for use as a stormwater reservoir. In March, a $2.1 million contract was awarded to a Missouri engineering firm to design the improvements needed to prepare the quarry to accept water for flood control. The design study was expected to be completed by yearend with the quarry becoming operational as a flood basin in 1993. In October, the board halted blasting designed to increase the quarry's water storage capacity after nearby property owners complained that the blasting was damaging foundations in their homes and depositing debris on their properties. The board also approved a $34,000 contract to assess reported property damage and to examine ways to reduce negative effects of the blasting.

Little, if any, progress was made by the Chicago Metropolitan Water Reclamation District in its plans to incorporate parts of the Material Service Co.'s Thornton Quarry and Vulcan Materials McCook Quarry in its flood control system.

The Illinois State Geological Survey (ISGS) provided geologic and hydrogeologic data in support of dewatering and cleaning up freight tunnels and basements flooded by the Chicago River. The flooding occurred on April 13 when the river burst through a 20-foot hole in the tunnel wall beneath the Board of Trade, Merchandise Mart in downtown Chicago.

Recontec Inc. brought its industrial waste recycling facility in Newman, Edgar County, on-line for a 6-month test period in late December. The demonstration period should show the company whether its process will be a profitable method of extracting zinc and other reusable minerals from industrial wastes. Recontec will use 750 tons of zinc-laden industrial waste slurry from Kentucky. The process will first treat the slurry with sodium carbonate to remove chlorides and recover calcium sulfate (gypsum) and sodium chloride (salt), which will be available for resale. The remaining zinc filter cake will be digested in sodium hydroxide to dissolve the zinc and lead, but leave copper, silicates, calcium, precious metals, and iron. The zinc and lead would be recovered from solution by electrowinning. After this circuit is working successfully, a second circuit will be set up to recover the remaining minerals.

EXPLORATION ACTIVITIES

Geologists with ISGS, the U.S. Geological Survey, and other State geologic surveys completed an extensive 5-year geologic study of southern Illinois and parts of adjacent Missouri, Kentucky, and Indiana. Information from 75 maps, 500,000 feet of core samples, oil well logs, and measuring instruments was incorporated in the resulting computerized map that covers 7,500 square miles. More than 5,000 square miles lie in Illinois and cover 17 counties. The object of the study was to boost economic development and lessen the risk factors involved in mineral exploration in the area. Minerals with potential for economic mineral development in the area include barite, coal, dolomite, fluorspar, lead, limestone, oil and gas, construction sand and gravel, industrial sand, tripoli (microcrystalline silica), and zinc.

One request for a prospecting permit for fluorspar in the Shawnee National Forest was filed with the U.S. Bureau of Land Management. At yearend, the U.S. Forest Service was conducting an analysis to determine extent of surface disturbances that the prospecting might cause.

LEGISLATION AND GOVERNMENT PROGRAMS

Four acts affecting the minerals industry in Illinois were enacted in 1992. Senate bill 326 (Public Act 87-0830), approved in January, amended the Oil and Gas Act and created a six-member Oil and Gas Board in the Department of Mines and Minerals. The board oversees regulations pertaining to the drilling, converting, and deepening of oil wells and to the extraction of oil and gas. Senate bill 1716 (Public Act 87-0886), approved in July, amended the Natural Resources Act to give the Department of Energy and Natural Resources the power to participate in Federal geologic mapping programs. Senate bill 2056 (Public Act 87-1011), approved in September, amended the Mines Inspection Act to make it gender neutral, allowing women

to work in underground mines. A provision to allow the storage of a 48-hour supply of explosives underground was removed from the original bill by amendment. A bill with similar provisions, H.R. 2057, was vetoed by the Governor in December. House bill 3773 (Public Act 87-0976), approved in September, amended the Abandoned Mined Lands and Water Reclamation Act to make additional land eligible for reclamation under the act.

Several counties were considering developing reclamation standards under their zoning powers. Mining operations that have less than 10 feet of overburden and disturb less than 10 new acres each year are exempt from State regulation. Local legislation, if passed, could affect several hundred currently unregulated operations, mostly construction aggregate producers.

The ISGS, a division of the Department of Energy and Natural Resources, was established in 1905 to study and report on the State's geology and mineral resources. Its programs of research and service include Mineral Resources and Minerals Engineering, Environmental Geology and Geochemistry, and General and Basic Research.

ISGS completed a study of earthquake-induced landslides along a segment of the bluffs of the Ohio and Mississippi Rivers from Olmsted, Pulaski County, to Chester, Randolph County. A total of 221 landslides was recognized and classified into three major types: rock/debris falls (11% of landslides), block slides (25%), and rotational/translational slides (64%). Stability analyses of three representative landslides indicated that they would have occurred only during an earthquake, but could be initiated by earthquake loadings similar to those generated by the New Madrid earthquakes of 1811-12.

ISGS focused on two major issues in its coal research as follows: first, to identify and evaluate remaining minable coal resources, and second, to help protect and create markets for Illinois' coal in the face of increasing competition and mounting environmental controls. ISGS identified 180 billion tons of coal resources, while noting that only 50 billion tons has high potential for development. Of the 10 billion tons identified as relatively low-sulfur coal, only 3.7 billion tons has a high potential for development. To help productivity in coal mines, a key factor in economic competitiveness, the ISGS is working with the U.S. Bureau of Mines (USBM), the University of Illinois, Southern Illinois University, and Northern Illinois University to find ways to maximize coal production from longwall and high-extraction retreat mining. ISGS is also researching methods to utilize high-sulfur coal and still meet the regulations of the Clean Air Act that go into effect in 1995 and 2000. Another project involving the blast furnace injection method of steel production may lead to new markets for Illinois coal. Oil and gas research was focused on methods to get better recovery from existing fields. Historically, the recovery rate from the State's existing fields has been only 35%, leaving 5.9 billion barrels in the ground. Recent studies in the King Field identified 1 to 2 million barrels of oil, producible by a combination of water flooding and strategic-reservoir management techniques.

The IFOC continued work on a mineral appraisal of the Shawnee National Forest at the request of the U.S. Forest Service. IFOC also conducted a mineral resource investigation of the Chicago-Region Supplemental Airport, Lake Calumet Site in northeastern Illinois. A report on the investigation is expected by mid-1993.

The U.S. Minerals Management Service reported receiving royalties totaling more than $55,000 from minerals mined from properties leased from the Federal Government. All of the leases were in the Shawnee National Forest. The total included $35,964 from the production of 34,959 tons of fluorspar with a sales value of $719,288. Royalties from barite and zinc recovered as byproducts of the fluorspar were $2,380 from 5,956 tons of barite with a sales value of $47,604 and $16,670 from 900 tons of zinc with a sales value of $333,394.

FUELS

Twenty-one companies produced 60.3 million short tons of bituminous coal from 39 mines in 17 of Illinois' 102 counties. Underground mines accounted for 47.5 million tons or 78.7% of the total production, while surface mines accounted for 12.8 million tons. Total production increased 0.5% from 60 million tons in 1991; however, while underground production increased 7.6%, production from surface mines fell 19.2% from 15.9 million tons produced in 1991. Surface mining has declined steadily since peaking in 1969 and accounted for only 21.3% (down from 30.2% in 1990) of the coal mined in 1992. Conversely, longwall mining has continued to grow rapidly, accounting for 29% (up from 22.3% in 1990) of the underground coal mined.

Much of the reduction in surface mining resulted from the closure of two mines and reduction in production of a third mine in the Belleville area by Peabody Coal Co.

Peabody announced in February that it would close two mines and reduce production at a third mine in the Belleville area because of a combination of depleted reserves and loss of the mines' principal market. Mining at the River King No. 6 Mine at Marissa, St. Clair County, closed in mid-August. The three mines have been supplying between 2.5 and 2.6 million metric tons annually to the Associated Electric Cooperative Inc. (AEC) powerplant in New Madrid, MO. AEC announced in 1992 that it would switch from the high-sulfur Illinois coal to low-sulfur Wyoming coal to fulfill sulfur dioxide limitations required by the Clean Air Act Amendments. Peabody estimated that 350 miners will permanently lose their jobs by the January 1, 1995, deadline for completing the switch to low-sulfur coal.

Plans to close Peabody's No. 10 underground mine at Pawnee, Sangamon County, won a reprieve in December when the company was granted a 19-month extension on its long-term sales contract that was scheduled to expire on

December 31, 1992. Approximately 385 workers who had been laid off in October in anticipation of the shutdown were recalled on December 28. Franklin, Perry, Randolph, and Saline Counties accounted for 53.1% of the coal that was produced in 17 counties in 1992.

Of historical interest, the world's largest electric coal-stripping shovel, which was extensively damaged by fire in September 1991, was sold for salvage in April. The shovel was placed in service in 1967 by Arch of Illinois Inc. at its Captain Mine near Conant, Perry County.

Estimated crude oil production increased 1.8% from 19.1 million barrels in 1991 to 19.4 million barrels in 1992. However, the attendant value of the crude decreased 2.9% from $384.9 million in 1991 to $373.9 million in 1992. Estimated natural gas production decreased 25.8% in volume and 26.5% in value from 466 billion cubic feet valued at $1.01 million to 343 billion cubic feet valued at $743,000 in 1992.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Industrial minerals accounted for almost 99% of the value of all nonenergy mineral production in Illinois. The value of industrial minerals produced increased by $58.8 million (8.8%) over the value produced in 1991.

Cement.—Illinois ranked 8th in quantity and 10th in value with respect to the 39 States producing portland cement. Production increased 7.8% from 2.67 million short tons in 1991 to 2.86 million tons in 1992. The associated value increased 9.3% from $108.8 million in 1991 to $119.98 million. Four plants with a combined finished-production capacity of 2.75 million short tons operated at full capacity utilization during the year. All of the plants used the dry process to produce cement. Cement was manufactured by Dixon-Marquette Cement Inc. at Plainfield, Lee County; Illinois Cement Co., a subsidiary of Centex Cement Enterprises Inc. at La Salle, and Lone Star Industries Inc. at Oglesby, both in La Salle County; and Missouri Portland Cement Co. at Joppa, Massac County. Only one of the four companies produced masonry cement in 1992, and masonry cement production remained comparatively unimportant as the State ranked last of 36 States producing masonry cement.

Clays.—Nationally, Illinois ranked 8th in value and 15th in quantity of total clay produced. Clay production was reported from only 5 of the State's 102 counties. Livingston and Pulaski Counties accounted for almost 83% of the total volume and almost 95% of value of clay produced.

Common Clay.—Common clay production increased 4.1%, from 514,139 metric tons in 1991 to 535,282 tons in 1992. However, the associated value decreased 3.2% from $2.44 million to $2.36 million, marking the fourth time in 5 years that the value of common clay declined. The average value of common clay produced in Illinois was $4.41 per ton, well below the national average of $5.20 per ton. Common clay was produced by six companies in four counties. Major uses included the manufacture of common brick, cement, and drain tile. Illinois ranked 13th nationally out of 36 States in the production of common clay used to manufacture bricks. Common clay production was reported by Richards Brick Co. in New Douglas, Bond County, and in Edwardsville, Madison County; Eastern Illinois Clay Co. in St. Anne, Kankakee County; Lone Star Industries Inc. in Oglesby; Illinois Cement Co. in La Salle; Valley View Industries Inc. in Cornell, Livingston County; and Streator Brick Systems Inc. in Livingston County.

Fuller's Earth.—The production data for fuller's earth were withheld in 1992 because production was reported by only one company, Golden Cat Corp. at Olmsted, Pulaski County. Eleven States produced fuller's earth in 1992; Illinois continued to rank third in the quantity and fourth in the value produced. Pet waste absorbents accounted for the end use of almost 75% of the fuller's earth mined in Illinois. Other end uses included oil and gas absorbents and as an ingredient in animal feed and fertilizer. American Colloid Co. (ACC), headquartered in Arlington Heights, Cook County, purchased Golden Cat's fuller's earth operations in Paris, TN, in November. Although ACC's fuller's earth operation in Mounds, Pulaski County, was active in 1992, the company did not report production data to the USBM. The Pulaski County facility was operated by ACC's wholly owned subsidiary, Absorbant Clay Products Inc. ACC also purchased a foundry clay and coal blending operation in Chattanooga, TN, from Porter Warner Industries.

Fluorspar.—Illinois was the only State reporting fluorspar production in 1992. Fluorspar production and its attendant value declined again in 1992. The decline continued to result from a combination of increased competition from foreign imports, especially Chinese, and a decrease in the use of chlorofluorocarbons because of environmental concerns.

Ozark-Mahoning Co. (O-M), the only company mining fluorspar, completed a $500,000 upgrading of its processing plant in Rosiclare. O-M's parent company, Alf Autochem North America Inc., continued research on a chlorine-free freon substitute using fluorspar (CaF_2) as the prime ingredient. O-M operated three underground fluorspar mines in Hardin County, the No. 1 Mine in the Cave-in-Rock district and the Annabel Lee and Denton Mines in the Harris Creek District. About 35% to 40% of the No. 1 Mine's production is from land in the Shawnee National Forest leased from the U.S. Forest Service.

The Hardin County Fluorspar Museum began a fundraising drive to finance the repair and renovation of its facility in Rosiclare. A major donation from Elf Autochem, parent of the Ozark-Mahoning Co., formed the basis for the drive.

TABLE 2

ILLINOIS: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	9,056	$27,834	$3.07
Plaster and gunite sands	231	765	3.31
Concrete products (blocks, brick, pipe, decorative, etc.)	899	3,236	3.60
Asphaltic concrete aggregates and other bituminous mixtures	1,946	6,631	3.41
Road base and coverings[1]	6,174	29,159	4.72
Fill	3,920	11,375	2.90
Snow and ice control	46	185	4.02
Railroad ballast	106	534	5.04
Other miscellaneous uses[2]	33	187	5.67
Unspecified:[3]			
Actual	11,116	37,489	3.37
Estimated	2,169	6,325	2.92
Total	[4]35,695	123,720	3.47
Total[5 6]	32,382	123,720	3.82

[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

Lime.—Illinois continued to rank seventh in both the quantity and value of lime produced in 1992. Lime was manufactured in 33 States. Companies producing lime were Vulcan Materials Co. in McCook and Marblehead Lime Co., a subsidiary of General Dynamics Corp., with plants at Thornton and South Chicago, all in Cook County. Marblehead, which also has plants in Indiana and Michigan, was the third largest lime producer in the Nation in 1992.

Production data for lime production in Illinois are grouped with Indiana and Missouri to conceal proprietary company data. Missouri ranked 1st nationally, and Indiana ranked 11th in lime production in 1992. The three States produced 3.5 million short tons of lime valued at $174.6 million. The quantity produced was 0.8% more than that produced in 1991, and the value increased by 2.9%. Illinois' increases for the same period were 8.4% and 6.2%, respectively.

Mississippi Lime, Alton, acquired Virginia Lime Co. in Ripplemead, VA, from Scottish Heritable Inc. and renamed it the Eastern Ridge Lime Co. LP. After the acquisition, Mississippi Lime announced the formation of a new company, North American Management Co., to manage and service its operations in Illinois, Missouri, and Virginia. The Illinois operations include the Bluff City Minerals Co. LP (formerly Mississippi Lime-Alton Mine) and a proposed lime plant to be built by Prairie du Rocher Lime Co. LP in Randolph County.

Peat.—Peat was produced in 20 States in 1992. Illinois ranked fifth in the quantity mined and fourth in sales value. Reported peat production in Illinois increased more than 40% in volume and 34% in value over that reported in 1991. Peat was produced in Lake County by Dahl Enterprises Inc. and Roots Peat Farm and in Whiteside County by Hyponex Corp. and Markman Peat Co. Almost all of the peat produced in Illinois was used for general soil improvement, with very minor amounts used by nurseries and for earthworm cultivation. More than 80% of the peat harvested was of the reed-sedge variety. Other varieties produced included humus, hypnum moss, and sphagnum moss.

Sand and Gravel.—Construction.—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Illinois construction sand and gravel statistics are compiled by geographical districts as depicted in the State map. These data are summarized by major use category in table 2 and by use and district in table 3.

Illinois continued to rank seventh nationally in both the quantity and the value of construction sand and gravel produced. All 50 States reported construction sand and gravel production. Both the quantity of construction sand and gravel produced and its attendant value increased dramatically in 1992. Production increased 35.7% from 26.3 million short tons in 1991 to 35.7 million tons in 1992. The value showed a corresponding increase of 36.9% from $90.4 million to $123.7 million. Construction sand and gravel production was by 113 companies from 153 pits in 54 of the State's 102 counties.

Two of the largest construction-sand-and-gravel-producing companies in the Nation were headquartered in Illinois. Material Service Corp. of Chicago ranked 17th with three operations, all in Illinois, and Meyer Material Co. of Des Plaines ranked 18th with nine operations, five in Illinois. Rounding out the top 10 producing companies in Illinois were Vulcan Materials Co., 6 pits; Thelen Sand & Gravel Inc., 1 pit; R. A. Cullinan and Sons Inc., 4 pits; Elmhurst-Chicago Stone Co., 2 pits; Road Materials Corp., 5 pits; Bluff City Material Co., 2 pits; Feltes Sand & Gravel Co. Inc., 2 pits; and Galena Road

TABLE 3

ILLINOIS: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	4,008	14,082	1,571	4,033	2,682	7,450	795	2,268
Plaster and gunite sands	W	W	W	W	149	490	—	—
Concrete products (blocks, brick, etc.)	647	2,375	66	203	118	438	68	220
Asphaltic concrete aggregates and other bituminous mixtures	1,152	4,138	W	W	606	1,903	W	W
Road base and coverings[1]	4,491	22,505	377	1,390	1,155	4,737	151	527
Fill	2,377	7,360	481	1,106	838	2,299	224	610
Snow and ice control	20	86	W	W	20	75	W	W
Railroad ballast	W	W	W	W	W	W	—	—
Other miscellaneous uses[2]	155	634	169	614	31	212	62	151
Unspecified:[3]								
Actual	8,953	30,175	1,209	4,410	384	1,306	570	1,599
Estimated	604	1,741	92	297	842	2,419	631	1,868
Total[4]	22,406	83,095	3,966	12,053	6,823	21,330	2,501	7,242
Total[5 6]	20,326	83,095	3,598	12,053	6,190	21,330	2,269	7,242

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

Gravel Co., 1 pit. The leading counties, in order of quantity produced, were McHenry (15 pits), Kane (10 pits), Lake (5 pits), Du Page (2 pits), Cook (5 pits), Tazewell (5 pits), Grundy (3 pits), Woodford (6 pits), and Peoria (4 pits). Table 2 shows the disposition of construction sand and gravel sold or used in Illinois in 1992.

Vulcan Materials Co., Birmingham, AL, reported that property additions in 1992 totaled $44 million. Included in the acquisitions were two aggregate operations in Will County, the Bolingbrook and Plainfield construction sand and gravel facilities owned by Avery Gravel Co.

Industrial.—Illinois continued to rank first nationally in both the quantity and the value of industrial sand mined in 1992. Although the quantity of industrial sand produced in Illinois in 1992 increased by 6.4%, its value decreased by 0.8% from that of 1991. Correspondingly, the unit value of industrial sand decreased from $13.80 in 1991 to $12.87 in 1992. The majority of industrial sand was used for glass containers, molding and core facing, flat glass, hydraulic frac sand, and chemicals.

Unimin Corp., U.S. Silica Co., Manley Brothers, and Fairmont Minerals Ltd. mined high-purity silica sand from the Ordovician age St. Peter sandstone in La Salle County. Unimin also had an operation in Ogle County. Manito Investment Co. mined a Quaternary age quartz-feldspar dune sand in Mason County for the foundry sand and amber-colored glass market.

Ball Corp. purchased the assets of Kerr Glass Manufacturing Corp., which manufactures glass containers mainly for the food processing industry. Included in the purchase was the Kerr manufacturing facility in Plainfield, Will County.

Stone.—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—Crushed stone accounted for an estimated 44% of the total value of all nonenergy mineral commodities produced in Illinois in 1992. Estimated crushed stone production in 1992 increased 6% in quantity and 9.3% in value over the figures reported for 1991. Nationally, Illinois continued to rank second in both the quantity quarried and in the value of crushed stone production, which was reported by 49 of the 50 States.

The value of crushed stone produced increased from $295.4 million in 1991 to $322.8 million in 1992. This increase in the estimated value of crushed stone produced accounted for 45.5% of the

total increase of the value of nonenergy minerals produced in Illinois.

One of the important uses of crushed stone in Illinois is agricultural limestone, which is often produced from the fines generated when limestone is crushed for aggregate. About 1 million tons of nitrogen fertilizers is applied to Illinois croplands each year. Four pounds of limestone is needed to counteract the acidifying effect of each pound of nitrogen. The resulting 4 million tons of agricultural limestone used in Illinois each year is supplied by 119 quarries in Illinois and 24 quarries in neighboring States. However, the neutralizing effect of limestone varies from quarry to quarry because of differences in limestone purity and fineness of grinding. The Illinois Department of Agriculture tests the agricultural limestone from all 143 quarries each year to determine the calcium carbonate equivalent rating and particle size. Farmers can use this information to ensure that the correct amount of limestone to achieve the desired neutralizing effect is applied and to determine the most economical source of the limestone.

Dimension.—Dimension stone was a minor contributor to the State's mineral production. Illinois ranked last in both quantity and value when compared with the 35 States producing dimension stone. The State's only producer, Rein, Schultz & Dahl Inc., finished quarry-run dolomite for veneer and flagstone at its Fox River crushed stone quarry, near South Elgin, Kane County.

Tripoli.—Illinois produced more than 70% of the tripoli mined in the United States in 1992. Tripoli was mined in only four States. Unimin Specialty Minerals Inc., Illinois' sole tripoli producer, produced crude and finished material at its Elco and Tamms plants in Alexander County. Nationally, approximately 85% of the tripoli produced is used for fillers and extenders, in sharp contrast to just 15 years earlier when more than 60% of the tripoli was mined for abrasives.

Other Industrial Minerals.—Two other industrial minerals, barite and gemstones, were produced as a result of mining operations in 1992. Several other industrial mineral commodities were manufactured from minerals shipped in from other States or imported.

Barite was produced by Ozark-Mahoning as a byproduct of fluorspar mining in 1992. Although both the quantity of barite produced and its corresponding value increased by more than 50%, Illinois ranked last among the five States that reported barite production. Approximately 80% of the barite produced was used as a filler or extender in paint with the remaining 20% being used in other filler applications.

Illinois' national ranking in gemstone production improved to 15th from 16th in 1991 as the result of a 30.7% increase in the reported value. All 50 States reported gemstone production in 1992. Gemstone materials found in Illinois included a variety of mineral specimens such as calcite, chalcopyrite, dolomite, fluorite, galena, and sphalerite. Fossil specimens and geodes were also collected for sale as gemstones.

Gypsum was recovered from a 220-acre site formerly owned by Alcoa Aluminum Corp. in East St. Louis, St. Clair County, by River Resources Inc. of Chesterfield, MO. At yearend, a dispute between the city of East St. Louis, which reportedly was receiving royalties on the sale of the gypsum, and the owners of the property remained unresolved. The property, which was owned by the city when the lease was negotiated in 1989, was awarded to the current owners in partial settlement of a $3.5 million suit against the city in 1990.

In the production of calcined gypsum, Illinois ranked 25th in volume and 24th in its associated value among the 28 States reporting the manufacture of calcined gypsum. Production increased by almost 10% from 1991 to 1992.

Gypsum wallboard prices that hit a 14-year low of $68 per thousand square feet early in 1992 rebounded to $73 by yearend and were expected to continue rising during 1993 as new building construction continued to increase. As a result of the firming prices, Chicago-based USG Corp. reported operations were running at 93% of capacity at yearend.

National Gypsum Co. produced calcined gypsum from gypsum mined in Michigan at its wallboard plant at Waukegan in Lake County.

Crude iodine was processed into inorganic iodine chemicals by Allied Signal Corp. at Metropolis, Massac County, and by West Argo Inc. at Des Plaines in Cook County. Organic iodine chemicals were manufactured by Echolab Inc. at Joliet, Will County.

Illinois continued to rank second nationally in the value of finished iron oxide pigments produced. Illinois producers of iron oxide pigments included AST Co. in Granite City, Madison County; George B. Smith Color Co. in Kirkland, De Kalb County; Harcros Pigments Inc. in East St. Louis, St. Clair County; Prince Manufacturing Co. in Quincy, Adams County; and Solomon Grind-Chem Service Inc. in Springfield, Sangamon County. Types of natural iron oxide pigments produced included black (magnetite), brown iron oxide, red iron oxide (including pyrite and cinder), and yellow iron oxide. Black, brown, red, and yellow synthetic iron oxides were also produced.

Illinois ranked second nationally in the value of expanded perlite sold or used in 1992 although it was fifth in the quantity processed. Perlite was expanded by three companies as follows: Manville Products Corp., which was acquired by Schuller International Corp. in 1992, in Will County; Illinois Strong-Lite Products Corp. in La Salle County; and Silbrico Corp. in Cook County.

A grant from the Illinois Community Development Assistance Program allowed the city of Tuscola, Douglas County, to purchase and upgrade the Douglas Water Co. Upgrade of the water system will ensure Cab-O-Sil, a division of the Cabot Corp., the potable and industrial water it required to remain in operation. Cab-O-Sil produces fumed silica for use as reinforcing, thickening, suspending, and anticaking agents in a wide variety of products.

Illinois ranked fifth in the quantity of iron and steel slag but dropped to eighth in the value sold or used in 1992. Iron and steel slag production was reported from 28 States. It was used primarily as road base, fill, and aggregate. The slag was processed and distributed in Illinois by the following companies—Heckett Co. Div. of Harsco Corp. from plants at Riverdale and Chicago in Cook County and at Sterling in Whiteside County; by International Mill Service Co. at Alton, Chicago, and Granite City; by Standard Lafarge Co. at Granite City; and by Warner Co. at Pana in Christian County.

Elemental sulfur was recovered from oil refinery operations by Marathon Oil Co. at Robinson in Crawford County, Shell Oil Co. at Hartford in Madison County, Unocal Corp. at Schaumburg in Cook County, and Mobil Oil Corp. at Joliet. Illinois continued to rank seventh in both quantity and value of elemental sulfur recovered when compared with the 28 States that reported sulfur recovery. Teepak Inc. produced synthetic sodium sulfate as a byproduct in its cellulose manufacturing process at Danville, Vermilion County.

Illinois ranked third in quantity and fifth in the value of expanded vermiculite sold or used in 1992. Vermiculite was exfoliated in 20 States for use in insulation, aggregates, horticulture and soil conditioners, and fireproofing. Illinois manufacturers included W. R. Grace & Co. at West Chicago, Du Page County; Strong-Lite Products Corp. at Seneca, La Salle County; and Thermic Refractories Co. at Girard, Macoupin County. Crosfield Chemicals started production of detergent-grade synthetic zeolites at its new plant in Joliet. The plant produced a 4A-grade zeolite product intended to replace phosphorus in detergents.

Several other industrial minerals were processed to manufacture higher value end products in Illinois. Olin Corp. purified wet-process phosphoric acid to produce sodium phosphates at its Joliet plant. Motorola Inc., Chicago, was one of five domestic companies that produced quartz crystal in 1992. More than 2 million short tons of salt was distributed and used in Illinois in 1992. Major uses included ice control, agricultural uses, food additives, and water conditioners.

Metals

Illinois was a minor producer of metals with all of its metal production derived as byproducts of fluorspar beneficiation. The State was, however, a leader in the production of iron and steel from iron ore shipped in from other States or imported and from recycled iron and steel. Illinois was also an important producer of primary aluminum. The processing of metals shipped into the State to manufacture higher value end products also made a significant contribution to Illinois' overall economy.

Copper, Lead, Silver, and Zinc.—Copper, lead, silver, and zinc were produced as byproducts of Ozark-Mahoning's fluorspar mining operations in 1992. The USBM did not report data on metal production in 1991, but reported metal recovery in 1992 was significantly greater than that reported in 1990.

Big River Zinc Co. operated a primary electrolytic zinc refinery producing zinc metal, zinc alloys, zinc powders, zinc sulfate monohydrate, and zinc oxide. In 1991, 89,549 tons of zinc production was reported.[3] The plant also produced 139,549 tons of commercial-grade electrolytic sulfuric acid and 2 million pounds of cadmium. The company also recovered cadmium as a byproduct of smelting zinc concentrates.

Iron and Steel.—Illinois continued to rank in the top five States nationally in the production of raw steel. Although the steel market appeared to be gaining momentum during the fourth quarter, major developments related to the Illinois iron and steel industry in 1992 tended to be negative.

Acme Steel Co. changed its name to Acme Metals Inc. to reflect a corporate restructuring under which the company's manufacturing units will no longer report to the steelmaking unit. Acme was created by a 1986 spinoff from Interlake Corp. The restructuring will not affect Acme's basic strategy of making steel for niche customers, including its own manufacturing business. Acme produces steel, steel strapping and strapping tools, welded steel pipe and tube, and automotive jacks. Acme announced in September that it would trim its salaried work force by 10% by yearend. A majority of the 70 people affected worked at the Riverdale plant. Approximately one-half of the affected workers accepted a voluntary early retirement offer. At yearend, Acme announced that it was proceeding with a feasibility study of options for installing a thin slab caster/hot-strip mill at its Riverdale facility. The installation under study would replace the existing ingot pouring, ingot rolling, and narrow hot-strip mill facilities. The proposed installation could cost as much as $200 million. It would be fed with steel produced in Acme's basic oxygen furnace also in Riverdale. A decision was expected in early 1993.

General Motors (GM) Powertrain foundry in Tilton, Vermillion County, remained for sale at yearend. Negotiations between GM and one of the world's foremost independent foundry operators, Intermet Corp. of Atlanta, GA, were broken off on November 12. An investment group from Fort Wayne, IN, expressed a desire to acquire the facility if certain concessions were given by GM and a long-term agreement could be reached with the United Auto Workers union. The group offered its proposals to GM at a meeting in December, but as of yearend GM had not responded to the proposals.

Laclede Steel Co. reported losses of $7.5 million in 1992, a slight improvement over the $8.3 million loss reported in 1991. Company officials attributed much of the loss to special charges related to relocating the company's wiremaking operations and to the construction of a recovery plant to process hazardous dust. Laclede announced that it would close its wire mill at Alton sometime in 1993 when expansion of its Hammond, IN, facility was completed. Approximately 100 union steelworkers at Alton are expected to lose their jobs when production is

transferred to the plant in Hammond, which is closer to the company's major markets and has a lower salaried, nonunion work force. Laclede's minimill, which employs more than 1,200 people in Alton, will not be affected by the closing.

National Steel Corp. announced plans to reduce its salaried work force and to shut down the cold-roll finishing units at the Granite City steel plant. The reduction of salaried personnel was part of efforts to cut expenses and consolidate staff by moving its headquarters from Pittsburgh, PA, to Mishawaka, IN. An undetermined number of Granite City employees were scheduled to be transferred to Mishawaka over the next 2 years.

Shareholders of Northwestern Steel and Wire Co. (NWS), based in Sterling, Whiteside County, approved a recapitalization transaction with Kohlberg and Co., a New York investment firm. Kohlberg will invest $45 million for improvements needed to improve NWS's competitiveness.

Fire destroyed the St. Anne Foundry plant in Kankakee, Kankakee County, in April. At yearend, the company's owner indicated that the foundry would be rebuilt in 1993, but reconstruction had not yet started. The Thomas Steel Corp., a Lemont minimill, declared bankruptcy in June and was offered for sale in September. The company continued to operate below capacity but near the break-even point.

USX Corp. discontinued production in February and closed its southeast Chicago South Works steel mill in April. A total of 690 employees was terminated as a result of the shutdown. The integrated mill, which was built in 1880 to supply railroad companies with steel rails, employed more than 22,000 during World War II. Competition and shrinking structural steel markets forced the operation out of business. USX officials indicated that it would have taken a huge capital investment to make the facility competitive with other structural steelmakers.

The Chicago South Works comprised a dozen product mills spread over 650 acres along the Lake Michigan shoreline. At yearend USX was negotiating with a minimill operator who is considering purchasing part of the facility for the manufacture of stainless steel. Civic leaders also feel the site has excellent potential for redeveloping the area with a mix of residential and commercial use, especially if a new airport is sited at Lake Calumet. It has been estimated that 6,000 to 8,000 residential units could be built on the site to relocate most of the people who would be displaced by the airport. One problem that will have to be overcome before the site can be redeveloped is the removal of potentially toxic waste generated by 112 years of steelmaking.

Offsetting part of the negative news related to iron and steel, several companies announced new plant or facility upgrading. Amsted Industries Inc., Chicago, announced in December plans to reopen its American Steel Foundries Inc. facilities in Granite City and to consolidate most of its foundry operations to that location. The move could result in the shutdown of the company's plants in East Chicago and Hammond, IN, and Alliance, OH. Company officials indicated the decision was based upon incentives offered by the city, State, and local utilities. Incentives offered included tax breaks, the establishment of an enterprise zone, breaks on utility rates by Illinois Power Co., and health-care benefits for employees by St. Elizabeth Medical Center. The incentives offered illustrate the lengths to which governments will go to attract or keep core businesses in the wake of the recent recession. This is especially true of municipalities whose economy is largely dependent upon one industry. In Granite City's case, this industry is steel, which was especially impacted by the recession.

The Granite City facility was at one time considered the largest steel foundry in the free world. At its peak the foundry employed 1,750 people and produced more than 25,000 railroad car side frames and bolsters per year. It closed in 1982 when the market for railroad cars became depressed and did not reopen until 1989. It closed again in July 1991 and is scheduled to reopen in early 1993. Approximately 275 workers laid off in the 1991 closing are slated to be rehired. Company officials indicated that up to 1,300 employees could be rehired within 3 years if product sales goals were met.

Birmingham Steel Corp. completely refurbished its Illinois Steel Div. mill at Kankakee at a cost of $14 million. Included in the upgrade was the addition of burners that increased reheat furnace production to 100 tons per hour and rolling mill capacity by 30%.

In January, Ford Motor Co. began a $200 million refitting of its Chicago Heights, Cook County, stamping plant. The refitting will allow Ford to move to a next-generation technology for building automobile bodies.

Laclede Steel invested $6.7 million in capital improvements in 1992. Included in the improvements were a pipe finishing and shipping facility at its Vandalia, Fayette County, plant and improvements to the caster mold and electric arc furnace in Alton.

National Steel's Granite City steel plant brought its new slab caster on-line in March. The new facility makes the company's semifinished steel production 100% continuously cast. Granite City Steel employs 2,300 hourly workers and almost 600 salaried employees. National Steel, the country's fourth largest steelmaker, cut its losses to $48.4 million in 1992 after losing $189.5 million in 1991.

Other Metals.—In an effort to cut costs, Alcoa Building Products announced, in November, the closing of its South Bend, IN, aluminum siding manufacturing plant and the transfer of its operations to Princeville, Peoria County. The move was expected to be completed by the end of March 1993.

Reynolds Metals Co. completed a $27 million expansion at its McCook sheet and plate plant, increasing machined plate aluminum capacity by 50% to 148,600 metric tons per year. Included in the project, which began in 1990, was the installation of two new ingot furnaces,

additional 5-axis skin mills for machining aluminum plate up to 6 inches thick, enlarged ultrasonic inspection tanks, and control systems to ensure strict dimensional and finishing requirements. The McCook plant was built by the Federal Government in 1942 and leased to Reynolds in 1946. Reynolds purchased the facility in 1949. Currently 1,300 workers are employed at the site.

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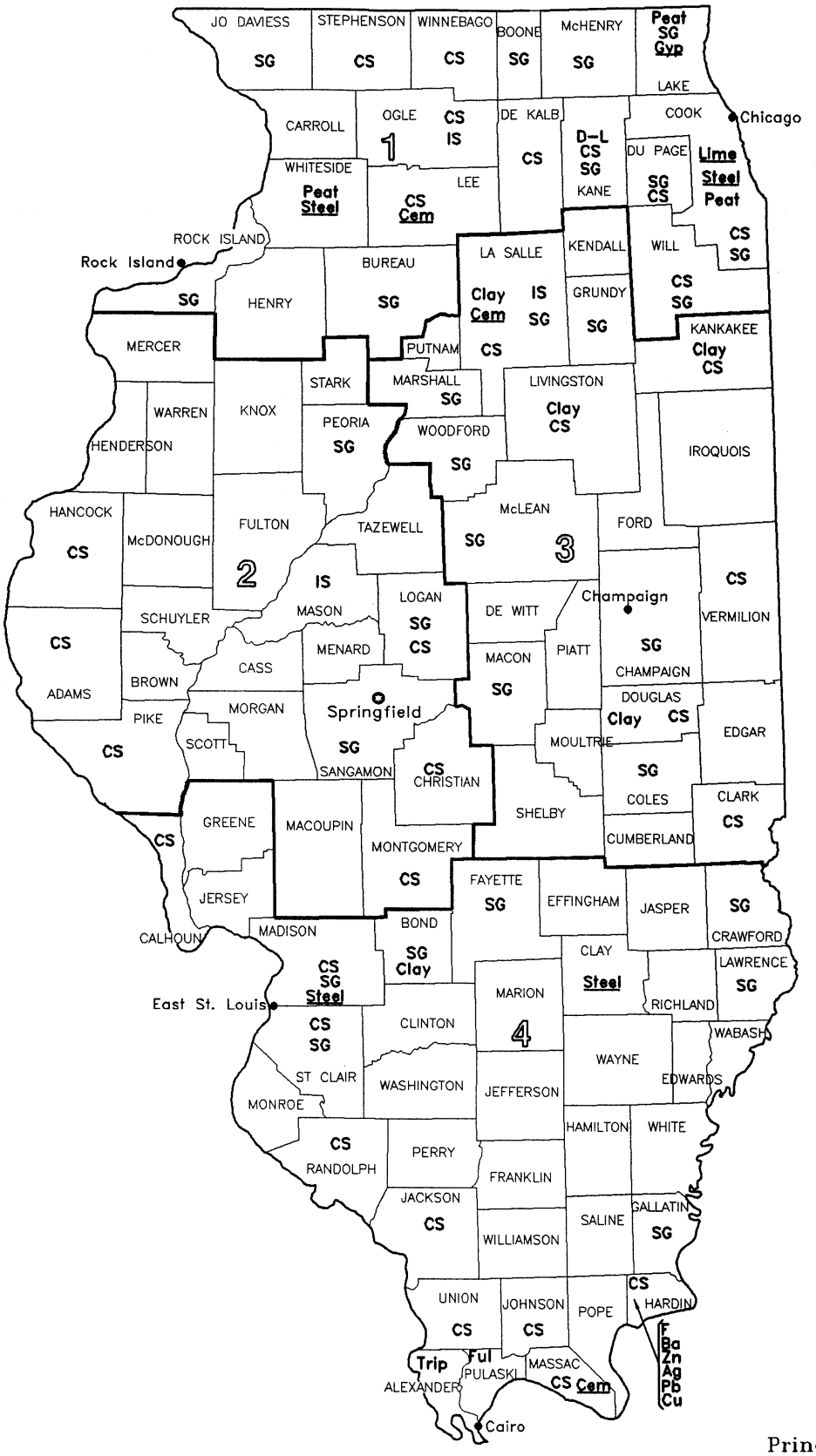
[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 34 years of mineral-related industry and government experience and has covered the mineral activities in Illinois in 1990 and 1992. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

[2]Geologist, Industrial Minerals and Mineral Economics Section, Illinois State Geological Survey, Champaign, Illinois.

[3]Cohokia-Dupo (IL) Journal. Big River Zinc Plant Is Big Producer Of Zinc Products. Feb. 26, 1992.

ILLINOIS



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Ag	Silver
Ba	Barite
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
Cu	Copper
D-L	Dimension Limestone
F	Fluorspar
Ful	Fuller's earth
Gyp	Calcined Gypsum
IS	Industrial Sand
Lime	Lime plant
Pb	Lead
Peat	Peat
SG	Sand and Gravel
Steel	Iron and Steel plant
Trip	Tripoli
Zn	Zinc

Principal Mineral-Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Dixon-Marquette Cement Inc., a subsidiary of Prairie Materials Sales Inc.	12152 South Plainfield Naperville Rd. Plainfield, IL 60544	Quarry and plant	Lee.
Illinois Cement Co., a subsidiary of Centex Cement Enterprises Inc.	Box 442 La Salle, IL 61301	Quarry, clay pit, plant	La Salle.
Lone Star Industries Inc., Cement & Construction Materials Group	1 Greenwich Plaza Box 5050 Greenwich, CT 06836	do.	Do.
Missouri Portland Cement Co., a subsidiary of Lafarge Corp.	Box 4288 Davenport, IA 52801	Plant Quarry	Massac. Hardin.
Clays:			
American Colloid Co.	1500 West Shore Dr. Arlington Heights, IL 60004	Pit and plant	Pulaski.
Lowe's Southern Clay Inc.	P.O. Box 1086 Cape Girardeau, MO 63702	do.	Do.
Richards Brick Co.	234 Springer Ave., Box 407 Edwardsville, IL 62025	do.	Bond and Madison.
Streator Brick Systems Inc.	West 9th St. Streator, IL 61364	do.	Livingston.
Fluorspar:			
Ozark-Mahoning Co., a subsidiary of Alf Atochem North America Inc.[1]	Box 57 Rosiclare, IL 62982	Underground mines	Hardin and Pope.
Gypsum (calcined):			
National Gypsum Co.	2001 Rexford Rd. Charlotte, NC 28211	Plant	Lake.
Iron oxide pigments (finished):			
Harcros Pigments Inc.	235 East 42d St. New York, NY 10017	do.	St. Clair.
Prince Manufacturing Co.	700 Lehigh St. Bowmanstown, PA 18030	do.	Adams.
Solomon Grind-Chem Service Inc.	Box 1766 Springfield, IL 62705	do.	Sangamon.
Iron and steel:			
Acme Metals Inc.	13500 South Perry Ave. Riverdale, IL 60627	Iron and steel furnaces	Cook.
Granite City Div. of National Steel Corp.	Box 365 Granite City, IL 62041	do.	Madison.
LTV Steel Co.	1641 GH Republic Bldg. Cleveland, OH 44101	do.	Cook.
Lime:			
Marblehead Lime Co., a subsidiary of General Dynamics Corp.	222 North La Salle St. Chicago, IL 60601	Plants	Do.
Vulcan Materials Co.	Box 7497 Birmingham, AL 35253	Plant	Do.
Peat:			
Hyponex Corp.	14111 Scottslawn Rd. Marysville, OH 43041	Bog and plant	Whiteside.
Markman Peat Co.	Route 3 Morrison, IL 61270	do.	Do.
Roots Peat Farm	Box 6005 Lindenhurst, IL 60046	do.	Lake.

See footnote at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Perlite (expanded):			
Manville Products Corp.	Route 6, Box 3429 Joliet, IL 60434	Plant	Will.
Silbrico Corp.	6300 South River Rd. Hodgkins, IL 60525	do.	Cook.
Strong-Lite Products Corp.	1120 Oak St. De Kalb, IL 71611	do.	La Salle.
Sand and gravel:			
Construction:			
Elmhurst-Chicago Stone Co.	400 West 1st St. Elmhurst IL 60126	Pits and plants	Du Page and Kane.
Material Service Corp., a division of General Dynamics Corp.	222 N. La Salle St. Chicago, IL 60601	do.	Grundy, Kane, McHenry.
Meyer Material Co.	380 S. Wolf Rd. Des Plaines, IL 60017	do.	Boone, Kane, McHenry.
R. A. Cullinan and Sons Inc.	Box 166 Tremont, IL 61568	do.	McHenry and Tazewell.
Road Materials Corp.	Box 209 Algonquin, IL 60102	do.	Kane and McHenry.
Thelen Sand & Gravel Inc.	28955 West Route 173 Antioch, IL 60002	Pit and plant	Lake.
Vulcan Materials Co.	Box 7497 Birmingham, AL 35253	Pits and plants	De Kalb, McHenry, Macon, Will.
Industrial:			
Manito Investment Co.	Box 166 Tremont, IL 61568	Pit and plant	Mason.
Unimin Corp.	Box 33 Eiko, IL 62929	Pits and plants	La Salle and Ogle.
U.S. Silica Co.	Box 187 Berkeley Springs, WV 25411	Pit and plant	La Salle.
Fairmont Minerals Ltd.	Box 167 Wedron, IL 60557	Pits and plant	Do.
Slag (iron and steel):			
Heckett Co.	612 North Main St. Butler, PA 16001	Plants	Cook, Kankakee, Whiteside.
International Mill Service Co.	1818 Market St. Philadelphia, PA 19103	do.	Madison.
St. Louis Slag Products Co. Inc., a division of Standard Lafarge Co.	Box 430 Granite City, IL 62040	Plant	Do.
Stone (crushed limestone-dolomite):			
Elmhurst-Chicago Stone Co.	Box 57 Elmhurst, IL 60126	Quarries and plants	Will and Du Page.
Material Service Corp., a division of General Dynamics Corp.	222 N. La Salle St. Chicago, IL 60601	do.	Cook, Logan, Menard, Montgomery, Vermilion, Will.
Dravo Basic Materials, a division of Dravo Corp.	Route 1, Box 218 Cave-in-Rock, IL 62919	do.	Hardin.
Vulcan Materials Co.	Box 7497 Birmingham, AL 35253	do.	Clark, Cook, Kankakee, Livingston, Will.
Sulfur (recovered):			
Marathon Oil Co.	Box 598 Robinson, IL 64254	Plant	Crawford.

See footnote at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sulfur (recovered)—Continued:			
Mobil Oil Corp.	Box 874 Joliet, IL 60434	Plant	Will.
Shell Oil Co.	Box 262 Wood River, IL 62095	do.	Madison.
The Uno-Ven Co.	1650 East Golf Rd. Schaumburg, IL 60196	do.	Will.
Tripoli:			
Unimin Corp.	Box J Tamms, IL 62988	Underground and open pit mines and plant	Alexander.
Vermiculite (exfoliated):			
W. R. Grace & Co., Construction Products Div.	6051 West 65th St. Bedford Park, IL 60638	Plant	Du Page.
Strong-Lite Products Corp.	Shipyard Rd. Seneca, IL 71611	do.	La Salle.

[1]Also barite, copper, lead, silver, and zinc.

THE MINERAL INDUSTRY OF INDIANA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Geological Survey, Indiana Department of Natural Resources, for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.[1]

The value of nonfuel mineral production in Indiana in 1992 increased to an alltime high of $477 million. After a slowdown in 1990-91, mineral production in Indiana resumed a growth pattern that showed an increase in nonfuel mineral value each year from 1983 through 1989. Once again, improved demand for industrial minerals used primarily in construction resulted in increased production.

Nationally, Indiana ranked 22d in value of nonfuel mineral output. The State was also the Nation's leader in steel production and ranked ninth in coal production. Output of both of these commodities increased in 1992.

TRENDS AND DEVELOPMENTS

Production of crushed stone and sand and gravel, commonly referred to as construction aggregate, was at an alltime high in Indiana in 1992. Output of these two commodities of about 72 million short tons surpassed the previous record of 66 million tons reported in 1989. During the past 10 years, growth in Indiana's construction aggregates industry has resulted in production of more than twice the 1982 output of about 33 million tons. From 1983 through 1992, the value of construction aggregate production has totaled about $1.9 billion or slightly more than 50% of Indiana's value of nonfuel mineral production for that period.

A continuing trend in the construction aggregates industry in Indiana (and nationally) is the growth in tons produced per mining operation. Essentially, fewer operations are producing greater quantities of material. In 1979, Indiana produced at that time State record tonnages of crushed stone and sand and

TABLE 1
NONFUEL MINERAL PRODUCTION IN INDIANA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	368	$27,813	e317	e$24,092	371	$24,822
Portland	do.	2,417	114,414	e2,252	e105,844	2,466	110,737
Clays[2]	metric tons	1,051,703	3,273	929,964	3,516	841,723	3,016
Gemstones		NA	W	NA	561	NA	720
Peat	thousand short tons	37	W	26	W	27	512
Sand and gravel:							
Construction	do.	r23,489	r74,373	e18,100	e60,400	28,862	95,889
Industrial	do.	W	W	W	W	118	1,278
Stone:							
Crushed	do.	e[3]36,700	e[3]147,700	37,924	152,489	e43,000	e178,000
Dimension	short tons	e r[3]198,242	r[3]28,565	r[3]189,010	r[3]27,596	e190,412	e26,767
Combined value of clays (ball), gypsum (crude), lime, stone [crushed marl and miscellaneous stones (1990), dimension limestone and sandstone (1990-91), dimension sandstone (1990)], and values indicated by symbol W		XX	r32,281	XX	r28,797	XX	35,145
Total		XX	r428,419	XX	r403,295	XX	476,886

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" figure.
[3]Excludes certain stones; kind and value included with "Combined value" figure.

gravel. In 1991, the State produced about 38 million short tons of stone at 85 quarries for an average of 446,000 tons per quarry. In 1979, the average quantity produced per quarry was about 310,000 tons. By 1991, crushed stone quarries in Indiana were producing approximately 44% more stone on an average than in 1979. The increase for sand and gravel pits was about 20%. In 1992, about 181,500 tons of sand and gravel was produced per pit versus about 151,000 tons in 1979.

In some cases, the trend toward larger operations is indicative of opposition, typically at the local level, to the opening of new mining sites. The development of new equipment and technology in the industry also contributed to this growth.

EMPLOYMENT

Despite the gains in production in 1992, employment in mining and mineral-related industries declined in 1992. Generally, improved technology and equipment have resulted in greater production with fewer workers.

In 1992, Indiana employed about 6,700 workers in mining, a decline of about 900 employees from 1991. Construction employment also dropped slightly from about 117,000 in 1991 to about 109,000 in 1992. Steel mill employment decreased to about 36,100 workers in 1992 from 37,900 in 1991.[2]

Overall in Indiana, employment in mining, construction, and manufacturing accounted for nearly 30% of the jobs in the nonagricultural employment sector.

LEGISLATION AND GOVERNMENT PROGRAMS

The Indiana Geological Survey (IGS) at Bloomington was the State's lead agency in industrial mineral and fossil fuel research. This research was focused on the impact of minerals in relation to the environment, geology, and ground water. In 1992, the Mineral Resources section of the IGS completed a study of the geologic and economic potential for shallow underground limestone and dolomite mines in Indiana. The study identified potential benefits of underground mining in urban areas where mine expansion is typically hampered by costs and local zoning laws. The study was expected to be published in 1993.

Another study related to land use and mineral resource development continued in Putnam County. This study involved the mapping and tabulating of stone and other mineral resources in the county and is to serve as a prototype for similar studies in other Indiana counties.

Also in 1992, the IGS published a report on the State's coal analysis data base.[3] The report contains data for 1,416 coal samples that were collected and chemically analyzed by the IGS.

On July 27, 1992, the U.S. Department of Energy signed a cooperative agreement with PSI Energy Inc. and Destec Energy Inc. to demonstrate coal gasification repowering of an existing generating unit at the Wabash River Generating Station in West Terre Haute. The plant was expected to cost $600 million to renovate and operate for the first 3 years with each partner contributing $200 million. This technology will allow the use of high-sulfur Indiana coal as 98% of the coal's sulfur is removed before burning. The plant will be designed to use coal with a maximum sulfur content of 5.9% (dry basis) and a minimum energy content of 13,500 British thermal unit/pound (moisture and ash-free basis). The operation was scheduled to be on-line by July 1995, about the time when amendments to the Clean Air Act of 1990 take effect.

Operation of a scrubbing system that may become a prototype for reducing sulfur dioxide emissions at coal-burning powerplants using high-sulfur coal started up in Indiana during the year. In June, Northern Indiana Public Service Co. (NIPSCO) began operating a $150 million flue gas desulfurization system at its Bailly Generating Station in Porter County. Air Products & Chemicals Inc. and Mitsubishi Heavy Industries America Inc. own and operate the desulfurization system under a 20-year agreement with NIPSCO. The scrubbing system absorbs sulfur dioxide emissions by mixing wet limestone with burning coal. In this process, a reusable gypsum byproduct is produced, which is sold to USG Corp. for use in wallboard manufacturing. The operation was expected to require about 128,000 tons of limestone per year and generate about 237,000 tons of byproduct gypsum annually.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Industrial minerals were produced in Indiana at about 287 operations, according to data reported to the U.S. Bureau of Mines and listed in table 1. Sand and gravel was produced at 159 pits, crushed stone at 85 quarries, dimension stone at 16 quarries, clay and shale at 12 pits, cement at 5 plants, peat at 5 bogs, lime at 2 plants, gypsum at 2 mines, and industrial sand at 1 operation. Production from these operations accounted for the State's mineral production value of $477 million in 1992.

In addition, the following mineral commodities were processed in the State: calcined gypsum, expanded perlite, iron and steel slag, and sulfur (recovered). The combined value of these commodities, as reported to the U.S. Bureau of Mines, was about $45 million.

Cement.—Output of nearly 2.5 million tons of portland cement in 1992 was the highest total reported for Indiana since 1976. Production increased by about 10% compared with that of 1991. Masonry cement production also increased during the year by about 17%. The gains in cement output reflected improved demand from the construction industry. Both portland and masonry cement were manufactured at four plants in Cass, Clark, Lawrence, and Putnam Counties. One company, Lehigh Portland Cement Co., also produced a calcium aluminate cement, for use in lining blast furnaces at steel mills, at its Buffington Station plant in Gary, Lake County.

TABLE 2
INDIANA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	10,048	$31,290	$3.11
Plaster and gunite sands	161	629	3.91
Concrete products (blocks, brick, pipe, decorative, etc.)	546	1,766	3.23
Asphaltic concrete aggregates and other bituminous mixtures	3,976	13,831	3.48
Road base and coverings[1]	2,858	11,224	3.93
Fill	3,321	8,162	2.46
Snow and ice control	295	858	2.91
Railroad ballast	W	W	W
Other miscellaneous uses[2]	349	1,435	4.11
Unspecified:[3]			
Actual	6,281	23,449	3.73
Estimated	1,028	3,246	3.16
Total[4]	28,862	95,889	3.32
Total[5 6]	26,183	95,889	3.66

W Withheld to avoid disclosing company proprietary data; included in "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

Clays.—Indiana again ranked 10th in the Nation in output of common clay and shale. In 1992, 11 pits were in operation in 9 counties with Clark, Clay, and Morgan Counties the leaders in production. Also, one company operating one pit reported production of ball clay in Dubois County. Most of the clay was used in cement manufacturing with smaller quantities used in brickmaking. The ball clay was sold for use as a filler and as an absorbent material.

Gypsum.—Indiana again ranked seventh in the United States in production of crude gypsum. In 1991, the value of production, according to the reported data, decreased sharply by 40% compared with 1990 data. In 1992, value increased by 95% with production increasing by 5%.

The State's two producers, USG Corp. and National Gypsum Co., each operated one underground mine in Martin County. Nationwide, these 2 companies operated 16 other gypsum mines or about one-third of the U.S. total. USG's Shoals Mine was among the Nation's top five gypsum mines in output. The gypsum was used to manufacture wallboard for use in construction.

Lime.—Output of lime in 1992 increased by about 8% reflecting the improved conditions in the State's steel industry. Both of Indiana's lime plants were in Lake County in the northwestern part of the State and were in proximity to the area's major steel mills. Nationally, Indiana ranked 11th among the 32 lime-producing States.

Peat.—Output of peat from the State's five bogs increased slightly in 1992. Peat was harvested from bogs in Allen and La Porte Counties in the northern part of the State and from bogs in Hamilton and Madison Counties in central Indiana. Most of the output was the reed-sedge type, which was sold for use in general soil improvement. Nationally, Indiana ranked seventh of 20 States producing peat in 1992.

Sand and Gravel.—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Indiana construction sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 3 presents these statistics for the three Indiana districts.

Indiana was the Nation's 12th largest producer of construction sand and gravel in 1992. Construction sand and gravel continued as the State's third leading nonfuel mineral commodity in terms of value, accounting for about 20% of the total. Production increased by about 23% compared with that of 1990. Output of almost 29 million short tons was the second highest total in the past 20 years.

In 1992, 97 companies reported production from 159 pits in 61 of the State's 92 counties. Over the past 2 years, the average price per ton (plant f.o.b.) of construction sand and gravel increased 5% from $3.17 in 1991 to $3.32 in 1992.

During the year, six construction sand and gravel companies began operating pits in Elkhart, Kosciusko, LaGrange, Posey, Shelby, and Steuben Counties. Also, Irving Materials Inc. began operating a new pit near its existing operations in Madison County.

Silver Creek Sand & Gravel Co. Inc. lost a zoning change request to expand operations in Clark County. The company planned to resubmit the request in 1993.

Stone.—Crushed.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for

TABLE 3

INDIANA:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	2,689	8,072	4,087	14,923	3,271	8,294
Plaster and gunite sands	62	293	99	336	—	—
Concrete products (blocks, brick, etc.)	87	320	336	1,052	123	394
Asphaltic concrete aggregates and other bituminous mixtures	1,924	6,679	1,606	5,911	418	1,151
Road base and coverings[2]	1,295	4,900	1,321	5,145	226	1,144
Fill	990	2,159	1,932	5,122	398	881
Snow and ice control	123	309	W	W	W	W
Railroad ballast	—	—	—	—	W	W
Other miscellaneous uses[3]	327	1,294	118	405	76	284
Unspecified:[4]						
Actual	145	487	5,109	18,834	1,027	4,127
Estimated	596	1,809	419	1,396	13	42
Total[5]	8,238	26,321	15,028	53,124	5,553	16,318
Total[6 7]	7,473	26,321	13,633	53,124	5,038	16,318

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."

[1]Excludes 44,599 short tons valued at $126,033, not reported by county.

[2]Includes road and other stabilization (cement and lime).

[3]Includes filtration.

[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.

[5]Data may not add to totals shown because of independent rounding.

[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.

[7]Total quantity and total value in thousand metric tons and thousand dollars.

even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Estimated production of 43 million short tons of crushed stone in 1992 marked the first time more than 40 million tons of stone was produced in the State. Output of stone has exceeded 30 million tons each year since 1987 and almost doubled since 1986. Stone production in 1992 surpassed that of all other mineral commodities in Indiana, including coal. The value of stone production of $178 million accounted for about 37% of the State's nonfuel mineral value. Nationally, Indiana ranked 12th in production.

Demand for crushed stone from the construction industry has been at a record level in Indiana for the past 5 years. Output has averaged 38.3 million short tons per year during that period. Production for the 5 years before this period averaged about 25.6 million tons annually.

During the year, Lowell Mining Co. opened a quarry in Lake County. The France Stone Co. opened a new quarry in Putnam County. Martin Marietta Aggregates completed development of a quarry and began producing in Howard County. The firm also completed an expansion project at its underground mine in Marion County. J. M. Huber Corp. began operating a limestone grinding plant at the Burns International Harbor. The fine-ground limestone obtained from Michigan was sold to NIPSCO for use in flue gas desulfurization at its Bailly Generating Station.

Dimension.—Once again in 1992, Indiana was the leading producer of dimension stone in the United States. Nearly 20% of the Nation's dimension stone was quarried in Indiana. During the year, plans for an interstate highway from Indianapolis to Evansville were under consideration by the State Department of Transportation (DOT). Construction of the proposed highway was expected to overlay dimension limestone resources in Greene, Monroe, and Daviess Counties. The DOT and Indiana Limestone Institute were studying the potential effect on these resources before determining the final route for the highway.

Metals

No metals were mined in Indiana. Metals discussed in this section were processed from materials received from both foreign and domestic sources. Production and value data for these metals are not included in table 1.

Aluminum.—Indiana again ranked fourth of 14 States producing aluminum. The Aluminum Co. of America (Alcoa) Warrick Operations at Newburgh, Warrick County, was the State's only producer of primary aluminum.

To comply with amendments to the Clean Air Act of 1990 that take effect in 1995, Alcoa has begun using a natural gas/coal-firing system at its generating plant that powers its aluminum smelting complex. Alcoa, in a program with the Gas Research Institute, developed the gas/coal firing-system to meet the new emission standards while maintaining the capability of using Indiana-produced coal.[4]

Iron and Steel.—Indiana continued to lead the Nation in production of raw steel. In 1992, about 20.4 million short tons of steel was produced in Indiana, according to the American Iron & Steel Institute. Output increased by about 6% over that of 1991, mostly reflecting improved consumer demand for appliances and, to a lesser extent, for automobiles. Indiana accounted for about 22% of the Nation's steel production in 1992. Output has remained relatively stable over the past 5 years, averaging about 20.6 million tons annually.

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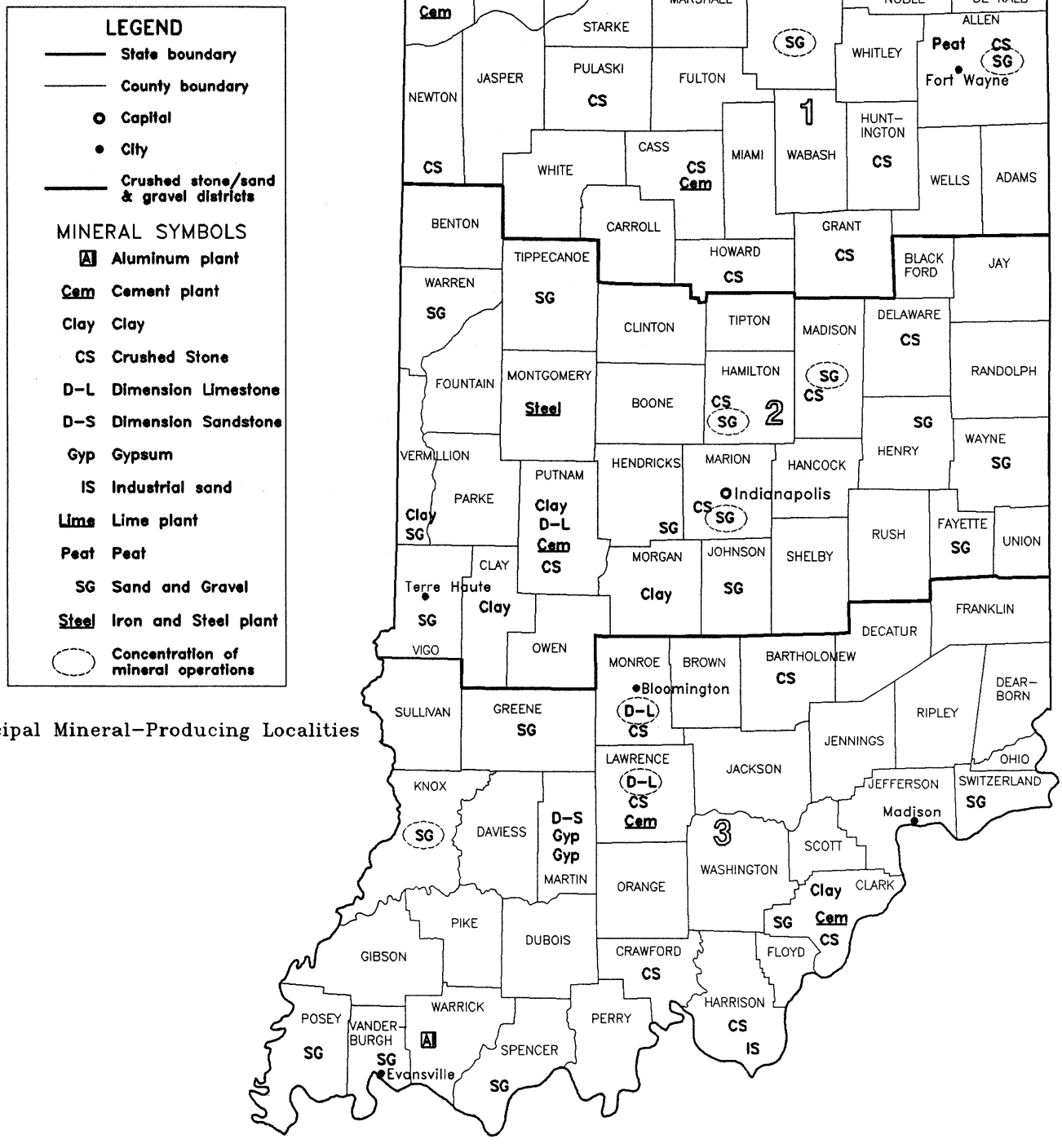
[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related industry and government experience and has covered the mineral activities in Indiana for 2 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Indiana Employment Review, Labor Market Information, Jan. 1993, p. 5.

[3]Hasenmueller, W. A., and C. V. Miller. The Indiana Coal Analysis Database, Computer Database 1, IN Geol. Surv. CD1, 1992, 13 pp.

[4]American Metal Market. Alcoa Opts for Co-Firing Powerplants. V. 100, No. 165, Aug. 26, 1992.

INDIANA



Principal Mineral-Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Aluminum:			
Aluminum Co. of America	Warrick Operations Box 10 Newburgh, IN 47630	Smelter and fabricating plant	Warrick.
Cement:			
Essroc Materials Inc., a subsidiary of Societe des Ciments Francais:	Box 35750 Louisville, KY 40232		
Logansport plant[1 2]		Plant, quarry, clay pit	Cass.
Speed plant[1 2]		do.	Clark.
Lehigh Portland Cement Co., a subsidiary of Heidelberger Zement AG:	Box 1882 Allentown, PA 18105		
Buffington Station plant		Plant	Lake.
Mitchell plant		Plant and quarry	Lawrence.
Lone Star Industries Inc., Greencastle plant[1 2]	Box 120014 Stamford, CT 06912	Plant, quarry, clay pit	Putnam.
Clays:			
General Shale Products Corp.	Johnson City, TN 37601	Pits and plant	Morgan.
Hydraulic-Press Brick Co., Haydite Div.	Brooklyn, IN 46111	Pit and plant	Do.
Log Cabin Coal Co.	304 South Depot St. Brazil, IN 47834	do.	Clay.
Gypsum:			
National Gypsum Co.	2001 Rexford Rd. Charlotte, NC 28211	Underground mine and plant	Martin.
USG Corp.	101 South Wacker Dr. Chicago, IL 60606	do.	Do.
Iron and steel:			
Bethlehem Steel Corp.	Bethlehem, PA 18016	Mill (integrated)	Porter.
Inland Steel Co., a subsidiary of Inland Steel Industries Inc.	3210 Watling St. East Chicago, IN 46312	do.	Lake.
I/N Tek	30755 Edison Rd. New Carlisle, IN 46552	Mill (rolling)	St. Joseph.
LTV Steel Co. Inc.	3001 Dickey Rd. East Chicago, IN 46312	Mill (integrated)	Lake.
National Steel Corp., Midwest Steel Div.	U.S. 12 Portage, IN 46368	Mill (rolling)	Porter.
Nucor Corp.	4425 Randolph Rd. Charlotte, NC 28211	Minimill	Montgomery.
USX Corp., Gary Works Div.	1 North Broadway Gary, IN 46402	Mill (integrated)	Lake.
Lime:			
Inland Steel Co., a subsidiary of Inland Steel Industries Inc.	3210 Watling St. East Chicago, IN 46312	Plant	Do.
Marblehead Lime Co., a subsidiary of General Dynamics Corp.	222 North LaSalle St. Chicago, IL 60601	do.	Do.
Peat:			
Beusching Peat Moss & Black Dirt	9134 Cook Rd., Route 3 Fort Wayne, IN 46825	Bog and plant	Allen.
Felger's Peat Moss & Black Dirt	9912 Valentine Rd. Fort Wayne, IN 46818	do.	Do.
Hyponex Corp.	2013 South Anthony Blvd. Fort Wayne, IN 46803	do.	Hamilton.
Millburn Peat Co. Inc.	Box 236 La Porte, IN 46350	do.	La Porte.

See footnotes at end of table.

TABLE 4—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Perlite (expanded):			
Chemrock Corp.	Box 5465 Lafayette, IN 47903	Plant	Tippecanoe.
Grefco Inc.	Box 48 Crawfordsville, IN 47933	do.	Montgomery.
Sand and gravel:			
Construction:			
American Aggregates Corp., a division of CSR America Inc.	Drawer 160 Greenville, OH 45331	Pits and plants	Hamilton, Marion, Wayne.
Evansville Materials Inc.	Box 3596 Evansville, IN 47734	do.	Posey, Spencer, Vanderburgh.
Fairfield Builders Supply Corp.	Box 4427 Lafayette, IN 47902	Pits	Boone and Tippecanoe.
Irving Materials Inc.	Box 369, Route 5 Greenfield, IN 46140	Pits and plants	Fayette, Hamilton, Henry, Johnson, Madison, Wayne.
S. E. Johnson Co. Inc. (Stoneco Inc.)	Box 29A Maumee, IN 43537	Pits	Allen, Jay, Miami.
Martin Marietta Aggregates	Box 30013 Raleigh, NC 27622	Pits and plants	Clark, Hamilton, Howard, Marion, Morgan, Vermillion, Vigo.
Meshberger Stone Inc.	Box 345 Berne, IN 46711	Pits	Hamilton and Hendricks.
OK Sand & Gravel Co. Inc.	5320 South Belmont Indianapolis, IN 46217	Pit and plant	Marion.
Rogers Group Inc.	Box 849 Bloomington, IN 47402	Pits and plants	Greene, Knox, Morgan, Warren.
Vulcan Materials Co.[1]	Box 7497 Birmingham, AL 35253	do.	Elkhart, Noble, St. Joseph, Steuben, Tippecanoe.
Industrial:			
Crisman Sand Co. Inc.	6480 Melton Rd. Portage, IN 46368	Pits and plant	Porter.
U.S. Silica Co.	Box 187 Berkeley Springs, WV 25411	do.	Harrison.
Stone:			
Crushed:			
Limestone:			
American Aggregates Corp., a division of CSR America Inc.	Drawer 160 Greenville, OH 45331-0160	Quarries and plants	Hamilton, Marion, Putnam.
Hanson PLC (The France Stone Co.)	6100 Ardmore Ave. Fort Wayne, IN 46809	do.	Allen, Jennings, Putnam, Ripley, Scott, Washington.
Irving Bros. Stone & Gravel Inc.	Box 300, Rural Route 13 Muncie, IN 47302	do.	Blackford, Delaware, Grant, Wells.
Mulzer Crushed Stone Inc.	Box 248 Tell City, IN 47586	Quarries, mine, plants	Clark and Crawford.
Rogers Group Inc.	Box 849 Bloomington, IN 47402	Quarries and plants	Greene, Lawrence, Monroe, Newton.
Dimension:			
Elliot Stone Co. Inc.	Box 743 Bedford, IN 47421	Quarry and plant	Lawrence.
B. G. Hoadley Quarries Inc.	Box 1224 Bloomington, IN 4740	do.	Monroe.

See footnotes at end of table.

TABLE 4—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone—Continued:			
Crushed—Continued:			
Dimension—Continued:			
Independent Limestone Co.	6001 South Rockport Rd. Bloomington, IN 47401	Quarry and plant	Monroe.
Indiana Limestone Co. Inc.	Box 72 Bedford, IN 47421	Quarries and plants	Lawrence and Monroe.
Reed Quarries Inc.	Box 64 Bloomington, IN 47402	Quarry and plant	Monroe.
Star Quarry Co. Inc.	Box 85 Clear Creek, IN 47426	do.	Do.
Victor Oolitic Stone Co.	Box 668 Bloomington, IN 47402	do.	Do.
Sulfur (recovered):			
Amoco Oil Co.	Box 710 Whiting, IN 46394	Elemental sulfur recovered as a byproduct of oil refining	Lake.

[1]Also crushed stone.
[2]Also clays.

THE MINERAL INDUSTRY OF IOWA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Geological Survey Bureau, Division of Energy and Geological Resources, Iowa Department of Natural Resources, for collecting information on all nonfuel minerals.

By Doss H. White Jr.,[1] and Robert M. McKay[2]

In 1992, Iowa's nonfuel mineral industry production was valued at $391.2 million, a $47 million increase over the value reported in 1991. The overall higher value was due to increased sales of all commodities except clay, gypsum, peat, and dimension stone. The value of these four commodities declined $2.1 million. Iowa ranked 28th nationally in nonfuel mineral value.

TRENDS AND DEVELOPMENTS

Holnam Inc. began work to convert the kilns at the Cerro Gordo plant to utilize wornout tires for fuel. Martin Marietta Aggregates Inc. acquired a 50% interest in Kaser Corp. Both firms produce crushed stone and sand and gravel in Iowa.

Canada Tungsten Mining Corp. Ltd. (CTMC) lowered its long-term leasehold interest in its Fort Madison ammonium paratungstate plant to salvage value. The leasehold interest was sold to AMAX Inc., a subsidiary of CTMC's parent company.

LEGISLATION AND GOVERNMENT PROGRAMS

The Iowa Legislature enacted House bill 2356, the Clean Air Act, which provided authorization for the Iowa Department of Natural Resources (DNR) to administer the Federal Clean Air Act. The Federal act impacts mineral industries in that new standards for visibility and particulate matter were set for calciners and dryers at plants processing or producing construction products, including lightweight aggregate.

The DNR awarded Holnam Inc. a $220,000 grant to assist the company in modifying kilns at its Cerro Gordo County cement plant. The grant originated through DNR's Landfill Alternative Grant Program, an outgrowth of the State's 1987 Groundwater Protection Act. The waste tires will provide approximately 15% of the plant's annual kiln fuel needs. This fuel conversion program will consume an estimated 2.1 million waste passenger tires annually (19 million metric tons, 21 million short tons), which is approximately 75% of the annual number of waste tires generated within the State. The majority of the waste tires will be supplied by UT Tire Recyclers of Des Moines.

The Iowa Geological Survey Bureau (IGSB) celebrated its 100th anniversary by hosting the Geological Society of

TABLE 1
NONFUEL MINERAL PRODUCTION IN IOWA[1]

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
Cement:							
Masonry	thousand short tons	53	$5,054	e34	e$3,264	50	$4,120
Portland	do.	2,525	122,466	e2,301	e112,749	2,824	116,477
Clays	metric tons	423,227	1,376	530,477	2,226	389,008	1,612
Gemstones		NA	14	NA	8	NA	1,606
Gypsum (crude)	thousand short tons	2,192	14,243	2,162	12,285	2,193	11,626
Sand and gravel (construction)	do.	r12,125	r39,488	e17,400	e55,800	16,825	58,382
Stone (crushed)	do.	e29,000	e118,600	231,057	2147,815	e 238,000	e 2186,200
Combined value lime, peat, sand and gravel [industrial (1992)], and stone [crushed dolomite and sandstone (1991-92), dimension]		XX	r8,888	XX	r10,045	XX	11,140
Total		XX	r310,129	XX	r344,192	XX	391,163

eEstimated. rRevised. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain stones; value included with "Combined value" data.

America North-Central Section annual meeting in April and by publishing a centennial edition of its annual publication, *Iowa Geology*. Bureau personnel completed work on evaluation of drill core and cuttings for base and precious-metal potential from the Midcontinent Rift. The investigation, partially funded by the U.S. Geological Survey (USGS) Strategic and Critical Minerals Program, concluded the IGSB's activities in that Federal program. Results of the study are to be published as a USGS Bulletin. The IGSB published the map "Ground Water Vulnerability Regions of Iowa." The map identifies geographic regions with similar hydrogeological characteristics and should prove useful to citizens, environmental scientists, and planners interested in the vulnerability of aquifers to recharge contamination.

The National Aeronautics and Space Administration concluded its funding of an IGSB study on the Manson Impact Structure in north-central Iowa. The 3-year program provided partial support for study of existing subsurface data (drill core and cuttings and seismic records) within and adjacent to the Cretaceous age meteor impact structure. The Manson Structure was also the focus of a 2-year joint IGSB-USGS drilling program to secure new core samples from within the impact structure. The program concluded at the end of 1992 after coring 1,219 meters (4,000 feet) in 12 holes across a radius of the 35-kilometer (22-mile) diameter circular structure; the deepest core was 381 meters (1,250 feet). The buried structure is the largest such feature in the United States. It has been dated at 65 million years old, which is coincident in time and possibly directly related to mass biotic extinctions at the end of the Cretaceous period.

FUELS

Several test wells in Washington County in southeast Iowa, operated by Earth Reference Systems, Long Beach, CA, remained open through 1992 for testing and possible future development. All wells were drilled to evaluate the hydrocarbon potential of Ordovician source and reservoir rock. A primary reason behind the exploration was to determine reservoir characteristics in relation to possible secondary recovery techniques.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Sales of Iowa's three leading mineral commodities, crushed stone, portland cement, and sand and gravel, accounted for $361 million in 1992. This was approximately 92% of the State's total mineral value. In 1992, industrial mineral production was by 249 operations, 217 commercial, and 32 county operated.

Cement.—Iowa ranked 10th in both production and value among the 37 portland cement-producing States and 17th in output and 13th in value among the 36 States with masonry cement production. Cement sales, both portland and masonry, accounted for approximately 31% of the State's 1992 mineral value.

The output of portland cement, 2.5 million metric tons or 2.8 million short tons valued at $116.5 million, increased 454,000 metric tons (500,000 short tons) and $3.8 million over the 1991 level. The increase was due to the State's economic recovery from the early 1990's recession with increased residential and commercial construction. Masonry cement production was 45,000 metric tons (50,000 short tons) valued at $4.1 million. In 1991, masonry cement output totaled 31,000 metric tons (34,000 short tons) valued at $3.2 million. The explanation for the increase in output and sales was due to the improved Iowa economy and an increase in construction activity.

The Iowa cement industry consisted of four companies operating three dry-process plants and a clinker grinding facility. These were in Cerro Gordo, Scott, and Polk Counties. Lehigh Portland Cement Co. and Holnam Inc. (formerly Northwestern States Portland Cement Co.) operated plants near Mason City in Cerro Gordo County, and Davenport Cement Co. operated a plant near Buffalo in Scott County. The Monarch Cement Co. operated a clinker grinding facility in Des Moines, Polk County, to produce portland cement. Clinker was shipped from the company's plant in Humbolt, KS. Of the other three facilities, Davenport and Holnam produced portland and masonry cement while Lehigh produced masonry cement.

The companies reported sales to ready-mix concrete producers, highway contractors, building material dealers, and other users.

Holnam Inc.'s conversion of its Mason City cement kilns to burn discarded tires as kiln fuel, assisted by a grant from the DNR, was scheduled for completion by mid-1993.

Clays.—Iowa was 1 of 44 States producing common clay and/or shale. The Iowa clay industry ranked 21st in tonnage and 24th in sales. Clay output totaled 389,000 metric tons (429,000 short tons) valued at $1.6 million. This was a 141,000-metric-ton (155,000-short-ton) decline below the 1991 production of 530,000 metric tons (585,000 short tons). Value declined $614,000 below the $2.2 million reported for 1991.

The State's clay industry consisted of six companies with eight pits and four brick plants in Cerro Gordo, Dallas, Scott, Webster, and Woodbury Counties. Four brick and tile and two cement companies reported clay production. Principal sales/uses reported were, in descending tonnages, portland cement manufacture, common brick, and tile manufacture (floor, wall, and ceramic).

Gypsum.—Iowa, 1 of 19 States with crude gypsum production in 1992, maintained its second-place ranking behind Oklahoma. Gypsum sales accounted for approximately 3% of the State's mineral value. The 1992 production and value, 1.989 million metric tons (2.193 million short tons) and

TABLE 2
IOWA : CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,101	$12,451	$4.02
Plaster and gunite sands	36	187	5.19
Concrete products (blocks, brick, pipe, decorative, etc.)	133	720	5.41
Asphaltic concrete aggregates and other bituminous mixtures	647	2,340	3.62
Road base and coverings[1]	3,233	8,079	2.50
Fill	1,235	3,122	2.53
Snow and ice control	163	607	3.72
Railroad ballast	W	W	6.48
Other miscellaneous uses[2]	208	557	2.68
Unspecified:[3]			
Actual	2,099	9,474	4.51
Estimated	5,970	20,846	3.49
Total	16,825	[4]58,382	3.47
Total[5 6]	15,263	58,382	3.83

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

$11.6 million, exceeded the 1991 level by 28,000 metric tons. Although tonnage increased, value declined from the $12.3 million reported in 1991. The $700,000 decline was brought about by a lowering of the unit price because of a soft market for crude gypsum.

The tonnage of gypsum calcined in 1992, 1,361 million metric tons (1,500 million short tons) valued at $20.5 million, exceeded the 1,288 million metric tons (1,420 million short tons) calcined in 1991. The 1992 value exceeded that of 1991 by $1.3 million. Calcined gypsum was used in the manufacture of wallboard and other plaster and cement products.

In Iowa, the gypsum sector of the mineral industry consisted of five companies operating several surface and underground mines in Des Moines, Martin, and Webster Counties. There was one operation each in Des Moines and Martin Counties, and four operations were in Webster County. Gypsum was calcined in five plants in Des Moines and Webster Counties.

Lime.—Both quicklime and hydrated lime were manufactured at a plant in Scott County. Linwood Mining & Minerals Corp. calcined a local limestone to produce quicklime. A small tonnage of quicklime was crushed and reacted with water in a hydrator to produce hydrated lime. Both production and value increased.

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines (USBM) for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

The State ranked 17th in tonnage and 19th in value among the 49 States with construction sand and gravel production. Sand and gravel sales ranked third and accounted for 15% of the Iowa mineral value. In 1992, sand and gravel production was reported by 109 companies operating 211 pits in 63 counties. Production totaled 15.2 million metric tons (16.8 million short tons) valued at $58.4 million. Although value exceeded the 1991 estimate by $2.6 million, production declined 544,000 metric tons (600,000 short tons) below the 1991 estimated value. The five leading sand and gravel-producing counties, tonnagewise, Polk, Sioux, Sac, Hamilton, and Marion, accounted for 6.6 million metric tons (7.3 million short tons), 43% of the total production, and $37 million, 64% of the value.

Industrial.—One firm in Muscatine County produced industrial sand and gravel. Production and value were withheld.

Stone.—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—Iowa's leading mineral commodity, valuewise, was crushed stone, which accounted for 48% of the State's mineral value. Limestone and dolomite were the only stone types produced. Output and value were estimated at 34.5 million metric tons (38 million short tons) and $186 million. This was higher than the 28 million metric tons (31 million short tons) and $148 million reported by industry in 1991.

Dimension.—The production of dimension limestone was reported by three firms in Dubuque, Jackson, and Jones Counties. The majority of sales was for flagging and veneer. Quarry blocks also were sold.

Other Industrial Minerals.—Peat was

TABLE 3

IOWA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	447	1,468	790	2,674	239	1,083
Plaster and gunite sands	12	46	8	48	W	W
Concrete products (blocks, brick, etc.)	W	W	35	159	W	W
Asphaltic concrete aggregates and other bituminous mixtures	W	W	191	590	210	770
Road base and coverings[1]	1,418	3,419	346	944	1,202	2,690
Fill	207	501	139	327	177	580
Snow and ice control	15	46	48	160	W	W
Railroad ballast	—	—	—	—	—	—
Other miscellaneous uses[2]	242	633	—	—	77	297
Unspecified:[3]						
Actual	490	2,980	176	850	712	2,811
Estimated	1,411	4,280	49	168	4,367	16,014
Total[4]	4,273	13,373	1,783	5,918	6,984	24,244
Total[5 6]	3,876	13,373	1,618	5,918	6,336	24,244

	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	885	3,512	14	48	727	3,666
Plaster and gunite sands	11	51	—	—	W	W
Concrete products (blocks, brick, etc.)	W	W	—	—	52	394
Asphaltic concrete aggregates and other bituminous mixtures	141	615	(7)	1	W	W
Road base and coverings[1]	60	197	133	326	74	504
Fill	160	567	11	26	540	1,121
Snow and ice control	W	W	1	3	29	147
Railroad ballast	W	W	—	—	—	—
Other miscellaneous uses[2]	48	212	—	—	67	239
Unspecified:[3]						
Actual	365	1,281	—	—	355	1,552
Estimated	67	229	46	156	—	—
Total[4]	1,737	6,664	204	560	1,845	7,622
Total[5 6]	1,576	6,664	185	560	1,674	7,622

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.
[7]Less than 1/2 unit.

produced by two firms in Muscatine and Worth Counties. National Gypsum Co. expanded crude perlite at two plants in Webster County. Perlite was sold primarily for plaster aggregate.

Iron oxide pigments were shipped into the State by brick companies for use as a coloring agent. Granite and marble were purchased by Iowa stone firms for monument fabrication.

Metals

Aluminum.—The Aluminum Co. of America operated an aluminum rolling mill near Davenport. The Davenport Works employed about 2,800 workers and produced 272,000 metric tons (300,000 short tons) annually. Sales were to the aerospace, automotive, and sheet metal industries.

Quanex Corp., Houston, TX, operated an aluminum plant at Davenport. During the year, Quanex completed a $60 million aluminum minimill next to its Davenport plant.

Brass-Copper.—PMX Industries, a subsidiary of Poongsan Corp., Seoul, Republic of Korea, operated a brass and copper rolling mill at Cedar Rapids. The mill produced brass and copper coils. Preliminary design work for a specialty steel mill at the Cedar Rapids facility was completed, but the project was on hold.

Ferroalloys.—Silvery pig iron and 50% ferrosilicon were produced by Keokuk Ferro-Sil Inc. at a Keokuk plant. This was the only U.S. silvery pig iron plant; the material was used in the manufacture of steel alloys.

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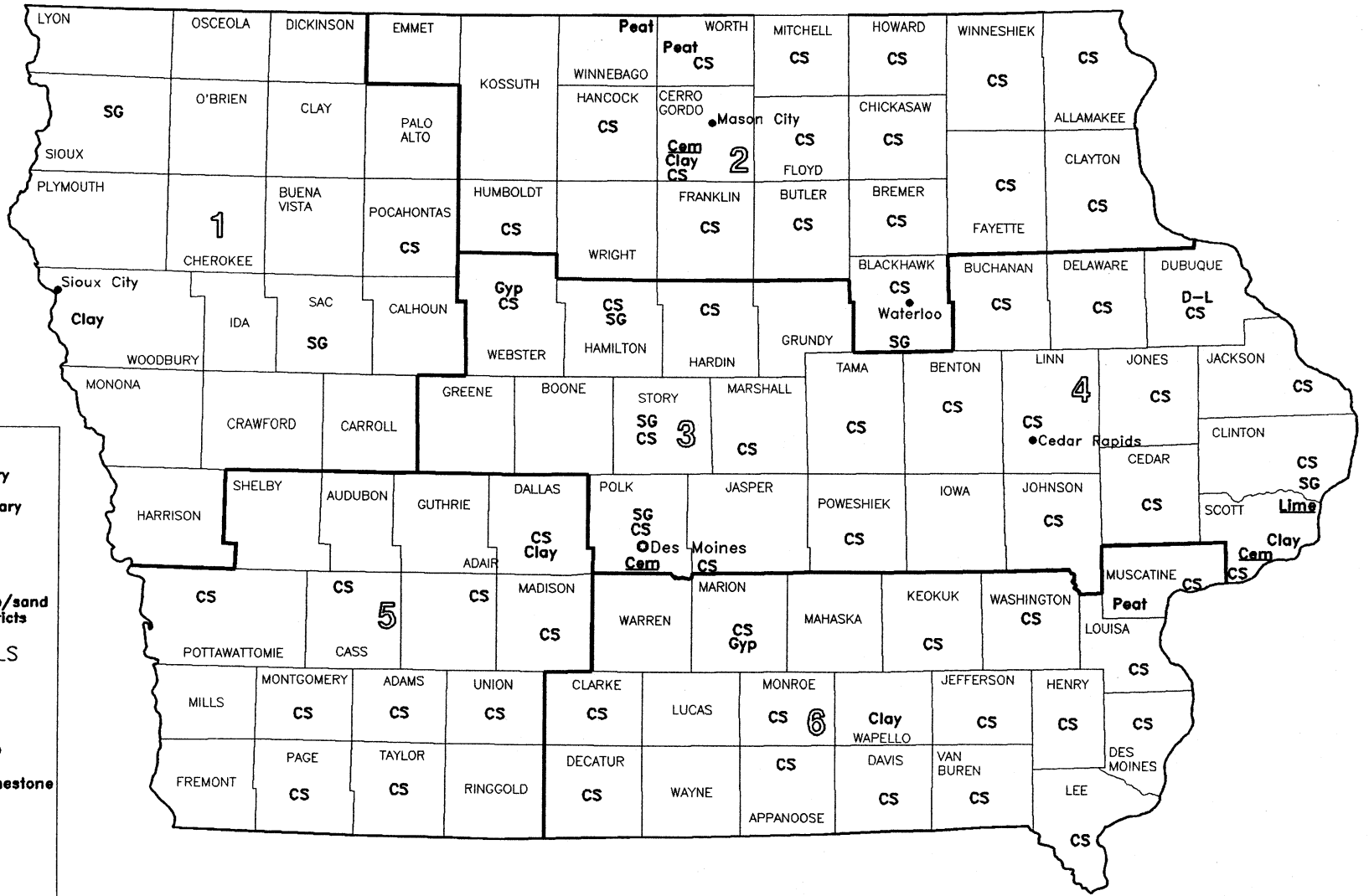
[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 32 years of mineral-related industry and government experience. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

[2]Geologist, Iowa Department of Natural Resources, Geological Survey Bureau, Iowa City, IA.

IOWA



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Cem	Cement plant
Clay	Clay
CS	Crushed Stone
D–L	Dimension Limestone
Gyp	Gypsum
Lime	Lime plant
Peat	Peat
SG	Sand and Gravel

Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Davenport Cement Co., a subsidiary of Cementia Holdings AG.	Box 4288 Davenport, IA 52801	Quarries and plant	Scott.
Holnam Inc., Dundee Div.	1840 N. Federal, Box 1008 Mason City, IA 50402	Quarry and plant	Cerro Gordo.
Lehigh Portland Cement Co., a subsidiary of Heidelberger Zement AG.[1]	Route 1, Box 200 Mason City, IA 50401	do.	Do.
The Monarch Cement Co.	5200 Park Ave. Des Moines, IA 50321	do.	Polk.
Clays:			
Lafarge Corp.[2]	Box 4049 Davenport, IA 52808	Quarries and plants	Scott.
Midland Brick Co.	Box A Redfield, IA 50233	do.	Dallas.
Sioux City Brick & Tile Co.	Box 807 501 Orpheum Bldg. Sioux City, IA 51102	do.	Dallas and Woodbury.
Gypsum:			
Celotex Corp., a division of Jim Walter Corp.	Box 698 Fort Dodge, IA 50501	Quarries and plant	Webster.
Georgia-Pacific Corp., Gypsum Div.	Box 758 Fort Dodge, IA 50501	Quarry and plant	Do.
Kaser Corp.[3]	Box 3569 Des Moines, IA 50322	Underground mine	Marion.
National Gypsum Co., Gold Bond Building Products Div.	Box 977 Fort Dodge, IA 50501	Quarry and plant	Webster.
United States Gypsum Co.	Box 878 Fort Dodge, IA 50501	Underground mine, quarries, plants	Des Moines and Webster.
Lime:			
Linwood Mining & Minerals Corp.[2]	401 East Front St. Davenport, IA 52804	Quarry, underground mine, plant	Scott.
Peat:			
Colby Pioneer Peat Co.	Box 8 Hanlontown, IA 50444	Plant	Worth.
Pikes Peat Co.	Route 6, Box 21 Muscatine, IA 52761	do.	Muscatine.
Perlite (expanded):			
National Gypsum Co., Gold Bond Building Products Div.	Box 977 Fort Dodge, IA 50501	do.	Webster
Sand and gravel (construction):			
Acme Fuel & Material Co.	Route 5, Box 34 Muscatine, IA 52761	Quarries and plant	Muscatine.
Basic Materials Corp.[4]	Box 2277 Waterloo, IA 50704	Quarries and plants	Black Hawk and Worth.
C & M Sand & Gravel Co.	727 Walnut St. Webster City, IA 50595	Pits and plants	Hamilton
Hallett Materials Co.	Box 3365 Des Moines, IA 50316	do.	Cherokee, Osceola, Polk, Sac, Story.
Kaser Corp.	P.O. Box 3569 Des Moines, IA 50322	do.	Jasper and Marion
Martin Marietta Aggregates Inc., Central Div.[5]	30013 SW 42d St. Topeka, KS 66609	Quarries, underground mine, plants	Various (13 counties).

See footnotes at end of table.

Table 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone:			
Crushed:			
Midwest Limestone Co. Inc.	Box 281 Gilmore City, IA 50541	Quarries and plants	Humboldt and Pocahontas.
The River Products Co. Inc.	103 E. College, Suite 220 Iowa City, IA 52240	Underground mine, quarries, plants	Johnson, Louisa, Washington.
Schildberg Construction Co. Inc.	Box 358 Greenfield, IA 50849	Quarries and plants	Adair, Adams, Cass, Dallas, Madison, Page, Pottawattamie, Taylor, Union.
Vulcan Materials Co.	5300 North Park Place, NE Box 1428 Cedar Rapids, IA 52406	do.	Benton, Clinton, Jackson, Johnson, Jones, Linn, Tama.
Wendling Quarries Inc.	Box 120 DeWitt, IA 52742	do.	Cedar, Clayton, Clinton, Delaware, Dubuque, Henry, Jackson, Jones, Linn, Muscatine.
Dimension:			
Weber Stone Co. Inc.[6]	Route 1 Anamosa, IA 52205	do.	Jones.

[1]Also clay and crushed stone in Cerro Gordo County.
[2]Also crushed stone in Scott County.
[3]Also crushed stone in Jasper, Keokuk, Marion, Monroe, Polk, and Washington Counties.
[4]Also crushed stone in Black Hawk, Bremer, Hancock, and Worth Counties.
[5]Also crushed stone in 23 counties.
[6]Also crushed stone in Jones County.

THE MINERAL INDUSTRY OF KANSAS

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Kansas Geological Survey for collecting information on all nonfuel minerals mined in the State.

By Jeanne E. Zelten[1] and David A. Grisafe[2]

The value of Kansas nonfuel mineral production was more than $405 million in 1992, an increase of $3.8 million over that reported to the U.S. Bureau of Mines by State mineral producers in 1991. This was a new State record for nonfuel mineral value; the previous record of $366.7 million was established in 1991. The new record was attained primarily because of increased total value of portland cement, helium, salt, and sand and gravel. Salt retained its first place ranking among the mineral commodities produced in the State, accounting for 24% of the total nonfuel mineral value. Kansas ranked 25th nationally in total nonfuel mineral value and continued as the Nation's leading producer of crude and refined helium. The State contributed about 1.3% of the Nation's total nonfuel mineral value of almost $32 billion. In industrial mineral production, Kansas ranked 19th nationally, contributing about 1.8% of the $20.7 billion revenues received.

TRENDS AND DEVELOPMENTS

The recession and anticipated slow recovery were expected to continue to influence the construction industry. Consolidation of operations and divestitures of extended company holdings were expected to increase as company strategies shifted to adapt to changing economic conditions. Compliance with Federal, State, and local regulations undoubtedly will occupy a larger percentage of operators' time and resources.

Worked-out portions of underground limestone quarries and salt mines in the Kansas City and Hutchinson areas continued to be used for controlled-environment storage, manufacturing, and office space. Constant temperature, pressure, and humidity are useful for

TABLE 1
NONFUEL MINERAL PRODUCTION IN KANSAS[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	39	$2,011	e30	e$1,530	34	$1,914
Portland	do.	1,707	76,564	e1,466	e65,970	1,710	79,464
Clays	metric tons	625,969	4,056	607,419	2,828	544,052	3,921
Gemstones		NA	W	NA	527	NA	W
Helium (Grade-A)	million cubic meters	W	W	39	76,540	W	W
Salt[2]	thousand metric tons	2,168	92,119	2,101	97,713	1,852	98,620
Sand and gravel (construction)	thousand short tons	r10,737	r23,771	e9,600	e22,100	11,979	27,289
Stone:							
Crushed[3]	do.	e20,800	e79,200	16,802	67,249	e16,900	e69,600
Dimension	short tons	3 r e30,315	3 r e3,142	3 r30,807	3 r3,128	W	W
Combined value of gypsum (crude), helium (crude), pumice, salt (brine), sand and gravel (industrial), stone [crushed quartzite (1991-92), crushed sandstone and quartzite (1990)], dimension sandstone (1990-91), and values indicated by symbol W		XX	r67,875	XX	r29,156	XX	124,274
Total		XX	r348,738	XX	r366,741	XX	405,082

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes salts in brines; value included with "Combined value" figure.
[3]Excludes certain stones; kind and value included with "Combined value" figure.

storage of sensitive materials such as movie film and paper documents. Several companies were evaluating expansion possibilities while others were considering alternate uses of their mines.

Lone Star Industries Inc. continued reorganization procedures under chapter 11 of the Federal Bankruptcy Act. The company reorganized its board of directors under pressure from stockholders.

AFG Industries Inc., located at Spring Hill in Wyandotte County, was acquired by foreign interests. AFG said the acquisition was not expected to affect company management or operations. The Kansas plant employs about 300 people in the production of glass for residential doors and windows.

EMPLOYMENT

At yearend, total mineral industry employment in Kansas was 9,737 workers. This figure represents an increase of 137 over that of 1991. Employment in the nonfuel mining sector increased 737 to 2,137 from December 1991 to December 1992. This included an average of 1,081 workers per day at surface operations, 138 at underground mines, and an average of 918 workers at mills and preparation plants.[3] Employment in the oil and gas extraction sector at yearend had decreased from 8,200 in 1991 to 7,600 in 1992, a decrease of 600 or 7.3%. In addition, an average of 74 coal miners worked daily during 1992. This was a decrease of about 19.6% from the 92 workers employed at coal mines in 1991. An average of nine employees worked daily at coal preparation plants.[4]

Employment in the mineral-dependent construction industry increased from 43,100 in December 1991 to 43,600 in December 1992. A decrease of 300 employees occurred in the stone, clay, and glass products sector, bringing the yearend total to 5,700. Employment in the metals sector increased from 2,800 in 1991 to 3,000 in 1992.[5]

According to the U.S. Department of Labor, injuries reported from nonfuel surface and underground mines totaled 54 injuries resulting in lost workdays and 53 injuries with no lost workdays during 1.85 million hours worked. More than 1.8 million hours worked at mills and preparation plants resulted in an additional 81 injuries causing lost workdays and 93 injuries with no days lost. In addition, surface coal mines reported two injuries resulting in lost work days and two injuries with no days lost during 144,842 hours worked. One injury causing no lost workdays was reported from 16,776 hours worked at mills and preparation plants.[6]

ENVIRONMENTAL ISSUES

To comply with new Environmental Protection Agency (EPA) regulations that will make recycling mandatory, Brown County officials investigated building a permanent recycling center at the county landfill. A recycling facility in buildings at the airport would be moved to make room for other operations in the buildings. Curbside pickup, hazardous material check programs, and a multicounty landfill were under consideration at yearend.

The Occupational Safety and Health Administration (OSHA) ruled that six nonasbestiform minerals, including actinolite, tremolite, and anthophyllite, would no longer be treated as forms of asbestos in health and safety regulations. These minerals, commonly found in aggregates, will be regulated as particulates. The ruling could save operators $7 million annually in control measures to deal with the minerals. The rule became effective May 29, after 6 years of debate.

EPA issued two regulations to implement air pollution controls required by the Clean Air Act Amendments of 1990. These included regulation of a number of mineral-products industries for toxic air pollutants and the implementation of permitting requirements for all major sources of air pollution. Also, new standards were set for particulate matter that apply to calciners and dryers at plants processing or producing construction products, including lightweight aggregate. EPA anticipated product price increases resulting from the new standards probably would be less than 0.5%, but could be as much as 1.75% for the lightweight aggregate industry.

EPA studied both the process and affects of using waste products as fuel in cement kilns. The studies were in response to public opposition and in an effort to reduce regulatory burdens on industry and to redefine a waste. All cement kilns in Kansas used waste material as part of their fuel input. EPA determined that there was no threat to human health or to the environment from the emissions created by burning certain hazardous wastes in cement kilns. Studies also indicated that cement products did not contain measurable increases in toxic metals. New regulation, expected in late 1994, would eliminate excessive regulations prohibiting the use of hazardous waste in the production of cement and other building materials.

A Kansas Air Quality Act met defeat when an undesirable amendment attached to the bill cost support for the measure. A similar plan may be introduced during the 1993 legislative session.

During the year, all of the quarry operators producing crushed stone collected stormwater discharge samples and submitted them to EPA, as per EPA requirements.

Existing sand and gravel dredge operators began to establish baseline data along the Kansas River, as required by the U.S. Army Corps of Engineers. The data are necessary before it can be determined how much degradation or riverbed lowering occurs as a result of dredging operations.

Several industries saw increased competition from alternative products, especially waste products, which often were sold at prices undercutting the prices of mined materials. Because of the increasing need to dispose of large quantities of waste material, the trend was expected to increase in coming years. Bottom ash, the residue produced at coal-burning powerplants, was sold for use as a lightweight aggregate in masonry applications. Byproduct lime and gypsum

from water-treatment facilities and flue gas desulfurization were used for soil conditioning, gypsum-board manufacture, and portland cement. Alkaline fly ash was used for stack gas cleaning. Concrete and road asphalt also were recycled.

In response to the Clean Air Act Amendments of 1990, research was carried out by Federal and State agencies in an attempt to substitute various materials for traditional mined materials to produce usable byproducts. For example, phosphate was used to replace limestone in flue gas desulfurization, resulting in a salable fertilizer byproduct. Innovative use and handling of waste products, along with demand for a number of industrial minerals and a variety of chemicals, was expected to increase as operators modify their facilities to comply with the new regulations.

Twelve sites in Kansas are on the EPA National Priorities List (NPL). Two of these Superfund sites, the Big River Sand Co. site and the Cherokee County site, involve previous mining operations. The Big River Sand Co. site is a 123-acre sand and gravel mining operation in Sedgwick County. The former owner disposed of paint-related waste on the property. In 1984 a surface cleanup was completed. Subsequent investigations showed that the site was no longer a threat to the community or the environment and the site was recommended for removal from the NPL.

The Cherokee County site is a 110-square-mile area of the Tri-State mining district in Cherokee County, in the southeastern corner of the State. Halliburton Co., E. I. du Pont de Nemours and Co., and more than a dozen other companies were cited by EPA in connection with mine cleanup in the mining district. The district encompasses Cherokee County, KS, Jasper County, MO, and Ottawa County, OK. Preliminary studies revealed lead, zinc, and cadmium contamination in soils, waste piles, and ground water. EPA planned to complete analysis of the site in 1993. The site was divided by EPA into six subsites, which correspond to six general mining locations. The cost of the study to determine the extent of environmental damage will be shared by Halliburton, Du Pont, and seven other companies. Cleanup could reach the tens or even hundreds of millions of dollars.

In July 1990, the Kansas Department of Health and Environment was awarded a $387,000 grant for a 2-year study on the effects of lead and cadmium from abandoned mines and smelters on residents in the Galena area, Cherokee County. The study was funded by the Agency for Toxic Substances and Disease Registry. The Galena area is a 25-square-mile subsite of the Cherokee County Superfund site. In 1991, phases 1 and 2 of the project were completed and phase 3 was begun. Phase 1 included preliminary background work such as developing protocols, awarding contracts, and compiling existing data. Phase 2 included conducting a house-to-house census and distributing extensive questionnaires to residents. A random study group was selected, samples were taken, and other data collected. Phase 3, the data analysis phase, was begun in late 1991 and completed in 1992. The final report was expected to be completed in early 1993. The U.S. Bureau of Mines was involved with EPA in a cooperative reclamation study of the area, which began in 1987.

LEGISLATION AND GOVERNMENT PROGRAMS

The State was awarded three grants, totaling $702,127, from the U.S. Department of the Interior's Office of Surface Mining Reclamation and Enforcement. The funds will be used to administer the State's abandoned mine lands reclamation program, to fund anticipated emergency projects at abandoned coal mines, and to assist with State regulation of the surface effects of coal mining. The State also received $200,000 from the U.S. Department of Agriculture to help fund the Rural Abandoned Mine Reclamation Project.

House bill 2801 modified and made additions to the solid waste management statutes of the State. More stringent requirements were established regarding the disposal of solid wastes, including such things as the submittal of detailed waste management plans, the formation of waste management committees, and the imposition of waste tonnage fees.

Senate Concurrent Resolution 1633 extended the date from January 31, 1992, to January 31, 1993, for the Commission on Natural Gas Policy to submit its written report to the Governor and legislature with regard to State and Federal energy policies affecting natural gas. The commission was established in 1991 by Resolution 1626.

The U.S. Army Corps of Engineers stated that artificially created lakes and ponds excavated from dry land, including those created by aggregate producers, are not included under the definition of jurisdictional wetlands. With less regulatory restriction, operators are allowed greater flexibility in quarry development and reclamation.

The Kansas Department of Transportation (DOT) reported that contracts let during fiscal year 1993 (beginning July 1992) were $284.2 million. This is a drop from the $310.2 million reported for fiscal 1992 but the department said that the figures had to do with the planning time involved with more difficult projects before contracts were let. Less planning was necessary for contracts let in fiscal 1992. The department also suggested there would be a sharp increase for contracts let in fiscal 1994.

The Kansas DOT completed the Kansas Comprehensive Highway Program, a 5-year program to be implemented beginning in fiscal year 1993. Four major components of the program include substantial maintenance of existing roadways and bridges, major modification of the highway system to expand it and enhance safety, bridge replacements and modernization, and system enhancements involving safety, relief of congestion, improved access, and enhancement to economic development. Funding will be provided by a variety of Federal, State, and local government funds.

Several ongoing State and Federal Government programs provided information beneficial to mineral producers in the State. Scientists with the Kansas Geological Survey continued to evaluate drill core and seismic data from the Midcontinent Rift in north-central Kansas for base and precious-metal resource potential. The mineral resource potential of Permian red-bed deposits in the western part of the State also was evaluated. The study is part of a cooperative program with the U.S. Geological Survey to study the relationship between copper deposits in the red-beds and major evaporite sequences in Kansas. Studies continued on alkaline igneous intrusions in the Rose and Silver City domes in the southeastern part of the State.

Passage in May of the National Geologic Mapping Act of 1992, Public Law 102-285, could result in improved mapping coverage for Kansas. The State map component of the act identifies State geological surveys as the lead agencies to establish mapping priorities in their respective States. States must compete for funding, and equal distribution among States is not guaranteed. States are required to match the awarded funds. For 1993, full authorization of $18 million to States was funded at only $1.39 million.

FUELS

Oil, gas, and coal were produced in Kansas in 1992, primarily for use as fuels. The State received oil and gas mineral revenues, distributed to States by the Minerals Management Service and the Bureau of Land Management for onshore mineral leases on Federal lands, totaling $1,113,000 in 1992. This was an increase of $192,000 from 1991 distributions of $921,000.[7]

Oil and gas continued as a major portion of the Kansas mineral value produced. Production of oil was about 53.6 million barrels, a decrease of about 3.3 million barrels from that of 1991.[8] Natural gas production of more than 644 billion cubic feet was a decrease of about 10 billion cubic feet from 1991 production. Kansas ranked ninth nationally in oil production and sixth in the production of natural gas.[9]

Kansas ranked third in oil and gas well drilling in the United States in 1992, with a total of 1,443 wells drilled. This was a decrease of about 28% below the 2,008 completions in 1991. Of the 1992 total, 522 were oil wells, 192 were gas wells, and 729 were dry holes. New field wildcats accounted for 261 wells, 208 of which were dry holes. Interest in the Hugoton Basin in southwestern Kansas remained high. Drilling also was high in the Colony-Welda field, Anderson County, in the east-central part of the State. Exploration and development activities were low nationally as companies sought to reduce operating expenses. Unusually mild weather contributed to low sales of oil and gas.[10] Drilling and production increased toward yearend and were expected to increase in 1993 in response to increased demand resulting from Federal legislation, economic recovery, increased use of natural gas by electric utilities and fleet vehicles, and expansion of the interstate pipeline system.[11] Several energy tax proposals will be evaluated during 1993.[12]

Exploration for coalbed methane throughout eastern Kansas continued, particularly in Montgomery and Wilson Counties. Some activity also occurred in Coffey, Jackson, Labette, Leavenworth, Linn, Miami, and Shawnee Counties. Coalbeds in the Cherokee Group are good candidates for coalbed methane gas.

In a cooperative program with the USGS and the State Geological Surveys of Iowa, Missouri, and Nebraska, the State participated in a proposed 4-year study of coalbed methane in the Forest City Basin, underlying the northeastern corner of the State. More than 5,000 wells have been drilled in Kansas to evaluate gas potential. If commercial quantities of coalbed methane occur, the possibilities for production will be evaluated. Together with the USGS, the four States have applied to the U.S. Congress for $8 million, to be used during the study. A 6-month pilot study was approved by Congress in October.

Coal production decreased again in 1992. Total production, about 363,000 short tons,[13] was a decline of almost 13% from the 1991 production of 416,000 short tons and the lowest production reported in the State in more than 10 years.[14] Kansas ranked 24th nationally in coal production. High volatile bituminous coal was produced from three mines in Crawford County, in the southeastern portion of the State. Bituminous coal prices increased slightly from $22 per short ton in 1991 to $22.50 per short ton in 1992. Principal sales were to electric companies.[15]

The Interstate Oil and Gas Compact Commission and the Southern States Energy Board co-sponsored a conference, Coal and Natural Gas: Partner for Progress, to explore opportunities in co-firing for utilities and other industries. Increased environmental regulations will present opportunities for co-firing, particularly at powerplants. Education and cooperation will be essential if such programs are to succeed.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Production of industrial minerals in 1992 was influenced by slight increases in the construction industry as the economy slowly began to recover.

Permit-authorized construction in 1992 totaled almost $1.45 billion. The number of single- and multifamily residential units totaled 10,059, an increase of 1,855 over that of 1991. The value of nonresidential construction was nearly $480.6 million, while nonbuilding construction, including highways, totaled about $6.2 million.[16]

Increased highway construction in 1992 provided a boost to the industry. At yearend, residential construction was improving slowly, but commercial building remained stagnant, consisting primarily of remodeling existing facilities.

Aggregate and cement production increased in 1992, mostly because of increased funding for highway construction provided by the $151 billion

Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). Good weather also was a factor. As a result of ISTEA, Kansas increased transportation-related construction and anticipated further increases in 1993, as did most States. ISTEA funds are allocated over 6 years for improvements to highways and bridges. More than one-half the funding could be used for mass transit and other nonhighway purposes.

Based on anticipated increases in public works projects, residential building, environmental work, and road construction, the demand for aggregate and portland cement in the United States was expected to increase by up to 6% in 1993. Production in the State was anticipated to increase by up to 10% in 1993, the first year the State's expanded highway program will be in effect. Work at the Wichita Mid-Continent Airport was approved for 1993. Residential and commercial construction also were expected to increase.

Environmental and zoning regulations were cited as the primary reasons for making it increasingly difficult for the construction aggregates industry to expand existing quarries and to develop new quarry operations. As operations are forced to move further from market areas, transportation costs increase, ultimately affecting aggregate prices and competition.

Salt, helium, and crushed stone remained the leading industrial mineral commodities in terms of value and accounted for about 67% of the State's total nonfuel mineral value.

Cement.—Portland and masonry cement sales of $81 million ranked cement third among the industrial minerals produced and accounted for about 20% of the total 1992 mineral value. The State ranked 14th among the 37 portland cement-producing States and 22d among the 36 States with masonry cement facilities. Sales of portland cement increased almost $13.5 million, and masonry cement sales increased $384,000 above those reported in 1991. Anticipated increases in highway and public works projects in 1993 could increase sales up to 5%.

In 1991, cement operations included four plants in the southeastern part of the State: The Monarch Cement Co. at Humboldt, in Allen County; Heartland Cement Co. at Independence, in Montgomery County; Ash Grove Cement Co. at Chanute, in Neosho County; and Lafarge Corp.'s Fredonia Co-Processing Facility at Fredonia, in Wilson County. Monarch, in the Kansas City area of Wyandotte County, was the only cement producer to operate a ready-mixed concrete plant. The four companies produced both portland and masonry cement from four wet-process and seven dry-process kilns.

Cement plant operators continued to explore the use of waste products as fuel in cement kilns. Faced with low cement prices and a recovering economy, the industry investigated ways to cut fuel costs, which constituted approximately 25% of operating expenses. The high temperatures needed in cement kilns were used to burn waste materials, such as waste fuels, industrial wastes, spent organic solvents, and used tires. Canned wastes and tires were placed directly into the cement kilns along with the other raw materials; the high temperature completely decomposed the organic material. Because portland cement clinker requires a certain amount of iron, the metal containers and the steel radial belts from the tires are simply incorporated into the clinker. Hazardous wastes have been burned in cement kilns for years, and in 1992, waste fuels accounted for about 6.6% of the energy used for making cement in the United States. It appeared to be an environmentally safe and efficient way to dispose of hazardous waste and other materials that have long been a problem, thereby eliminating the need to mine other resources to satisfy fuel requirements.

The Monarch Cement Co. at Humboldt, Allen County, used tire-derived fuel regularly in its kilns during 1992. The company used tires to supply as much as 10% to 15% of its fuel requirements. Scrap tire sources included county landfills and tire companies and were acquired through brokers in the Kansas City and Wichita areas. Monarch was the only cement plant in the State that used only solid, nonhazardous material as an alternate fuel.

Ash Grove Cement Co. at Chanute, Neosho County, used canned waste products as an alternate fuel source. Heartland Cement Co. used spent organic solvents and canned organic wastes in its clinker operation in Independence, Montgomery County.

Lafarge Corp., the first cement producer in the State to use waste fuels, used supplemental fuels for more than 80% of its fuel requirements. Industrial wastes, such as a refinery byproduct banned from land disposal, were used successfully in the kilns. As of late 1991, all the State's cement plants were using waste material as a fuel source.

As part of a restructuring plan, BJ Titan Services Co. of Houston, TX, sold its cement interests in three Kansas operations to Allied Cementing Co. Inc., Russell County. The operations originally were purchased by BJ Services in 1980.

Clay.—Kansas ranked 22d among 44 States producing clay and shale, and sales accounted for almost 1% of the Kansas mineral value in 1992. Only common clay production was reported. Production decreased by 63,367 metric tons, but value increased $1,093, from what was reported by the industry in 1991.

Common clay production was reported by 11 companies operating 20 mines in 11 counties. The four leading counties, Allen, Montgomery, Neosho, and Woodson, accounted for about 60% of the tonnage produced. Principal end use reported by clay producers was portland cement manufacture. Other uses included common brick, animal feed supplements, lightweight aggregate, and sewer pipe.

Three companies manufactured brick at four plants in the State in 1992. Acme Brick Co. produced face, common building, and paving brick, as well as crushed brick for landscaping, at plants in Kanapolis, Ellsworth County, and Weir, Cherokee County. Face, common building, and paving brick were produced

by Cloud Ceramics at a plant in Concordia, Cloud County, and by Kansas Brick and Tile Co. Inc. at a plant in Hoisington, Barton County.

Gypsum.—Increased housing construction resulted in the gypsum industry beginning to rebound from 1991 losses, a trend expected to continue into 1993. Although commercial construction remained somewhat low, repair and remodeling of commercial buildings provided a boost to the industry.

Kansas ranked seventh in value of 19 States reporting crude gypsum production in 1992. Two companies, Georgia-Pacific Corp. in Blue Rapids, Marshall County, northeastern Kansas, and Gold Bond Building Products Div. of National Gypsum Co. in Medicine Lodge, Barber County, in the south-central part of the State, reported gypsum production in 1992. Both companies calcined the crude ore at plants near their mines. Crude gypsum production and value increased about 3.6% above levels reported by the two producers in 1991.

National Gypsum's Sun City mine, in Medicine Lodge, is the ninth largest producer in the United States. The company, the second largest producer of gypsum and gypsum products, remained under chapter 11 bankruptcy protection at yearend.

The gypsum market continued to be pressured by overcapacity and record-low prices. Substantial increase in available gypsum from flue gas desulfurization could create major concerns for the industry.

Helium.—Kansas continued to rank first of two States reporting production of crude helium in 1992. The State also ranked first of four States producing Grade-A helium.

Crude helium (at least 50% purity) was produced from natural gas and then purified to Grade-A helium (at least 99.995% purity). Reported crude helium production and value decreased by 20% and almost 18%, respectively, below 1991 levels. Reported Grade-A helium production by private industry increased substantially in both quantity and value.

Crude helium extraction facilities were operated by four companies: Enron Helium Co. at Bushton, in Ellsworth County; Kansas Nebraska Energy Inc. at Scott City, in Scott County; Centana Energy Corp. (National Helium Corp.) at Liberal, in Seward County; and Trident Helex Inc. at Ulysses, in Grant County. Grade-A helium was produced by Air Products and Chemicals Inc. at Liberal, in Seward County; Kansas Refined Helium Co. at Otis, in Rush County; and Praxair Inc.'s plants at Bushton, in Ellsworth County, and at Ulysses, in Grant County. The plants producing Grade-A also liquified helium.

Crude helium was sold to helium purification companies or stored. Surplus crude helium was stored under contract in the U.S. Bureau of Mines Cliffside Storage Reservoir near Amarillo, TX. The stored helium was returned to the owners for purification and sale when crude demand exceeded production.

Union Carbide Corp.'s industrial gas division formed a separate corporation and began operating under the name Praxair Inc. Mesa Petroleum continued construction of its Mesa Satanta helium plant near Satanta. The plant will have a capacity of 220 million cubic feet per year. Production was expected to begin in 1993.

Salt.—Salt continued as the State's leading mineral commodity, accounting for almost 24% of the total nonfuel mineral value. The State ranked fifth among the 14 salt-producing States. Reported salt production decreased 249,000 short tons and value increased $907,000 from reported 1991 levels. Demand for salt varied greatly throughout the year because of weather. Relatively mild weather early in the year resulted in low demand. At yearend, numerous storms throughout the Midwest depleted inventories, and producers were unable to keep up with the demand.

Several companies produced salt from Ellsworth, Reno, and Rice Counties in the south-central part of the State. Three companies operated underground room-and-pillar mines and two operated both underground mines and brine wells. In addition, one company in Sedgwick County operated only brine recovery wells for chloralkali feedstock used in the production of chlorine, caustic and chlorinated chemicals.

Lyons Salt Co. considered the storage, in unused parts of its Rice County mine, of nontoxic ash from metropolitan generating plants that use municipal debris for fuel. The company hoped to attract a railroad by providing a two-way haul, bringing ash into the mine as well as carrying salt out. Unused mine space was offered for document or information storage but, by yearend, the company had no customers.

Lyons Salt Co. was recognized by the Salt Institute for setting nationwide safety performance records for the lowest incidence and severity rates of accidents among salt mining and processing facilities. Also receiving safety awards from the Salt Institute during the year were Morton Salt Co. and North American Salt Co. The industry celebrated its safest year nationwide since 1969, when the awards programs were implemented.

Sand and Gravel.—Both construction sand and gravel and industrial were mined in Kansas during 1992. Sand and gravel was produced in most counties from a variety of deposits. Construction sand and gravel production, the fifth largest commodity, constituted about 6.7% of the total nonfuel mineral value produced in the State in 1992.

Construction.—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Mining and sales of construction sand and gravel accounted for about 6.7% of the Kansas mineral value in 1992. Reported production was more than 1.2 million short tons above that reported in 1990, reflecting increased construction activity. Reported value increased more than $3.5 million above that reported by

TABLE 2
KANSAS: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,130	$7,459	$2.38
Plaster and gunite sands	113	278	2.46
Concrete products (blocks, bricks, pipe, decorative, etc.)	194	491	2.53
Asphaltic concrete aggregates and other bituminous mixtures	1,594	4,493	2.82
Road base and coverings[1]	3,303	7,082	2.14
Fill	1,423	2,073	1.46
Snow and ice control	109	323	2.96
Other miscellaneous uses[2]	160	363	2.27
Unspecified:[3]			
Actual	493	1,113	2.26
Estimated	1,460	3,614	2.48
Total	11,979	27,289	2.28
Total[4 5]	10,867	27,289	2.51

[1]Includes road and other stabilization (cement).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

industry in 1990 and nearly $5.2 million above the estimated 1991 value. Kansas construction sand and gravel statistics are compiled by geographical districts, as depicted on the State map. Tables 2 and 3 present end-use data for this commodity in the State and in the six Kansas districts. District 5, in the south-central part of the State, reported the highest production, followed by districts 1, 4, 2, 3, and 6.

The construction sand and gravel industry consisted of 106 companies operating 303 pits in 62 of the State's 105 counties. The five leading counties, in decreasing order of tonnage produced, were Johnson, Douglas, Finney, Kearny, and Geary. About 20% of the State's production was from these counties. Five companies, Associated Material and Supply Co. Inc., Builders Sand Co., Central Sand Inc., Holliday Sand and Gravel Co., and Ritchie Sand Inc., together produced about 38.6% of the State total. Major end uses reported by producers included road base and coverings, concrete aggregate, asphaltic concrete aggregate and bituminous mixtures, and fill. A majority of the material was transported by truck from pits to plants and construction sites.

Industrial.—In 1991, production of industrial sand was reported by three companies, Alsop Sand Co. Inc., Holliday Sand and Gravel Co. Div., and Kaw Valley Sand and Gravel Inc., operating mines in Republic and Wyandotte Counties. Reported production and value increased 7.7% and 5%, respectively, above 1991 levels. In 1991, sales were for fiberglass production, sandblast applications, traction sand, and other miscellaneous uses.

Stone.—Both crushed and dimension stone were produced in Kansas during 1992. Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Growth in the lime and limestone industry was enhanced by the Clean Air Act Amendments of 1990 and other environmental legislation, which required installation of stack scrubbers at coal-fired powerplants. Lime and pulverized limestone are used in the scrubbers to remove sulfur oxides from stack gases. As the required scrubbers are installed and plants are brought into compliance with new regulations, the demand for lime and limestone is expected to increase over the next several years. Other areas of continued growth in usage included water treatment, to achieve proper pH balances, and treatment of sewage sludge and hazardous wastes.

The utilization of a stone deposit is determined by the quality of the stone, demand, available transportation, and availability of the deposit. For some aggregate uses and for dimension stone, physical characteristics are significant. For some chemical and other specialized uses, chemical composition is important. If specific physical or chemical characteristics are not important, haulage distances, local demand, and availability are the determining factors.

Crushed.—Crushed stone production estimated for 1992 was 16.9 million short tons valued at an estimated $69.6 million. This was an increase of 98,000 short tons over that reported in 1991. Estimated value increased approximately $2.4 million over that reported for 1991. Estimated sales accounted for about 17% of the State's mineral value in 1992, and nationally Kansas ranked 27th in crushed stone production.

In 1991, the most recent year with a full-year industry canvass, the crushed stone industry reported the operation of 137 quarries by 43 companies in 43 of the State's 105 counties. Limestone, sandstone, and quartzite were the stone types quarried. Limestone comprised more than 98% of the total. Chat also was produced.

The five leading counties in 1991, in decreasing order of tonnage produced, were Johnson, Allen, Elk, Dickinson, and

TABLE 3

KANSAS:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	923	2,284	488	1,574	W	W
Plaster and gunite sands	11	40	7	23	3	8
Concrete products (blocks, bricks, etc.)	W	W	W	W	—	—
Asphaltic concrete aggregates and other bituminous mixtures	431	1,109	262	719	41	99
Road base and coverings[2]	W	W	299	1,042	620	1,111
Fill	186	368	272	331	14	33
Snow and ice control	W	W	W	W	11	23
Railroad ballast	—	—	—	—	—	—
Other miscellaneous uses[3]	326	810	17	56	100	222
Unspecified:[4]						
Actual	163	293	—	—	—	—
Estimated	840	1,958	—	—	—	—
Total[5]	2,880	6,862	1,344	3,745	788	1,496
Total[6 7]	2,613	6,862	1,219	3,745	715	1,496

	District		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	222	642	1,417	2,760	(8)	(8)
Plaster and gunite sands	12	31	80	176	—	—
Concrete products (blocks, bricks, etc.)	46	95	37	93	—	—
Asphaltic concrete aggregates and other bituminous mixtures	300	1,251	518	1,198	—	—
Road base and coverings[2]	1,224	2,269	988	2,301	(8)	(8)
Fill	91	169	860	1,172	—	—
Snow and ice control	24	114	38	88	—	—
Railroad ballast	—	—	—	—	—	—
Other miscellaneous uses[3]	—	—	65	117	—	—
Unspecified:[4]						
Actual	—	—	331	820	—	—
Estimated	40	86	577	1,567	2	3
Total[5]	1,960	4,658	4,910	10,292	54	118
Total[6 7]	1,778	4,658	4,454	10,292	49	118

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Excludes 43,227 short tons valued at $117,874, not reported by county.
[2]Includes road and other stabilization (cement).
[3]Includes filtration.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value in thousand metric tons and thousand dollars.
[8]Withheld to avoid disclosing company proprietary data; included with "Total."

Lincoln. Four companies, N. R. Hamm Quarry Inc., Martin Marietta Aggregates, McAdam Limestone Products Inc., and J. H. Shears & Sons Inc., together produced about 36% of the 1991 State total. All four companies produced limestone; Shears also produced sandstone. Limestone production in 1991 was reported by 41 companies operating quarries in 40 counties. Major end uses reported by limestone and sandstone producers were for graded road base (14%), cement manufacture (12%), and bituminous and concrete aggregate (about 8% each).

Sandstone and quartzite production was reported from five counties in 1991. Sandstone was quarried by Ash Grove Cement Co., Bayer Construction Co. Inc., Bohl Construction Inc., and J. H. Shears & Sons Inc. operating four quarries in Neosho, Franklin, Phillips, and Graham Counties. Sales were for cement manufacture and other unspecified

uses. Quartzite was quarried by Lyon Rock Quarry, in Smith County, and sold for landscaping applications.

Chat, fragments of siliceous rock, limestone, and dolomite remaining from lead-zinc milling operations, is found in Cherokee County. According to State records, Bingham Sand and Gravel produced chat in 1991.

Dimension.—In the 1991 Kansas dimension stone industry, three companies, Bayer Stone Inc., H. J. Born Stone Co. Inc., and Pray Building Stone Co., operated four quarries in Chase, Cowley, and Pottawatomie Counties and produced building limestone. Estimated 1992 production and value decreased significantly below those reported in 1991. According to the Kansas Geological Survey, six other companies produced building limestone, while another company produced building sandstone in 1991. The State ranked 24th nationally in dimension stone production.

Dimension stone, primarily granite and marble, was shipped to a number of stone companies throughout Kansas, cut into shapes, and sold for cemetery monuments and for building applications.

Volcanic Ash, Pumice, and Pumicite.—Kansas was one of six States producing volcanic ash, pumice, and/or pumicite in 1992. Calvert Mines Inc. in Norton, Norton County, and Kansas Minerals Inc. in Burr Oak, Jewell County, operated the State's only volcanic ash mines. Reported production and value increased 6.7% and 77.8%, respectively, over 1991 totals. Processed volcanic ash was sold for use as abrasives, absorbents, filter aids, and roofing.

Other Industrial Minerals.—Several industrial mineral commodities produced in Kansas as byproducts of other industries or shipped into the State either were sold as recovered or processed into higher value products.

Anhydrous ammonia was produced by Farmland Industries Inc.'s 399,000-short-ton-per-year-capacity plant in Lawrence, Douglas County, and the company's 220,000-short-ton-per-year-capacity plant in Dodge City, Ford County. The ammonia primarily was used for agricultural applications.

Tetra Technologies and Vulcan Chemicals entered a joint venture to construct a calcium chloride facility in Wichita, Sedgwick County. The plant, designed and constructed by Tetra, will use byproduct and coproduct hydrochloric acid waste streams provided by Vulcan to produce commercial-grade liquid calcium chloride. Tetra will market the final product, which will be used for snow and ice melting road applications by adding it to rock salt and sand mixtures before application to the road surface. The plant was scheduled to open in January 1993.

A variety of gemstones, minerals, and fossils were collected by amateur collectors and professionals, both for private collections and for commercial sales. The materials were sold as specimens and formed into a variety of decorative items. Rock and mineral specimens included aragonite, barite, calcite, chalcopyrite, chalk, covellite, dolomite, galena, garnet, geodes, selenite gypsum, halite, hemimorphite, limonite, marcasite, opal, freshwater pearls, pyrite, pyrolusite, quartz (clear, amethyst, agate, chert), sphalerite, and spinel. Both massive and crystalline varieties of many of these minerals were collected. Fossils included trilobites and petrified wood.

Micro-Lite Inc., a subsidiary of Clarkson Construction Co. of Kansas City, MO, mined lamproite by surface methods near Chanute, in Neosho County. The material was dried, screened, and sold for animal feed supplements.

Perlite was expanded by Lite Weight Products Inc. at a plant in Wyandotte County. The crude perlite was obtained from mines in the Western United States. Sales were for horticultural aggregate, cavity fill insulation, and concrete aggregate.

Cultured quartz crystals were produced by Thermo Dynamics Corp. in Merriam, Johnson County. The company was one of the two largest producers of cultured quartz crystals in the country. Crystal was produced for both domestic and foreign use in electronics and optical devices.

Two companies, Texaco Refining and Marketing Inc. at El Dorado, in Butler County, and Farmland Industries Inc. at Coffeyville, in Montgomery County, recovered sulfur as a byproduct of petroleum refining. Total recovery increased about 25% and value decreased about 33% from the 1991 amounts reported by the two companies.

PQ Corp.'s zeolite plant in Kansas City, Wyandotte County, produced both detergent- and catalyst-grade zeolite. Sodium silicate, made from sand and soda ash, and aluminum trihydrate are the feed materials for the synthetic zeolites (sodium aluminosilicate). Expansions at the plant, which has been in operation since 1982, were completed in 1991. The expansions were needed because of increased demand for detergent builder for use in phosphate-free detergents.

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[1]State Mineral Officer, U.S. Bureau of Mines, Denver, CO. She has 15 years of mineral-related industry and government experience.

[2]Associate scientist, Geologic Investigations, Kansas Geological Survey, Lawrence, KS.

[3]U.S. Department of Labor, Mine Safety and Health Administration. Mine Injuries and Worktime, Quarterly. Jan.-Dec. 1992.

[4]Kansas Department of Human Resources, Labor Market Information Services. Monthly Labor Summary. Mar. 3, 1993.

[5]Work cited in footnote 4.

[6]Work cited in footnote 3.

[7]Minerals Management Service. Mineral Revenues 1992.

[8]Energy Information Administration. Petroleum Supply Annual, 1992, v. 1, May 1993.

[9]Energy Information Administration. Natural Gas Annual, Oct. 1993.

[10]Petroleum Information. Resume 1992.

[11]Work cited in footnote 8.

[12]Work cited in footnote 9.

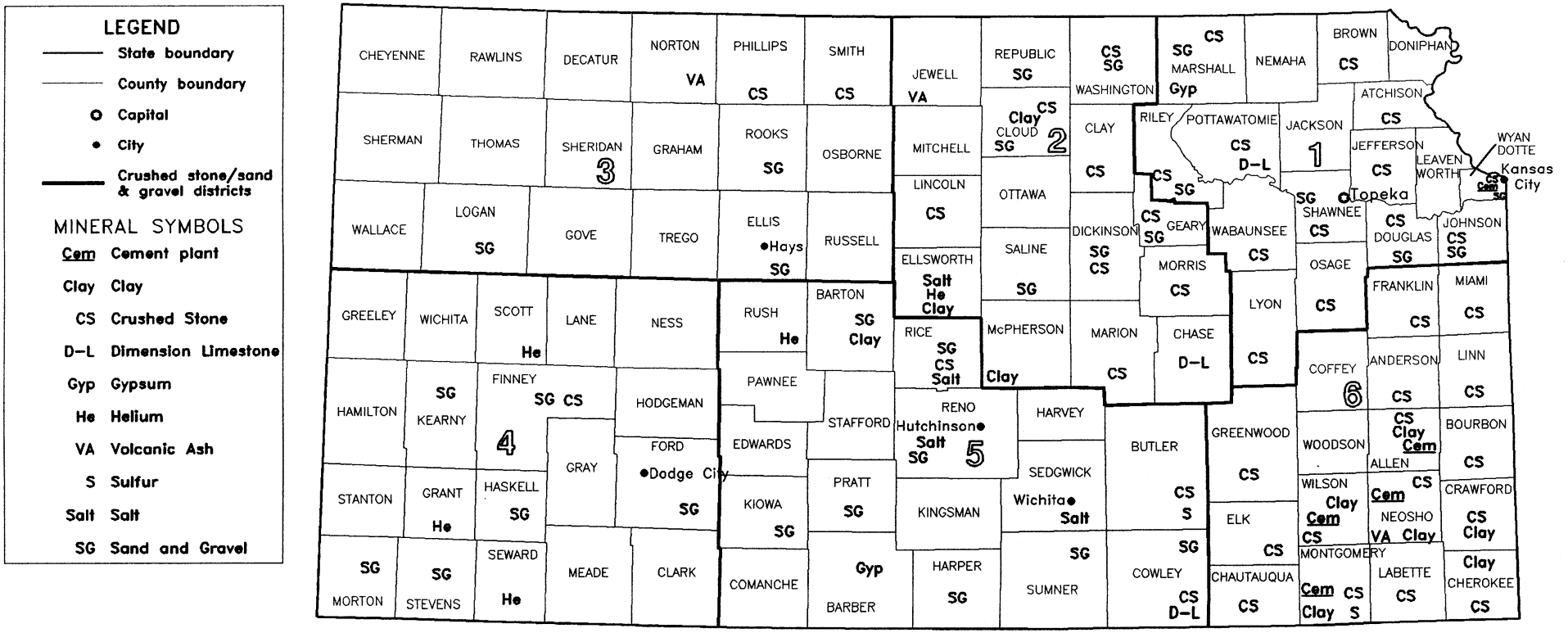
[13]Energy Information Administration. Coal Production 1992.

[14]Energy Information Administration. Weekly Coal Production, May 8, 1993.

[15]Work cited in footnote 14.

[16]U.S. Department of Commerce, Bureau of the Census. Permit Authorized Construction in Permit Issuing Places. Annual 1992.

KANSAS



Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Ash Grove Cement Co.[1, 2]	Box 25900 Overland Park, KS 66225	Plant and quarry	Neosho.
Lafarge Corp.[3]	Box 479 Fredonia, KS 66736	do.	Wilson.
Heartland Cement Co.[4]	Box 428 Independence, KS 67301	do.	Montgomery.
Lone Star Industries Inc.	Box 297 Bonner Springs, KS 66012	do.	Wyandotte.
The Monarch Cement Co.[5]	Box 187 Humboldt, KS 66748	do.	Allen and Wyandotte.
Clay:			
Acme Brick Co., Justin Industries Inc.	Box 247 Weir, KS 66781	Quarries and plants	Cherokee and Ellsworth.
Buildex Inc., a division of Clemens Coal Co.	Box 15 Ottawa, KS 66067	Quarry and plant	McPherson.
Cloud Ceramics, a division of General Finance Inc.	Box 369 Concordia, KS 66901	Quarries and plant	Cloud.
Featherlight Building, Justin Industries Inc.	Box 247 Weir, KS 66781	Quarry	Ellsworth.
Kansas Brick & Tile Co. Inc.	Box 450 Hoisington, KS 67544	Quarry and plant	Barton.
Mission Clay Products Corp.	826 E. 4th St., Box 6 Pittsburg, KS 66762	Quarry	Crawford.
Gypsum:			
Georgia-Pacific Corp., Gypsum Div.	Box 187 Blue Rapids, KS 66411	Underground mine and plant	Marshall.
National Gypsum Co., Gold Bond Building Products Div.	Box 143 Sun City, KS 67143	Quarry, underground mine, plant	Barber.
Helium:			
Air Products and Chemicals Inc.	Box 2527 Liberal, KS 67905-2527	Plant	Seward.
Centana Energy Corp. (National Helium Corp.), a subsidiary of Panhandle Eastern Corp.	Box 2079 Liberal, KS 67905-2079	do.	Do.
Enron Helium Co.	Route 1, Box 5A Bushton, KS 67427	do.	Ellsworth.
Kansas Nebraska Energy Inc.	Route 3, Box 175 Scott City, KS 67871	do.	Scott.
Kansas Refined Helium Co.	Box 312 Otis, KS 67565	do.	Rush.
Praxair Inc.	Route 1, Box 14DD Satanta, KS 67870	Plants	Ellsworth and Grant.
Trident Helex Inc.	Route 1, Box 14D Satanta, KS 67870-9511	do.	Grant.
Perlite (expanded):			
Lite-Weight Products Inc.	1706 Kansas Ave. Kansas City, KS 66105	Plant	Wyandotte.
Salt:			
Cargill Inc., Salt Div.	Box 1403 Hutchinson, KS 67501	Wells	Reno.
Hutchinson Salt Co.	1800 Carey Blvd. Hutchinson, KS 67501	Underground mine	Do.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Salt—Contined:			
Independent Salt Co.	Box 36 Kanopolis, KS 67454	Underground mine	Ellsworth.
Lyon's Salt Co., a division of B.S.C. Holding Co.	Box 498 Lyons, KS 67554	Underground mine	Rice.
Morton Salt Div., a division of Morton-Norwich Products Inc.	1000 Morton Rd. S. Hutchinson, KS 67505	Wells	Reno.
North American Salt Co.	6950 West 56th Mission, KS 66202	Wells and underground mine	Reno and Rice.
Vulcan Materials Co., Chemicals Div.	Box 12283 Wichita, KS 67277	Wells	Sedgwick.
Sand and gravel:			
Construction:			
Alsop Sand Co. Inc.[6]	Box 345 Belleville, KS 66935	Quarries and plants	Republic County.
Associated Material Supply Co. Inc.	6015 N. Broadway, Box 4064 Wichita, KS 67204	Quarries	Sedgwick and Sumner.
Builders Sand Co.	4919 Lamar Ave. Mission, KS 66202	Dredges and plants	Johnson, Shawnee, Wyandotte.
Central Sand Inc.	990 N. Westlink Wichita, KS 67212	Quarry	Sedgwick.
L.A. Knebler Construction Co. Inc.	6611 N. Ridge Rd. Wichita, KS 67205	Dredges and plants	Dickinson and Sedgwick.
Miles Sand Inc.	4852 N. Meridian Wichita, KS 67204	Quarry	Do.
Ritchie Sand Inc., a division of Ritchie Corp.	Box 8901 Wichita, KS 67208	Dredge and plant	Sedgwick.
J.H. Shears & Sons Inc.[7]	Box 1605 Hutchinson, KS 67501	Quarries and plant	Reno.
Industrial:			
Holliday List and Clark Construction Co., Holliday Sand and Gravel Co. Div.	6811 W. 63d Overland Park, KS 66202	Dredges and plants	Wyandotte.
Kaw Valley Sand and Gravel Inc.	Box 11055 Kansas City, KS 66111	do.	Do.
Stone:			
Crushed:			
Bayer Construction Co. Inc.	509 Yuma, Box 889 Manhattan, KS 66502	Quarry	Franklin.
Bingham Sand and Gravel	Box 728 Baxter Springs, KS 66713	do.	Cherokee.
Bohl Construction Inc.	120 7th St. Phillipsburg, KS 67661	do.	Phillips.
Folge Quarry Co. Inc.	800 E. 23rd St., Route 1 Ottawa, KS 66067	do.	Franklin.
N.R. Hamm Quarry Inc.	Box 17 Perry, KS 66073	Quarries and plants	Brown, Clay, Jefferson, Leavenwort, Osage, Pottawatomie, Riley, Washington.
Inland Quarries, Americold Corp.	Box 2926 Kansas City, KS 66110	Underground mine and plant	Wyandotte.
Killough Quarries Inc.	Box 623 Ottawa, KS 66067	Quarries and plants	Anderson, Douglas, Osage.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone—Continued:			
Crushed—Continued:			
Lyon Rock Co.	214½ S. Main Smith Center, KS 66967	Quarry	Smith.
McAdam Limestone Products Inc.	Route 1 Moran, KS 66755	do.	Allen, Anderson, Bourbon, Cowley, Greenwood, Linn.
Martin Marietta Aggregates, Central Div.	Box 5904 Topeka, KS 66605	Quarry	Anderson, Dickinson, Elk, Greenwood, Leavenwort, Marion, Rice, Riley, Shawnee.
Midwest Minerals Inc.	Box 412 Pittsburg, KS 66762	do.	Cherokee, Crawford, Labette, Montgomery, Neosho, Wilson.
George M. Myers Inc.	Box 289 El Dorado, KS 67042	do.	Butler.
Walker Stone Co. Inc.	Box 563 Chapman, KS 67431	Quarries and plants	Dickinson and Geary.
Dimension:			
Bayer Stone Inc.	Box 889 Manhattan, KS 66502	Quarries	Pottawatomie.
H.J. Born Stone Co. Inc.	Box 45 Silverdale, KS 67005	Quarry	Chase and Cowley.
Pray Building Stone Co.	Route 5, Box 46A Winfield, KS 87156	do.	Do.
Sulfur (recovered):			
Farmland Industries Inc.	Box 570 Coffeyville, KS 67337	Secondary recovery plant	Montgomery.
Texaco Refining and Marketing Inc.	Box 1121 El Dorado, KS 67042	do.	Butler.
Volcanic materials:			
Calvert Mines Inc.	Box 97 Norton, KS 67654	Pit and plant	Norton.
Kansas Minerals Inc.	Box 385 Mankato, KS 66956	do.	Jewell.
Micro-Lite Inc.	3802 South Santa Fe Chanute, KS 66720	do.	Neosho.

[1]Also clay in Neosho County.
[2]Also crushed stone in Johnson and Neosho Counties.
[3]Also clay and crushed stone in Wilson County.
[4]Also clay and crushed stone in Montgomery County.
[5]Also clay and crushed stone in Allen County.
[6]Also industrial sand in Republic County.
[7]Also crushed stone in Dickinson, Graham, Lincoln, and Lyon Counties.

THE MINERAL INDUSTRY OF KENTUCKY

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Kentucky Geological Survey for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.,[1] and Garland R. Dever, Jr.[2]

The value of nonfuel mineral production in Kentucky in 1992, of $401 million was the highest in State history. Value increased by about $58 million, primarily because of a 27% gain in production of crushed stone. Nationally, Kentucky improved its position to 27th in nonfuel mineral value from 29th the year before.

Conditions in the State's coal industry remained about the same as production increased slightly to about 161 million short tons. The State remained the Nation's third leading coal producer, accounting for about 16% of U.S. output.

TRENDS AND DEVELOPMENTS

The coal industry remained a major economic driver of the State's overall economy. Amendments to the Federal Clean Air Act (CAA) requiring lower sulfur dioxide emission limits by 1995 and 2000 have resulted in research and development to meet these new requirements. Kentucky's ranking as among the Nation's top five producers of coal, lime, and limestone has positioned the State to utilize these natural resources in balancing environmental protection with economic development.

Coal-burning electric utilities were evaluating options for compliance with the CAA. The two options most often considered were switching to a lower sulfur coal or scrubbing coal through a flue gas desulfurization (FGD) system. For Kentucky, the fuel switching option would lower demand for medium- and high-sulfur coal. Use of scrubbers would allow for continued use of more of Kentucky's coal and increase demand for lime and limestone.

In a related development, BRT Transfer Terminal Inc., Grand Rivers, received authorization to expand coal handling capacity at two terminals from 16 million to 35 million tons per year. The expansion was approved by the Division of Air Quality of the Cabinet of Natural Resources and Environment Protection. The increased capacity would allow BRT to purchase and blend coal from other States if electric utilities decided to switch suppliers.

EMPLOYMENT

The number of workers in the State's mining industry dropped slightly in 1992. Coal mining employment in 1992 declined to about 23,400 from 25,000 workers in 1991. Employment in industrial minerals, despite an increase in production, remained at about 1,500. Historically, employment in mining reflects market conditions, but the continuing development of technology and equipment in recent years has lowered the number of production workers needed by industry.

TABLE 1
NONFUEL MINERAL PRODUCTION IN KENTUCKY[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2]	metric tons	826,205	$8,282	707,587	$2,942	760,310	$3,777
Gemstones		NA	W	NA	548	NA	W
Sand and gravel (construction)	thousand short tons	8,802	29,581	e7,700	e27,200	7,396	24,412
Stone (crushed)	do.	e[3]50,100	e[3]182,900	46,266	191,893	e58,800	e251,100
Combined value of cement, clays (ball), lead (1990), lime, sand and gravel [industrial (1990-91)], silver (1990), stone [crushed dolomite (1990)], zinc (1990), and values indicated by symbol W		XX	138,101	XX	120,541	XX	121,285
Total		XX	358,864	XX	343,124	XX	400,574

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" figure.
[3]Excludes certain stones; kind and value included with "Combined value" figure.

LEGISLATION AND GOVERNMENT PROGRAMS

The Kentucky General Assembly enacted two bills aimed at retaining and expanding the State's manufacturing industries. The Industrial Revitalization Authority was created under Senate bill 315 to provide incentives to companies faced with imminent closure because of problems with outdated equipment. The Industrial Development Authority, created with enactment of House bill 812, provided tax incentives for 10 years to manufacturing companies that locate in the State.

The amount of coal severance tax redistributed to counties where coal is produced or where it has an impact, such as in counties with primary coal-haulage roads, was increased. Under Senate bill 205, 15% of the severance tax will be returned to these counties in 1993 and 18% in 1994. In 1992, 12% of the tax was returned to the counties. Coal severance tax collections in 1992 totaled about $210 million.

The Kentucky Geological Survey (KGS) was the primary State agency investigating the economic, environmental, and geologic impact of mineral resources in the State. Kentucky produces in excess of 225 million tons of mineral commodities annually. As a result, investigations and research of the mining and minerals-related industries by the KGS were essential to the State in land-use planning policies and decisions.

In 1992, the KGS continued studies on carbonate rocks used by the construction and coal-related industries. Limestone and dolomite from the High Bridge Group were analyzed from core drilling in Mason County. In southeastern Kentucky, the Newman Limestone was investigated to determine the availability of low-silica limestone, which is typically used for rock dust in underground coal mining.

The KGS also published reports on the Eastern Kentucky Coal Field, including one on design, construction, and monitoring of a ground water reservoir developed in mine spoils created by a mountaintop-removal and hollow-fill coal operation (Report of Investigations 6) and estimated available coal resources in the Booneville Quadrangle, the seventh study area in a coal availability project (Information Circular 42). Original, mined-out, remaining, restricted (land use and technological), and available coal resources were determined for each project area.

The KGS work on coal availability is part of a national research effort coordinated with the U.S. Geological Survey (USGS) and U.S. Bureau of Mines (USBM), as well as other State geological surveys. In conjunction with this work, the USBM published a coal recoverability study for the Matewan Quadrangle in Kentucky. Results of the study indicated that of the original 1.193 billion short tons of resource in the quadrangle, only 89 million tons remains economically recoverable at a cost of $25 per ton or less.[3]

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Industrial minerals were produced in Kentucky at about 127 operations, according to data reported to the USBM and listed in table 1. Crushed stone was produced at 86 quarries and mines, sand and gravel at 22 pits and dredges, common clay and shale at 10 pits, ball clay at 6 pits, lime at 2 plants, and cement at 1 operation. Production from these operations accounted for the State's nonfuel mineral production value of $401 million in 1992.

In addition, the following mineral commodities were processed in Kentucky: synthetic graphite, synthetic mullite, expanded perlite, iron and steel slag, sulfur (recovered), and exfoliated vermiculite. The combined value of these commodities as reported to the USBM was about $30 million.

Cement.—Both portland and masonry cement were produced at one plant in Kentucky by Kosmos Cement Co. Following a nationwide trend to lower fuel costs, Kosmos Cement began the process to obtain permission to burn hazardous waste at its cement kiln. A test burn was conducted during the year, and the company filed for a permit with Jefferson County officials. Public hearings continued during the year with a decision expected in 1993.

Clays and Shale.—In 1992, output of clay in Kentucky increased for common clay but declined for ball clay. Common clay used for brick manufacture benefited from demand from the construction industry. The decline in ball clay reflected a 12% increase in output by Tennessee, which led the Nation in ball clay production.

Ball clay was used in the manufacture of ceramic tile, dinnerware, plumbing fixtures, refractories, electrical porcelain, fiberglass, ceiling tile, and glass. The State's two producers, Old Hickory Clay Co. and Kentucky-Tennessee Clay Co., operated mines and plants in Kentucky and Tennessee and were among the Nation's and the world's largest producers.

Lime.—Kentucky ranked fifth in the United States in lime production. In 1992, output remained about the same as that of 1991.

The State's two lime plants, the Maysville plant in Mason County and the Black River plant in Pendleton County, ranked second and third, respectively, in production among the 113 plants operating nationwide in 1992. Both were owned and operated by Dravo Lime Co.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Kentucky construction sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 3 presents end-use statistics for

TABLE 2
KENTUCKY: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,708	$12,663	$3.42
Concrete products (blocks, brick, pipe, decorative, etc.)	302	1,244	4.12
Asphaltic concrete aggregates and other bituminous mixtures	1,463	4,114	2.81
Road base and coverings[1]	1,546	3,827	2.48
Other miscellaneous uses	23	94	4.09
Unspecified:[2]			
Estimated	354	2,470	6.98
Total	7,396	24,412	3.30
Total[3 4]	6,710	24,412	3.64

[1]Includes fill, snow and ice control.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[4]Total quantity and total value in thousand metric tons and thousand dollars.

Kentucky's four districts.

Output of construction sand and gravel declined for the second year in a row. During the past decade, the State's sand and gravel production has remained relatively stable. During that time, about 71 million short tons or an average of about 7.1 million tons of sand and gravel was produced annually. Output ranged from a low of 5.5 million tons in 1983 and 1989 to a high of 8.8 million tons in 1990.

In 1992, production of 7.4 million tons was from 22 pits and dredges in 17 of the State's 120 counties. Most of the sand and gravel was mined in District 3, the location of the State's most populated cities of Louisville and Lexington.

Stone (Crushed).—Crushed stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed stone accounted for about 63% of Kentucky's value of nonfuel mineral production in 1992. Nationally, the State ranked fifth in output, advancing from ninth a year ago, as production increased by nearly 13 million short tons. The estimated output of nearly 59 million tons was the highest ever reported for the State. State highway construction work and an airport expansion project in Louisville contributed to the improved demand for crushed stone.

Metals

In 1992, no metals production or exploration was reported in Kentucky. The Lafayette Mine in Crittenden County, which produced small quantities of fluorspar and zinc in 1989-90, was inactive again in 1992.

Aluminum.—Kentucky remained the Nation's second leading producer of primary aluminum. Output in 1992 was about the same as that of 1991. The United States produced about 4 million metric tons of aluminum in 1992 with Washington, the leading State, accounting for about 31% of the total.

Iron and Steel.—The State's steel industry was adversely affected by weak sales in automobiles and appliances. Armco Steel Co., Kentucky's leading steel producer, closed a hot-strip mill at its Ashland Works. The mill had opened in 1952 and employed about 700 workers before it was closed in July. Armco, which continued to employ about 2,900 workers at the Ashland Works, cited the 40-year-old age of the mill and reduced efficiency for the closure.

Also during the year, Armco completed installation of a $51.7 million gas cleaning system to control air pollution at its Ashland facilities. The system included scrubbers that remove particles from gases during steel production and dust collection equipment.

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[1]Regional Minerals Specialist, U.S. Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related industry and Government experience and has covered the mineral activities in Kentucky for 7 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Geologist, Coal and Minerals Section, Kentucky Geological Survey, Lexington, KY.

[3]Rohrbacher, T. J., D. D. Teeters, G. L. Sullivan, and L. M. Osmonson. Coal Reserves of the Matewan Quadrangle, Kentucky. BuMines IC 9355, 1993, 36 pp.

TABLE 3

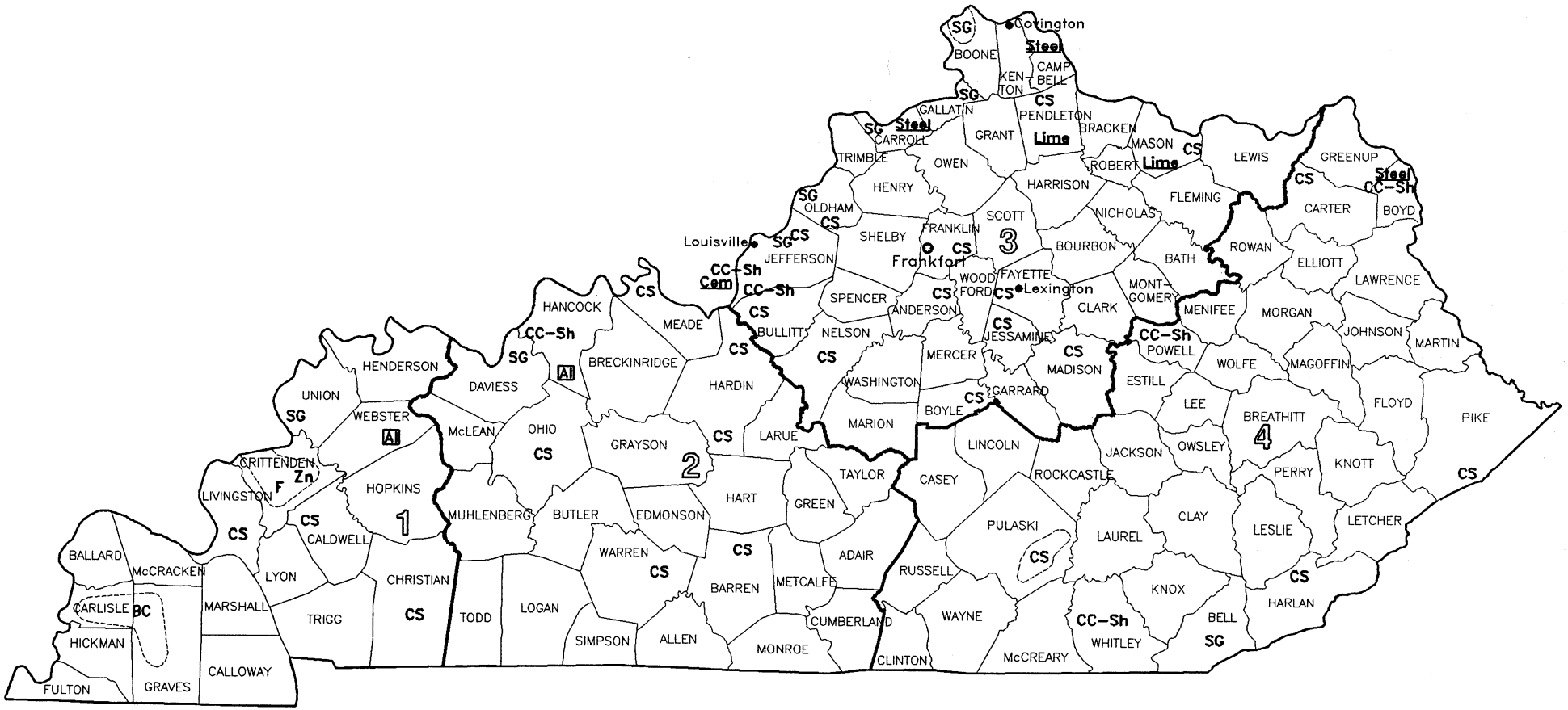
KENTUCKY: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1[1]		District 2		District 3		District 4[2]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products	—	—	769	2,300	3,241	11,606	—	—
Asphaltic concrete aggregates and road base materials[3]	—	—	386	1,332	[4]2,624	[4]6,609	—	—
Other miscellaneous uses	—	—	23	94	—	—	—	—
Unspecified:[5]								
Estimated	—	—	—	—	354	2,470	—	—
Total[6]	—	—	1,178	3,727	6,218	20,686	—	—
Total[7 8]	—	—	1,069	3,727	5,641	20,686	—	—

[1]Withheld to avoid disclosing company proprietary data; included with District 2.
[2]Withheld to avoid disclosing company proprietary data; included with District 3.
[3]Includes fill.
[4]Includes snow and ice control.
[5]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[6]Data may not add to totals shown because of independent rounding.
[7]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[8]Total quantity and total value in thousand metric tons and thousand dollars.

KENTUCKY



Principal Mineral–Producing Localities

LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Al	Aluminum plant	Lime	Lime plant
BC	Ball clay	SG	Sand and Gravel
CC–Sh	Common Clay & Shale	Steel	Iron and Steel plant
Cem	Cement plant	Zn	Zinc
CS	Crushed Stone		Concentration of mineral operations
F	Fluorspar		

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Aluminum (primary):			
Alcan Aluminum Corp.	Box 44 Sebree, KY 42555	Smelter	Webster.
Cement:			
Kosmos Cement Co.[1 2]	Dixie Highway Box 72319 Louisville, KY 40272	Plant	Jefferson.
Clays:			
Ball clay:			
Kentucky-Tennessee Clay Co.	Box 449 Mayfield, KY 42066	Mines and plant	Carlisle and Graves.
Old Hickory Clay Co.	Box 66 Hickory, KY 42051	do.	Graves.
Common clay:			
General Shale Products Corp.	Box 3547 CRS Johnson City, TN 37602	Mine and plant	Jefferson and Whitley.
Kentucky Solite Corp.	Box 27211 Richmond, VA 23261	do.	Bullitt.
Sipple Brick Inc.	Box 567 Stanton, KY 40380	do.	Boyd and Powell.
Ferroalloys:			
SKW Alloys Inc.	Box 217 Calvert City, KY 42029	Plant	Marshall.
Iron and steel (pig iron):			
Armco Steel Co., L.P.	Middletown, OH 45202	do.	Boyd.
NS Group Inc.	9th and Lowell Sts. Newport, KY 41072	Plants	Boyd and Campbell.
Lime:			
Dravo Corp.[2]	One Gateway Center Pittsburgh, PA 15222	Underground mines and plants	Mason and Pendleton.
Sand and gravel (construction):			
Bellview Sand & Gravel Inc.	5725 Bellview Rd. Petersburg, KY 41080	Pit	Boone.
Boone County Sand & Gravel Co. Inc.	Box 476 Burlington, KY 41005	Pit	Do.
Delta Materials Inc.	Box 9, Route 1 Shawneetown, IL 62984	Dredges and plants	Henderson, Livingston, and Union.
Morrow Gravel Co.	11641 Mosteller Rd. Cincinnati, OH 45241	Pits and plant	Boone.
Nugent Sand Co.	Box 6072 1833 River Rd. Louisville, KY 40206	Dredges	Jefferson and Trimble.
Yager Materials Co. Inc.	Box 2000 Owensboro, KY 42302	Dredge	Daviess.
Stone (crushed):			
Elkhorn Stone Co.	Box 737 Elkhorn, KY 41522	Quarry	Pike.
Hanson PLC	Box 7529 Louisville, KY 40707	Underground mines, quarries, plants	Various.
Ken-Mor Stone Inc.	Box 729 Morehead, KY 40351	Quarries	Carter and Morgan.
Medusa Aggregates Co.	880 Corporate Dr., Suite 101 Lexington, KY 40503	Quarries and plants	Edmonson, Nelson, Ohio, Pendleton, Warren.

See footnotes at end of table.

TABLE 4—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone (crushed)—Continued:			
Nally & Gibson Georgetown Inc.	100 Farmers Bank Dr. Georgetown, KY 40324	Quarries	Green, Scott, Taylor, Washington.
Rogers Group Inc.[3]	Box 310 Shepherdsville, KY 40165	Underground mine, quarries, and plants	Bullitt, Christian, Jefferson, Oldham.
Vulcan Materials Co.	3001 Alcoa Highway, Box 7 Knoxville, TN 37901	Underground mines, quarries, plants	Fayette, Hardin, Livingston, Meade.

[1]Also clays.
[2]Also stone.
[3]Also sand and gravel.

THE MINERAL INDUSTRY OF LOUISIANA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Louisiana Geological Survey for collecting information on all nonfuel minerals.

By Doss H. White Jr.,[1] and William E. Marsalis[2]

Louisiana's nonfuel mineral production in 1992 totaled $309.3 million. This was a $42.5 million decline in value from that reported by the mineral industry in 1991. Although there was an increase in the value of gemstones, lime, and industrial sand and gravel, it failed to offset a decline in the demand and sales of gypsum, construction sand and gravel, salt, crushed stone, and sulfur. The value of these five mineral commodities fell $53.9 million between 1991 and 1992. The State ranked 32d nationally in mineral value and accounted for 35% of the Nation's salt tonnage and 42% of the Frasch sulfur production.

TRENDS AND DEVELOPMENTS

Louisiana, by the nature of its geology of surficial deposits of sands, gravels, and clays, is deficient in raw materials for crushed stone production. For many years, oyster shell, dredged from Lake Pontchartrain and ancient reefs along the gulf coast, filled a part of the State's aggregate needs. In 1990, however, Lake Pontchartrain dredging was banned by the State. This necessitated obtaining a larger part of Louisiana's crushed stone requirement from out-of-State sources. Historically, natural aggregates were shipped into the State from quarries in Arkansas, Missouri, and Tennessee via barge transport on the Mississippi River. Recently, one company began shipping aggregate to Louisiana from a quarry in Yucatan, Mexico.

Over the past decade, however, Louisiana has moved toward the forefront in the use of artificial aggregates, also termed synthetic or plant-manufactured aggregates. They are a blend of cementitious materials bonded chemically. Two artificial products, Agglite and Aardelite, have been produced by pelletizing blends of fly ash from coal-burning powerplants and portland cement or hydrated lime. A newcomer to the Louisiana construction market is Addlite, a synthetic aggregate produced by crushing cellular concrete. A water-cement slurry is mixed with a low-density foam, and the mixture is then cured, crushed, and screened into aggregate of the required size.[3]

Another means of satisfying a part of Louisiana's aggregate needs is by concrete recycling. When highways are to be reconstructed, the existing concrete pavement is demolished and the pavement rubble is crushed into various size aggregates. The State Department of Transportation and Development permits the use of crushed concrete pavement as an aggregate on any project that specifies the use of stone. Several contractors were using portable crushers for concrete aggregate manufacture. Most remanufactured concrete aggregate is used for asphalt aggregate in new

TABLE 1
NONFUEL MINERAL PRODUCTION IN LOUISIANA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	368,322	$1,066	360,154	$3,646	384,123	$3,589
Gemstones		NA	7	NA	27	NA	3,960
Salt	thousand metric tons	13,016	120,827	13,240	130,587	12,054	112,334
Sand and gravel:							
Construction	thousand short tons	r14,588	r56,375	e13,300	e48,900	12,664	48,698
Industrial	do.	559	10,003	W	W	519	9,267
Stone (crushed)	do.	e2,100	e16,800	W	W	W	W
Sulfur (Frasch)	thousand metric tons	1,337	W	1,063	W	1,105	W
Combined value of gypsum (crude), lime, stone [crushed miscellaneous (1991)], and values indicated by symbol W		XX	163,313	XX	168,642	XX	131,432
Total		XX	r368,391	XX	351,802	XX	309,280

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

paving.[4]

In other developments, the Port of New Orleans won the lucrative winter steel shipment contract for USX's Gary, IN, plant. Indiana steel is normally shipped through the Great Lakes; however, this route is closed by ice from mid-December to mid-April. The USX steel was shipped through the Port of Mobile, AL, in 1990 and 1991, but competitive pricing and local cooperation brought the steel shipments back to Louisiana's principal port.

A pipe-threading company in Marrero added to the steel tonnage shipped through the New Orleans port. Tubular Threading Inc.'s plant near New Orleans threaded oil well tubular pipe that allows the steel pipe sections to be joined. The company threaded approximately 9,000 metric tons or 10,000 short tons from the USX pipe mill at Fairfield, AL, and threaded an additional 1,814 to 4,536 metric tons (2,000 to 5,000 short tons) per month during the winter. The pipe was shipped from the USX pipe mill in Lorain, OH.[5]

Canadian potash was another mineral commodity shipped through the Port of New Orleans public bulk terminal. The crude potash was shipped from the mines in Canada through Chicago via the Canadian Pacific and Soo Line Railroad. From Chicago, the mineral was shipped to New Orleans by the Illinois Central Railroad. Potash was loaded directly onto cargo vessels from covered hopper railcars. The 1992 potash tonnage exceeded 907,000 metric tons (100,000 short tons).[6]

Other minerals historically shipped through the public bulk terminal included metallic alloys such as ferrochrome, silicon, manganese, ferrosilicon, and "other minerals and sands;" fertilizers; barites; and miscellaneous ores.[7]

A $1.8 million infrastructure expansion project at the Port of West St. Mary was ongoing. Two salt producers, Cargill Salt Inc. and Barclay Chemicals Corp., exported through the port.[8]

Louisiana was one of two States with Frasch sulfur production. Frasch producers cut prices to below $100 per metric tons to undercut Canadian producers that are shipping sulfur to U.S. markets. Canadian sulfur is recovered from the processing of sulfur-rich natural gas, and recovered sulfur was cheaper to produce than the Frasch process material.

EMPLOYMENT

Data on Louisiana employment, including mining, are compiled by researchers at Louisiana Technical University, Ruston. In 1991, the latest year available, the extractive mineral industry, including the petroleum and natural gas sector, employed 68,678. This was a slight decline from the 69,364 employed in 1990. A continuing decline in oil- and gas-related activity was responsible for the drop in the mining sector.

ENVIRONMENTAL ISSUES

Phosphogypsum, a waste product created during the production of wet-process phosphoric acid in fertilizer manufacture, covered more than 536 hectares (1,200 acres) in Louisiana in 1989. Currently, the only disposal for the material that meets the approval of the U.S. Environmental Protection Agency is stockpiling, and phosphogypsum mounds or stacks have reached a height of 30.5 meters (100 feet) or more. Two Louisiana State University (LSU) researchers have focused on using the material to create artificial reefs. If their studies prove that the material is safe in an aquatic environment, the State may be on its way to solving a major waste disposal problem.

LSU studies began in November with artificial reefs of phosphogypsum constructed in tanks. If these prove to be safe and effective, the reefs will be constructed in shoreside ponds. If all goes well, the studies will advance to the natural oceanic environment.[9]

At yearend, residents of Bossiere Parish were preparing for a State Department of Environmental Quality hearing on a proposed plant for treatment of radioactive oilfield waste. The facility would receive waste from "all over the United States." The site of the proposed facility flooded "...in 3 of the last 4 years...," and local citizens were concerned over the possible spread of radioactive materials.[10]

LEGISLATION AND GOVERNMENT PROGRAMS

The 1992 Louisiana Legislature passed Act 1079, the Louisiana Non-Coal Surface Mining Law, that became effective on August 1, 1992. The law was the result of 4 years of cooperation between the Louisiana Department of Conservation (DOC) and the Concrete and Aggregates Association of Louisiana. The law affected 57 of the State's 64 parishes; 7 parishes were removed from the law's coverage by amendment on the last day of the session.

The act required surface mine operators for noncoal minerals to apply for a permit that included a reclamation plan and to pay a reclamation fee based on the mine's production.

A 1991 study by the DOC identified about 1,246 abandoned, noncoal mines that covered approximately 53,420 hectares (132,000 acres). During the same period, active mining was under way at 299 sites affecting an additional 20,235 hectares (50,000 acres).

Near yearend, the Joint Legislative Committee on the Budget voted to defer a request from the Department of Natural Resources to use almost $229,000 in fees expected to be collected in the current fiscal year to pay regulatory personnel. Rural sand and gravel operators complained that the tax would make them noncompetitive with out-of-State aggregate producers and would force them out of business. By deferring action on the requested funds, the committee ensured that no moneys would be available to pay regulatory employees, and Act 1079 was nullified.

In June, a State appeal court upheld the Department of Environmental Quality's ruling that effectively terminated shell dredging in Lake Pontchartrain.[11]

During the year, the Louisiana Geological Survey (LGS) conducted

several programs of interest to the State's mineral industry. Among these was a continuing cooperative coal resources program with the U.S. Geological Survey. LGS geologists interpreted and computerized data from approximately 10,000 core holes for inclusion in the National Coal Resources Data System. Surface geological mapping continued toward the goal of revising the 1984 Geologic Map of Louisiana.

In November, the Governor announced that a congressional oil and gas subcommittee would grant LSU $10 million for oil- and gas-related research. The State must match the congressional grant. Two other State universities, the University of New Orleans and the University of Southwestern Louisiana, would be involved in the studies. One focus of the research would be "oil spills, cleanup of spills, and the prevention of environmental damage," according to the executive director of the LSU Center for Coastal, Energy, and Environmental Resources.[12]

The U.S. Fish and Wildlife Service (FWS) completed construction of a $13.6 million National Wetlands Research Center on the University of Southern Louisiana campus in Lafayette. When fully staffed, the center will employ approximately 120 scientists and support personnel.

An FWS plan to place the Louisiana quillwort, an aquatic plant, on the Endangered Species List was opposed by landowners in Washington Parish. Sand and gravel firms and timber operations would be placed at a financial disadvantage if the plant was designated as endangered. A university professor whose students discovered the plant on a field trip testified that "the plant was worthless."[13]

A contractor to the U.S. Army Corps of Engineers began work on a 5.6-kilometer (3.5-mile)-long dike to protect the north bank of the Mississippi River-Gulf Outlet (MR-GO). The MR-GO is a major connection between the Gulf of Mexico and the Mississippi River and is separated from Lake Borgne by a thin strip of land. Much of the shipping to and from the Port of New Orleans travels through MR-GO.

The bank protection dike is composed of a filter fabric and a shell or shell-substitute inner core topped with armor stone. Approximately 2.3 million meters (2.5 million yards) of dredge material will cover a 688-hectare (1,700-acre) area behind the dike and is designed to reduce erosion of the area separating MR-GO from Lake Borgne.[14]

A second Corps contractor used stone to reinforce the revetments and dikes along the Red River Waterway from river mile 34 near Delhoste to river mile 141 near Colfax. No interruption to navigation occurred during the stone placement.[15]

At yearend, the U.S. Department of Energy (DOE) was considering a Louisiana salt dome for a proposed oil storage site. DOE was considering salt domes on both Weeks Island and Cote Blanche Island as the site for an expansion of the Strategic Petroleum Reserve (SPR). Once the site is selected and storage facility construction completed, water will be pumped from the Intercoastal Waterway to dissolve caverns in the dome. Concentrated brine resulting from the dissolved salt will be pumped into the Gulf of Mexico through a diffuser station that will release the brine in controlled volumes. Also considered were three other sites in Mississippi and Texas.[16]

FUELS

Lignite output from the State's two lignite mines increased almost 2%. Production in 1992 totaled 2.9 million million tons (3.2 million short tons) compared with the 2.86 million metric tons (3.15 million short tons) produced during the previous year.[17]

Oil production totaled 142 million barrels and gas output was 1.6 trillion cubic feet. This 1992 hydrocarbon production represented a continuing decline in the State's oil and gas output.

Hurricane Andrew forced at least a dozen oil refineries on Louisiana's coast to close or curtail production, eliminating almost 15% of the Nation's daily refining capacity. Refinery startup began in late August.[18]

The hurricane severely damaged more than 100 offshore oil and natural gas platforms in the Gulf of Mexico. Rigs in the areas south of Morgan City received the most damage. Most workers were evacuated before the storm hit, and there were no reports of death or injury.[19]

Oil production from Freeport-McMoRan's Main Pass Block 299 facility was temporarily suspended because of Hurricane Andrew. There was no structural damage to the oil and gas platforms, and production resumed in late August, averaging in excess of 43,000 barrels of oil per day.[20]

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

The State's mining industry, 165 companies with mines in 49 of Louisiana's 64 parishes, produced 8 different mineral commodities valued at $309.3 million. In descending value, salt, sulfur, and sand and gravel were the three leading commodities in terms of sales.

Clays.—Louisiana's clay industry ranked 23d in tonnage and 15th in value among the 33 clay-producing States. Clay production totaled 384,000 metric tons (423,000 short tons) valued at $3.6 million. This was a 24,000-metric-ton increase above industry production reported to the U.S. Bureau of Mines in 1991. Value, however, declined $57,000. The increased clay output mirrored the increased demand for brick and clay building products, which reflected the increase in residential and commercial construction. As in past years, the State's clay industry was composed of five companies operating surface mines in five parishes. Caddo and Pointe Coupee Parishes supplied more than 50% of the total production. Approximately 23% of the clay mined was used in brick manufacture. Brick was manufactured by Acme Brick Co., Jamestown; Athens Brick Co. Inc.,

TABLE 2
LOUISIANA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	8,950	$36,718	$4.10
Plaster and gunite sands	W	W	2.00
Concrete products (blocks, brick, pipe, decorative, etc.)	W	W	4.21
Asphaltic concrete aggregates and other bituminous mixtures	486	3,436	7.07
Road base and coverings	194	613	3.16
Fill	1,521	1,988	1.31
Other miscellaneous uses	79	330	4.18
Unspecified:[1]			
Actual	56	116	2.07
Estimated	1,360	5,497	4.04
Total	[2]12,644	48,698	3.85
Total[3 4]	11,470	48,698	4.25

W Withheld to avoid disclosing company proprietary data; included in "Other miscellaneous uses."
[1]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[2]Data do not add to total shown because of independent rounding.
[3]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[4]Total quantity and total value in thousand metric tons and thousand dollars.

Mooringsport; Kentwood Brick Co., Kentwood; and St. Joe Brick Works Inc., Slidell. One brick company purchased a plastic clay mined in Mississippi to blend with locally mined clays.

Other uses were in concrete block manufacture, as an ingredient in structural concrete, and as miscellaneous lightweight aggregate.

Gemstones.—Louisiana gemstone production was valued at almost $4 million. Two firms marketed precious opal produced from a State mine, and four companies harvested and marketed freshwater pearls and freshwater mother-of-pearl "slugs" for cultured pearl production.

Gypsum.—A near-surface salt dome near Winnfield was the site of an anhydrite mining operation. Winn Rock Inc. operated a surface mine and crushing complex in the Winnfield dome's anhydrite cap-rock. The crushed anhydrite, a variety of gypsum, was sold to drilling firms for road surfacing material for secondary roads, parking/storage areas, and to petroleum and natural gas well sites. The material recements itself with vehicle traffic and requires little maintenance. The company also mined pure gypsum. Output and value declined below that reported by the company in 1991.

Salt.—The State continued as the Nation's leader in salt production and accounted for approximately 35% of the U.S. output. Salt ranked first in value among the mineral commodities produced in Louisiana and accounted for about 36% of the State's 1992 total value. Output, 12 million metric tons (13.3 million short tons) valued at $112 million, decreased 1.2 million metric tons (1.3 million short tons) and $18.3 million below the 1990 figures reported by Louisiana's salt industry. State tax figures indicated that 9.9 million metric tons (10.9 million short tons) of salt brine was produced.

The industry structure, composed of three companies, remained unchanged in 1992. Akzo Salt Inc. operated an underground mine on Avery Island, Morton International Inc. mined salt from an underground operation on Weeks Island, and Carey Salt Co. operated an underground mine at Cote Blanche Island near Baldwin.

A late January collision between two tows on the Intercoastal Waterway 10 miles west of Morgan City resulted in the closure of all three salt mines for several days. One tow, pushing two barges of styrene, spilled its cargo, forcing a closure of the waterway. Barge traffic was backed up for 20 miles, and the waterway was closed for 10 days. The closure cut barge service to the mines; the lack of barges to load salt "hinders other mining activities."[21]

In March, two of the three companies cut their staff because of a decline in demand. Morton officials announced a 31-employee furlough. Twenty-six miners and five surface workers were laid off. A mild winter and a "lack of snow in the Midwest and elsewhere" negated the need for salt for ice and snow removal. Carey Salt Co. cut its workweek from 5 days to 4, resulting in a 20-employee reduction. Akzo Salt maintained its work force at the 1991 level.[22]

In May, Morton's Weeks Island Mine was evacuated because of an equipment fire. There were no injuries and the mine reopened within 24 hours.[23]

Opposition to a possible DOE expansion of the SPR on Weeks Island was voiced by Morton Salt Co. officials. Morton personnel noted that when the SPR was established in the late 1970's and early 1980's, the company suffered a substantial disruption in mining activities. The company was worried about the integrity of the dome and any geological risks that could result from new solution mining. A DOE official countered that if the Weeks Island site were chosen, "every effort will be made to have as little impact as possible on current salt mining."[24]

Sand and Gravel.—The sales of sand and gravel, both construction and industrial, ranked third among the eight industrial minerals mined in Louisiana and accounted for 18% of the 1992 State value. The sand and gravel industry was the mineral industry's leading employer.

TABLE 3

LOUISIANA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[1]	1,506	8,283	1,778	9,325	5,745	19,441
Asphaltic concrete aggregates and other bituminous mixtures	—	—	338	1,750	147	1,685
Road base and coverings	28	201	123	325	43	87
Fill	96	198	237	432	1,188	1,357
Other miscellaneous uses	—	—	—	—	(2)	(2)
Unspecified:[3]						
Actual	51	107	5	9	—	—
Estimated	451	2,000	110	662	798	2,835
Total	2,132	10,789	2,591	12,503	[4]7,922	25,405
Total[5 6]	1,934	10,789	2,351	12,503	7,187	25,405

[1]Includes plaster and gunite sands.
[2]Less than 1/2 unit.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

In 1991, the latest year with available data, the U.S. Army Corps of Engineers recorded 6,956 metric tons (7,667 short tons) of "sands, natural, of all kinds (except silica and quartz)" shipped into Louisiana ports and 1,234 metric tons (1,360 short tons) shipped from the State's ports. The Corps included gravel shipments with crushed stone.

Construction.—The production of construction sand and gravel is surveyed by the U.S. Bureau of Mines (USBM) for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

In 1992, the USBM received production and value data from 54 sand and gravel operations. Reported output, 11.5 million metric tons (12.6 million short tons), ranked the State 23d among the 50 States with a sand and gravel industry. Value was reported at $48.7 million, 21st nationally. The 1992 production and value data were 577,000 metric tons (636,000 short tons) and $202,000 lower than those reported in 1991.

The five leading parishes, (1) St. Helena, (2) St. Tammany, (3) Washington, (4) Rapides, and (5) Webster, accounted for approximately 60% of the State's total production. Principal sales, as reported by the sand and gravel producers, were for use in concrete aggregate, asphaltic concrete, and road construction.

Industrial.—Louisiana ranked 19th among the 38 States with industrial sand and gravel production. Sales were reported by three companies with mines in four parishes. Production, 471,000 metric tons (519,000 short tons), was valued at almost $9.3 million. Both output and value were considerably higher than reported in 1991 when two firms failed to report. As in past years, principal sales were to the sandblasting, glass container, silicon carbide, and chemical and foundry industries. Minor sales were for an antiskid media for airport runways.

T. L. James & Co. Inc. produced filter and blasting sand to complement its construction sand and gravel products line. The firm operates dredges at Honey Island near Pearl River. The industrial sands are shipped by bulk tanker, in 5,000- or 3,000-pound bulk bags, by dump trailers, or in 100-pound bulk bags.[25]

Stone.—**Crushed.**—The production of crushed stone is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

The estimates of Louisiana stone production and value (including oyster shell dredged from the Gulf of Mexico) were withheld to protect company proprietary data. The 1992 estimated production and value were lower than those reported in 1991.

Louisiana severance tax figures reveal that 662,000 metric tons (729,606 short tons) of shell was dredged during FY 1992. This was approximately one-half of the 1,309,000 metric tons (1,443,241 short tons) dredged in FY 1991. In FY 1978, 7,350,000 metric tons (8,102,000 short tons) of shell was dredged. The Louisiana severance tax on shell, like that on sand and gravel, was $0.06 per ton.

Winn Rock Inc. produced the only

stone mined instate (see gypsum section). Much of Louisiana's stone requirements was satisfied by aggregate barged into the State from quarries in Arkansas, Kentucky, Missouri, and Illinois. One firm shipped stone to Louisiana from Yucatan, and a second shipped stone from The Bahamas. U.S. Corps of Engineers preliminary figures for stone shipped to Louisiana ports in 1991, the last year with data available, totaled 646,000 metric tons (585,844 short tons). Export tonnage was noted at 127 metric tons (140 short tons). This category included "pebbles, gravel, and crushed stone."

Dimension.—Although no dimension stone was quarried in Louisiana, a significant tonnage was shipped through the State port system. Most was destined for foreign countries. U.S. Army Corps of Engineers preliminary data for 1991, the last year with data, indicated that shipments of "building or monumental stone roughly trimmed" into the State totaled 580 metric tons (640 short tons), and exports totaled 895 metric tons (987 short tons).

Sulfur.—Louisiana was one of two States reporting Frasch sulfur production; Texas was the second. Until 1991, sulfur was the leading mineral commodity produced instate; in 1991, it dropped to second behind salt where it remained in 1992. The decline was due to mine closings rather than a slump in sulfur demand. Two of the State's three mines were depleted and closed in 1991.

Complicating the picture was a drop in U.S. Frasch sulfur prices. In January, it fell to about $98 per metric ton as U.S. producers attempted to remove the profit from Canadian sulfur imports. The decline in the Frasch sulfur price was the third since June 1991. The Vancouver sulfur contract price was approximately $67 per metric ton with freight to Tampa, FL, about $65 per metric ton.[26]

In 1992, Louisiana's Frasch sulfur output rose slightly. In 1991, it was 1,063,000 metric tons (1,172,000 short tons); it rose to 1,105,000 metric tons (1,218,000 short tons) in 1992. Value data were concealed at the company's request, but fell about 24%.

Production was reported from Freeport Sulfur Co.'s Caminada Pass Mine in the Gulf of Mexico and Freeport-McMoRan Resources Partners Ltd.'s new Main Pass Mine 17 miles off Louisiana's coast.

Following Hurricane Andrew, Freeport-McMoRan announced that the Main Pass and Caminada facilities were undamaged. Sulfur production was temporarily suspended because of the hurricane. Production returned to prehurricane levels in September.[27]

In June, International Shipholding Corp. of New Orleans applied for a 15-year loan guarantee on $43.7 million to help finance a new sulfur carrier. The $58.3 million, 524-foot diesel-powered carrier would transport sulfur for Freeport-McMoRan Partners. The ship is scheduled to be constructed at the Morgan City shipyard.[28]

Sulfur was recovered from petroleum and/or natural gas at nine refineries. The tonnage, 731,000 metric tons (806,000 short tons), increased 39,000 metric tons (43,000 short tons) over that reported in 1991. Value, $43 million, decreased $18 million below the $61.1 million reported for the previous year. The reduction in the price of Frasch sulfur resulted in the drop of recovered sulfur prices.

Other Industrial Minerals.—Several industrial minerals not included in table 1 were shipped into the State and used as raw materials in several industrial processes, processed into higher value products, or resulted as a byproduct of various manufacturing processes.

Included were hydrated alumina, anhydrous ammonia, barite calcined bauxite, calcium chloride, garnet, iodine, lime, synthetic graphite, perlite, phosphate rock, dimension stone, and titanium dioxide pigments.

Metals

Alumina.—Three firms, The Ormet Corp., Kaiser Alumina & Chemical Corp., and LaRouche Chemicals Inc., operated refineries at Burnside and Gramercy. The refineries produced alumina from imported bauxite.

Iron and Steel.—Louisiana was the site of one steel mill, Bayou Steel Corp. at LaPlace. The company operated two 59-metric-ton (65-short-ton) electric furnaces.

Uranium.—Uncle Sam was the site of Freeport Uranium Recovery Co.'s 317,520-kilogram-per-year (700,000-pound-per-year) uranium oxide plant. The facility produced fuel for the electric utility industry.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 32 years of mineral-related industry and government experience and has covered the mineral activities in Louisiana since 1989. Assistance in the preparation of the annual report was given by Maylene E. Hubbard, editorial assistant.

[2]State geologist, Louisiana Geological Survey, Louisiana Department of Natural Resources.

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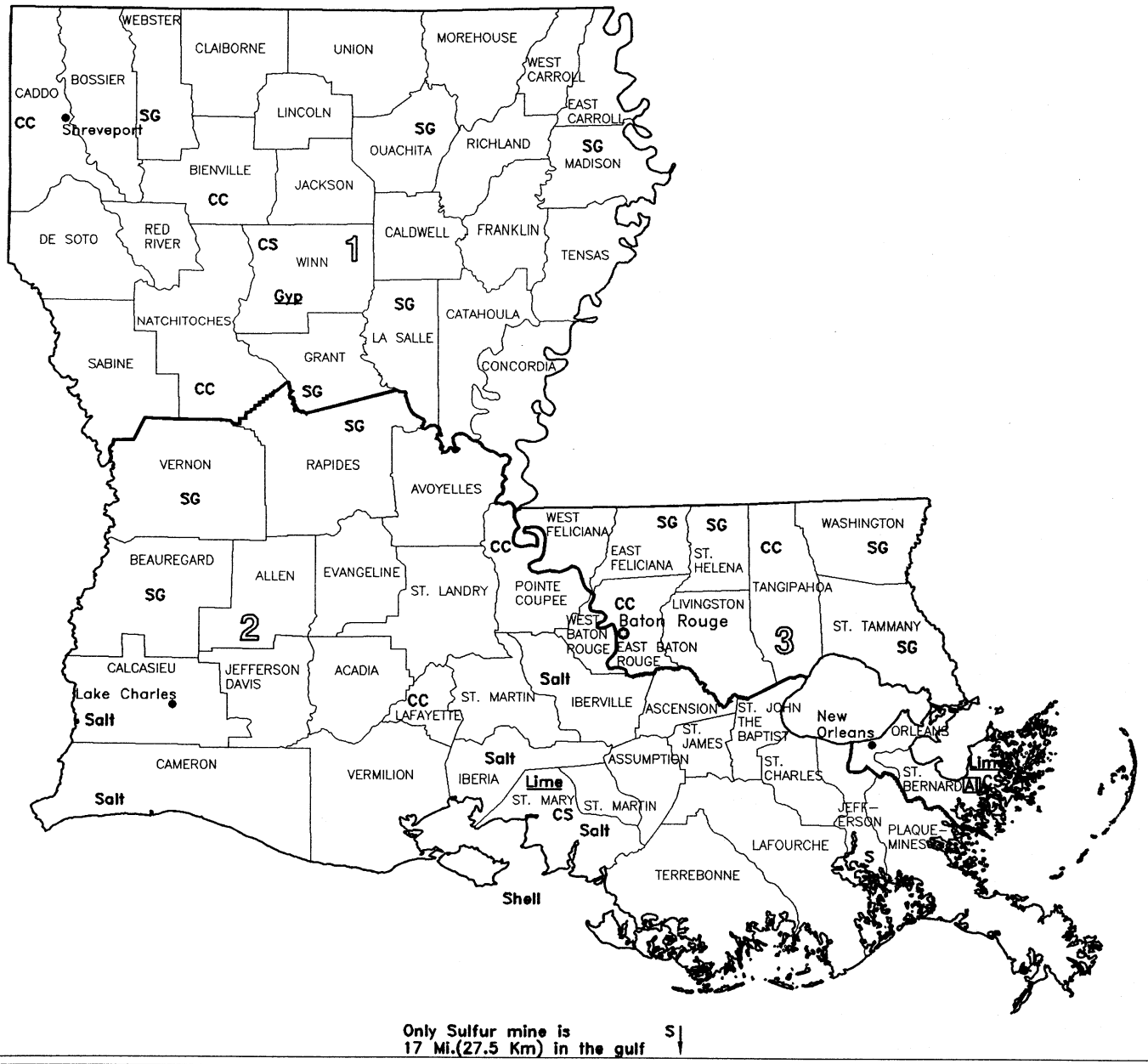
LOUISIANA



Only Sulfur mine is 17 Mi.(27.5 Km) in the gulf

S

LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Al	Aluminum plant
CC	Common Clay
CS	Crushed Stone
Gyp	Gypsum plant
Lime	Lime plant
S	Sulfur
Salt	Salt
SG	Sand and Gravel
Shell	Shell

Principal Mineral-Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	Parish
Clays:			
Athens Brick Co. Inc.	Box 70 Athens, TX 75751	Mines and plant	Caddo.
Big River Industries Inc.	Box 66377 Baton Rouge, LA 70806	Mine and plant	Pointe Coupee.
Featherlite Building Products	Box 5044 Jamestown, LA 70145	do.	Bienville.
Gypsum:			
National Gypsum Co.	Box 128 Westwego, LA 70094	Plant	Jefferson.
USG Corp.	101 South Wacker Dr. Chicago, IL 60606	do.	Orleans.
Lime:			
USG Corp.	do.	do.	Do.
Salt:			
Akzo Salt Inc.	Box 106 Avery Island, LA 70513	Mine	Iberia.
Cargill Salt Inc.	Box 91130 Lafayette, LA 79509	Brine wells	St. Martin.
North American Salt Co.	Box 10 Lydia, LA 70569	do.	St. Mary.
Morton International Inc.	Box 1996 New Iberia, LA 70561	Mine, brine wells	Iberia.
Sand and gravel:			
Gifford-Hill & Co. Inc.	Box 6615 Shreveport, LA 71136	Dredges, pits, plants	Jefferson Davis, Rapides, Tangipahoa, Webster.
Louisiana Sand and Gravel Co.	Box 963 Baton Rouge, LA 70821	Dredge and plant	St. Helena.
Standard Gravel Co. Inc.	Route 7, Box 53 Franklinton, LA 70438	Dredges and plants	St. Tammany and Washington.
Texas Industries Inc.	Box 5472 Alexandria, LA 71301	Dredges, pits, plants	Beauregard, Grant, La Salle, Ouachita, Rapides, St. Tammany.
Stone:			
Crushed:			
Dravo Lime Co.	One Gateway Center 7th Floor Pittsburgh, PA 15222	Dredges	Orleans and St. Mary.
Pontchartrain Dredging Corp.	Box 8005 New Orleans, LA 70182	Quarry and plant	Winn.
Winn Rock Inc.	Box 790 Winnfield, LA 71483	Quarry and plant	Winn.
Sulfur:			
Native:			
Freeport Minerals Co.	200 Park Ave. New York, NY 10165	Frasch process	Jefferson and Plaquemines.
Recovered:			
Cities Service Oil Co.	Box 300 Tulsa, OK 74102	Refinery	Calcasieu.
Exxon Co. U.S.A.	Box 551 Baton Rouge, LA 70821	Plant	East Baton Rouge.
Vermiculite (exfoliated):			
W. R. Grace & Co.	62 Whittemore Ave. Cambridge, MA 02140	do.	Orleans.

THE MINERAL INDUSTRY OF MAINE

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Maine Geological Survey for collecting information on all nonfuel minerals.

By Donald K. Harrison,[1] Walter Anderson,[2] and Michael E. Foley[3]

The value of Maine's nonfuel mineral production in 1992 was about $56 million, a $14.6 million increase over that of 1991. The primary reason for the gain was an increase in production of construction sand and gravel over 1991 estimates. Estimated output of crushed stone also increased in 1992. Portland cement, the State's second leading mineral commodity, in terms of value, also increased in both output and value over 1991 levels. Other mineral commodities produced, in descending order of value, were masonry cement, peat, gemstones, clays, and dimension stone.

TRENDS AND DEVELOPMENTS

After steadily declining since 1988, the overall total value of construction contracts in Maine finally rose in 1992. Although still below the peak building year of 1988, the total value of construction contracts jumped 46% over that of 1991. All categories of construction showed gains. The largest gains were reported in the value of residential and nonbuilding contracts, which were both up 53% from the previous year. The value of nonresidential construction contracts was also up by 31%. Because the construction industry is highly dependent on the availability of construction aggregate (construction sand and gravel, crushed stone), the increases in construction in 1992 were reflected in increases of construction commodities produced. Output of construction sand and gravel, the State's leading mineral commodity in terms of value, rose by 72% in 1992. Estimated output of crushed stone also showed a gain in 1992. Sales of both portland and masonry cement also increased.

EXPLORATION

Several mining firms continued baseline monitoring programs in possible preparation for base metal mining in the State.

BHP Minerals International Inc. postponed a $7 million ore sampling project in northern Somerset County that was seen as a prelude to a $40 million to $60 million copper and zinc mine. The company indicated that a drop in world metal prices and rising development costs contributed to the decision. Although the company received the last of three State environmental permits necessary for massive sampling operations at the Alder Pond deposit, the company indicated that it was reevaluating the 68 cores already drilled into the ore body. The Alder Pond deposit is believed to contain 3.5 million short tons of zinc, some copper and lead, and traces of silver and gold.

EMPLOYMENT

In 1992, the average number of workers employed in the mineral extractive industries in Maine was 571, about 44 less than that of 1991.[4] This included 363 workers in the sand and gravel industry and 117 in the stone industry. In addition, 91 employees worked at mineral-related mills and preparation plants in the State.[5]

TABLE 1
NONFUEL MINERAL PRODUCTION IN MAINE[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	W	NA	$174	NA	$108
Sand and gravel (construction)	thousand short tons	7,865	$29,349	e3,900	e14,800	6,703	26,932
Stone:							
Crushed	do.	e1,700	e8,700	1,706	9,899	e1,900	e11,400
Dimension	short tons	W	W	73	88	W	W
Combined value of cement, clays (common), peat, and values indicated by symbol W		XX	r17,235	XX	16,343	XX	17,479
Total		XX	r55,284	XX	41,304	XX	55,919

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

LEGISLATION AND GOVERNMENT PROGRAMS

In April, L.D. 2400, "An Act Concerning Site Protection at Former Mining Operations," was signed into public law as chapter 883. The bill set up a mining corrective action fund that may be used by municipalities for corrective action necessary to address problems that occur at metal mining sites following termination of mining operations and closure of the mine. Corrective action includes, but is not limited to, remedial action related to contaminated ground water; disposition of mining wastes; reclamation defects on or surrounding the site; and pollution control at the site.

In June, citizens of the town of Warren approved controversial local mining regulations by a vote of 651 to 534. Knox Nickel Corp., a Canadian mining firm, is seeking to mine a nickel-copper-cobalt deposit near Crawford Pond within the town's borders. When the company first announced it wanted to mine the deposit, the town responded by enacting a moratorium on any mine activity within its borders. The moratorium was allowed under State law. Although the Warren mining ordinance copied 95% of the State's Metallic Mining Regulations (chapter 13, effective August 26, 1991), the new law established more restrictive setbacks for mine tailings than the State's metal mining law allows. It also set stricter financial responsibility requirements for mining companies. Near yearend, Knox Nickel was consulting with its attorneys to determine what options and recourses the company might have.

In the adjoining town of Union, mining regulations were being written by a special town committee. The new rules will be closely based on the regulations approved by Warren voters in June. Although Knox Nickel said it has no plans to mine nickel in Union, the committee hopes to finish writing the regulations in time for voters to act on the rules at a March 1993 town meeting.

Near yearend, residents in the town of Woolwich voted to impose a 6-month moratorium on quarrying, rock blasting, and mining in both rural and residential districts. The purpose of the moratorium was to give the Woolwich Planning Board time to draft new ordinances for such businesses. According to the Planning Board, the ordinance needs to correspond to the town's 1991 Comprehensive Plan, which stresses that the town should protect its rural qualities.[6]

The Maine Geological Survey (MGS), a bureau of the Department of Conservation, continued to map, interpret, and publish geological information and provide technical assistance to the mineral industry, planning and regulatory agencies, and the general public. The MGS, together with the five other New England State Geological Surveys, began a study financed by the Minerals Management Service, U.S. Department of the Interior, to assess the availability of onshore sand and gravel in the region. The supply study is the second phase of a total resource assessment; the first phase, which involved a demand projection, was published in January. In the supply assessment, a series of maps is being prepared for each State to show sand and gravel deposits and areas that are off limits to mining. The volumes of aggregate that are off limits will be subtracted to identify a presently usable volume. The study is expected to be completed in late 1993. Following completion of the supply study, the demand and supply studies will be used to draw conclusions on the regional construction aggregate outlook and forecast whether offshore supplies of sand and gravel will be needed to meet future demand. A final report of the findings will be published with recommendations for future initiatives.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Cement.—Dragon Products Co., a subsidiary of CDN Cementos del Norte, operated New England's only cement plant in Thomaston, Knox County. The company produced both portland and masonry cement. Shipments of portland cement for the year increased about 6% compared with those of 1991. Masonry cement shipments remained unchanged.

In September, Dragon received permission from the State Department of Environmental Protection (DEP) to burn oil-contaminated soil at its cement plant in Thomaston. The majority of the oil-contaminated soil would come from service station underground tank leaks and tractor trailer turnovers. The petroleum in the soil will replace a portion of the materials used in the cement mix. The company will only accept contaminated soil removed from sites monitored by DEP or those that are tested for content.

Clays.—Morin Brick Co., the State's only producer of clay, mined common clay at operations in Androscoggin and Cumberland Counties primarily for use in brick manufacturing. Although output declined 30% in 1992, value decreased only 19% because of higher unit values.

Gemstones.—Major discoveries of several large gem finds in western Maine in recent years has sparked renewed interest in the region. The State is well known to rock collectors and mineral specimen collectors to contain many semiprecious and gem-quality specimens of amethyst, aquamarine, citrine, tourmaline, and topax, to name just a few.

Graphite (Synthetic).—Synthetic graphite was produced by Fiber Materials Inc. at a plant in Biddeford, York County.

Peat.—Peat was mined by two companies in Maine in 1992. Folson Marine Service Corp. mined peat for horticultural purposes in York County. Down East Peat LP used peat as fuel at a 22.8-megawatt, peat-fired electric powerplant near Deblois, Washington County. Fuel for the plant was harvested

TABLE 2
MAINE: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	983	$4,615	$4.69
Plaster and gunite sands	2	10	5.00
Concrete products (blocks, brick, pipe, decorative, etc.)	(1)	2	3.70
Asphaltic concrete aggregates and other bituminous mixtures	1,264	8,718	6.90
Road base and coverings[2]	1,544	5,190	3.36
Fill	862	1,810	2.10
Snow and ice control	736	1,971	2.68
Other miscellaneous uses	203	561	2.76
Unspecified:[3]			
Actual	271	562	2.07
Estimated	837	3,494	4.17
Total[4]	6,703	26,932	4.02
Total[5 6]	6,081	26,932	4.43

[1]Less than 1/2 unit.
[2]Includes road and other stabilization (cement).
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

from the adjacent Denbo Heath Bog by a private contractor. In January, Down East was purchased under provisions of a reorganization that involved the formation of Worcester Energy Co. Inc. and Worcester Peat Co. Inc.

Perlite (Expanded).—Crude perlite shipped in from New Mexico was expanded by the Chemrock Corp. at a plant in Rockland, Knox County. Both output and value decreased in 1992 from that of 1991. The expanded perlite was sold locally, primarily as a filter aid.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Construction sand and gravel was the State's second leading mineral commodity produced and accounted for almost one-half of the State's total value. In 1992, output rose 72% over the estimated output of 1991. A total of 75 companies and towns mined construction sand and gravel from 113 operations at 168 pits in 16 counties. Leading counties, in order of output, were Cumberland, York, Knox, Franklin, and Androscoggin. Major uses were for construction and roadbuilding.

Near yearend, the Wells Board of Selectmen passed an amended version of an ordinance regulating sand and gravel pits in the town. As amended, the proposed ordinance would exempt pits from which less than 500 cubic yards of sand and gravel is extracted over 2 years. Before the amendment, the proposed ordinance would have forced pit owners to remove 250 cubic yards each year to maintain a "grandfathered" status. The original ordinance drew criticism from some landowners who feared the ordinance would cause an undue burden on small pit owners who might be forced to remove more sand and gravel than they had planned to remain "grandfathered." The amended ordinance is expected to be voted on at a town meeting in April 1993.[7]

In September, Tilcon Maine Inc. agreed to drop its lawsuit against the State after winning permission to remove sand and gravel from a strip in North Belgrade that previously had been ruled off limits to mining. In May, Tilcon received permission from the Department of Environmental Protection (DEP) to mine 485,000 cubic yards of sand and gravel from 8.6 acres of a 133-acre tract the company owns in Belgrade. In granting the permit, the DEP denied the company permission to remove another 40,000 cubic yards along a property line shared with Blue Rock Industries, another sand and gravel company. That same month, the company sued the DEP to allow it to mine in the buffer zone. Following a change in State regulations, the DEP allowed mining to take place in the buffer zone.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—Crushed stone was the State's third leading mineral commodity after construction sand and gravel and cement. Estimated crushed stone production of 1.9 million short tons was 11% higher than that of 1991 and the highest since 1987, one of the peak building years. Leading counties, in order of output, were Knox, Androscoggin, and Cumberland. Other counties that produced crushed stone were Aroostook, Kennebec, and Penobscot. Limestone was the dominant stone quarried. Other rock types mined included calcareous marl, granite, traprock, and quartzite. Leading uses were for cement manufacture and bituminous aggregate.

Dragon Products Co.'s plan to establish a crushed stone quarry on Madison Mountain ended in September when the company agreed to sell the 107-acre parcel of land to a private individual.

The sale appears to end a 16-month battle between a citizens group (Neighbors of Madison Mountain) opposing the quarry and Dragon Products. Dragon, the State's largest supplier of ready mix concrete, had proposed using 15 acres of the parcel as a source of crushed stone for its cement products.

After nearly 5 years of trying to obtain permission to open a quarry in town, the Barletta Co. Inc. received approval in November from the Eliot Planning Board to open a $1.8 million crushed stone operation off Route 236. The Rocky Hill Quarry is planned as phased development with phased reclamation over its 50-year life span. Approximately 125 acres of a 300-acre parcel is expected to be mined and reclaimed. Earlier in the year, the company had received final approval from the DEP. At least one local resident had filed an appeal against the approval. The appeal was pending at yearend.

Dimension.—New England Stone Industries Inc. and Fletcher Granite Co. Inc. both produced dimension stone in Hancock County. Most of the stone was used for veneer, flagging, curbing, and rough blocks.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related experience and has covered the mineral activities in Maine for 8 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Director and State geologist, Maine Geological Survey, Augusta, ME.

[3]Resource administrator, Maine Geological Survey, Augusta, ME.

[4]"Average number of workers" is a summary of the average number of workers at individual mining establishments during periods (not necessarily continuous) of active operations.

[5]U.S. Department of Labor, Mine Safety and Health. Mine Injuries and Worktime Quarterly, Jan.-Dec. 1992, 32 pp.

[6]Times Record (Brunswick, ME). Woolwich Voters Approve Quarrying Ban. Dec. 2, 1992.

[7]Journal Tribune (Biddleford, ME). Small Gravel Pit Owners Get Break. Dec. 16, 1992.

MAINE

Principal Mineral–Producing Localities

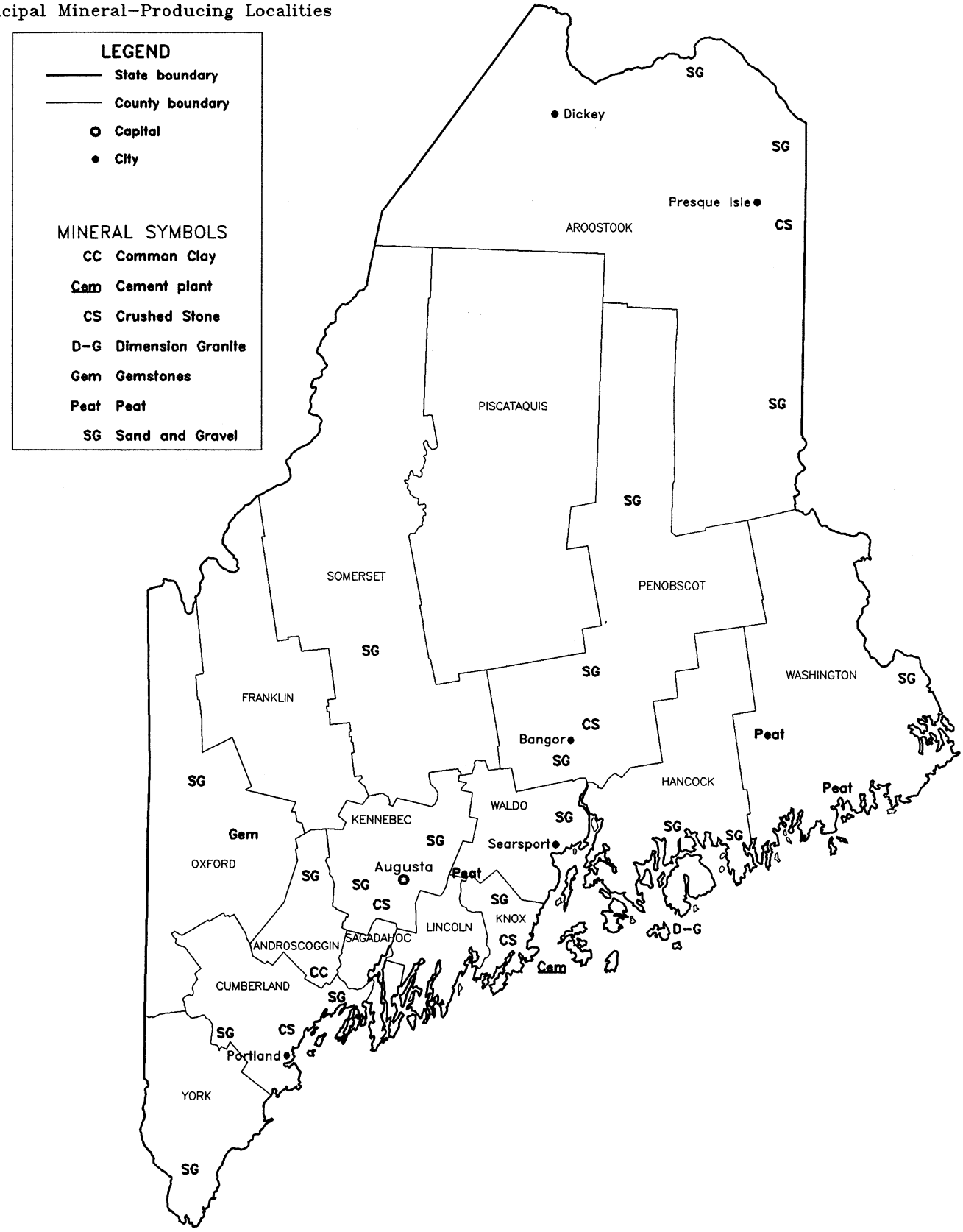

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Dragon Products Co.[1]	Box 191 Thomaston, ME 04861	Quarry and plant	Knox.
Clays:			
Morin Brick Co.	Mosher Rd. Gorham, ME 04038	Pits and mills	Androscoggin and Cumberland.
Graphite (synthetic):			
Fiber Materials Inc.	Biddleford Industrial Park Biddleford, ME 04005	Plant	York.
Perlite (expanded):			
Chemrock Corp.	1101 Kermit Dr. Suite 503 Nashville, TN 37217	do.	Knox.
Sand and gravel (construction):			
Dragon Products Co.[2]	Box 191 Thomaston, ME 04861	Pits	Androscoggin, Aroostook, Cumberland, Franklin, Kennebec, Knox, Somerset.
R. J. Grondin & Son[2]	Rural Route 4 Gorham, ME 04038	do.	Cumberland.
Lane Construction Corp.[2]	Box 103 Bangor, ME 04401	do.	Aroostook, Hancock, Penobscot, Waldo, Washington.
Maine Department of Transportation	State House Station 16 Augusta, ME 04333	do.	Aroostook, Kennebec, Knox, Oxford, Penobscot, York.
Portland Sand & Gravel Inc.	94 Walnut St. Portland, ME 04091	Pit	Cumberland.
W. S. Williams Construction Co.	RFD 1, Box 429 Gardiner, ME 04345	Pits	Lincoln.
Stone (1991):			
Crushed:			
Blue Rock Industries[3]	58 Main St. Westbrook, ME 04092	Quarries	Cumberland and Kennebec.
Pike Industries Inc.[3]	U.S. Route 3, Box 91 Tilton, NH 03276	do.	Androscoggin.
H. E. Sargent Inc.[3]	101 Bennoch Rd. Stillwater, ME 04489	Quarry	Penobscot.
Dimension:			
Fletcher Granite Co.	Groton Rd. W. Chelmsford, MA 01863	do.	Hancock.
New England Stone Industries	15 Branch Pike Esmond, MA 02917	do.	Do.

[1]Also sand and gravel and stone.
[2]Also crushed stone.
[3]Also sand and gravel.

THE MINERAL INDUSTRY OF MARYLAND

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Maryland Geological Survey for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.[1]

The value of nonfuel mineral production in Maryland declined to about $339 million in 1992. Value of mineral production dropped for the second year in a row as demand for minerals used in construction remained weak. Lower output was reported for most of the mineral commodities produced in the State. Maryland ranked 31st among the 50 States in value of nonfuel mineral production for the year.

TRENDS AND DEVELOPMENTS

About three-fourths of Maryland's mineral value was attributed to the production of sand and gravel and crushed stone. In 1992, output of these two commodities totaled about 36 million short tons, a moderate decline of about 3 million tons from the 1991 total. However, compared with 1990 data, production declined by about 13 million tons and was more indicative of the downturn in construction and resultant decline in the State's mineral industry.

The effects of the decline in demand for mineral aggregates by the construction industry became evident in 1992. The value of State highway construction expenditures in 1992 declined by about 37% compared with that of 1990. Highway construction expenditures in Maryland for 1992 were about $474 million, $708 million in 1991, and $748 million in 1990 as reported in the State budget.

Despite a slowdown in production of crushed stone and sand and gravel during the past 2 years, these industries have expanded considerably since a decade ago. Industry expansion and strong demand for these construction aggregates have increased land use conflicts in the State. During the early 1980's, an average of about 25 to 30 million short tons of sand and gravel and crushed stone was produced at about 70 pits and quarries. Production of these two commodities peaked in 1988 with output of about 52 million tons. From 1990 through 1992, output averaged about 41 million tons per year from approximately 95 pits and quarries.

A decision on the opening or expansion of mining operations in Maryland requires local government approval. Typically in the State, county government approval is required for development. In 1992, Charles County, which was among the State's top counties in sand and gravel production, completed a detailed report on that industry. A committee made up of representatives from residential communities, the sand and gravel industry, and county government compiled the report. Recommendations in the report included conducting a survey of sand and gravel resources in the county, as well as a ranking system to prioritize the mining of sand and gravel. This type of local land use planning is slowly emerging as a

TABLE 1
NONFUEL MINERAL PRODUCTION IN MARYLAND[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland)	thousand short tons	1,798	$91,172	e1,580	e$80,580	1,669	$84,191
Clays	metric tons	338,775	1,712	e258,760	e1,141	227,013	980
Gemstones		NA	3	NA	3	NA	1
Peat	metric tons	3	W	—	—	—	—
Sand and gravel (construction)	do.	18,271	104,023	e13,000	e72,800	11,988	69,297
Stone:							
Crushed	do.	e30,500	e163,900	25,545	188,001	e23,800	e180,400
Dimension	short tons	r e12,479	r e1,079	r12,355	r1,067	e11,365	e1,024
Combined value of other industrial minerals and value indicated by symbol W		XX	6,053	XX	4,720	XX	3,473
Total		XX	r367,942	XX	r348,312	XX	339,366

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

TABLE 2
MARYLAND: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	5,629	$33,912	$6.02
Plaster and gunite sands	384	2,353	6.13
Concrete products (blocks, brick, pipe, decorative, etc.)	W	W	7.20
Asphaltic concrete aggregates and other bituminous mixtures	W	W	3.50
Road base and coverings[1]	578	2,661	4.60
Fill	1,330	4,666	3.51
Other miscellaneous uses	548	2,351	4.29
Unspecified:[2]			
Actual	1,212	9,151	7.55
Estimated	2,308	14,204	6.15
Total[3]	11,988	69,297	5.78
Total[4 5]	10,875	69,297	6.37

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data may not add to totals shown because of independent rounding.
[4]One metric ton is equal to 1,000 kilogram or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

means for local government officials to balance the sometimes divergent interests in mineral resource development and environmental protection.

Although the instate production of minerals declined in 1992, the shipment of mineral commodities to the Port of Baltimore showed improvement. Overall, total import trade increased from 9.4 million short tons in 1991 to about 11.8 million tons in 1992. Imports of industrial minerals that increased in 1992 included gypsum by 44%, clay by 29%, and salt by 22%. The combined tonnage of these three commodities received at the port in 1992 was about 1.5 million tons, of which gypsum accounted for about 80%. Cement imports continued to decline, dropping to 116 tons in 1992, down from 277 tons in 1991 and 162,000 tons in 1990. The decline in cement imports reflected the availability of lower priced domestic supplies.

Coal was also produced in Maryland in Allegany and Garrett Counties. Output in 1992 was about 3.4 million short tons, a decline of about 11% from that of 1991, according to the Maryland Bureau of Mines.

EMPLOYMENT

Mining employment in Maryland declined by about 12% in 1992, indicative of the drop in mineral production. The number of workers in nonfuel mineral mining decreased to 773 in 1992 from 904 in 1991.[2] Coal miner employment also fell from 537 in 1991 to 498 in 1992.

Construction industry employment in 1992 of 118,300 was 9% lower compared with that of 1991.[3] In 1990, Maryland employed about 156,000 construction workers. The decline in construction employment as in mining followed the trend of decline in the State's construction industry as discussed in trends and developments.

LEGISLATION AND GOVERNMENT PROGRAMS

The Maryland General Assembly enacted House bill 1263, Chapter 605, that authorized the Department of Natural Resources to establish a fund for treatment of previously mined areas affected by acidic water.

Also enacted in 1992 was House bill 1227, Chapter 197, requiring the Maryland Department of the Environment (MDE) to study health and safety issues for the burning of hazardous waste in cement kilns. The legislation required the MDE to delay or suspend the issuance of permits for such practices. The study is to be completed by October 1, 1994.

The Maryland Geological Survey (MGS) was the primary State agency responsible for geologic and mineral resource studies. The MGS continued cooperative programs with the U.S. Bureau of Mines (USBM) on the collection of mineral information and with the U.S. Geological Survey primarily in geologic mapping. Offshore sand resources was the subject of a cooperative study by the MGS, Delaware Geological Survey, and the Minerals Management Service of the Department of the Interior. The loss of beach sands, with the potential for a loss of beach areas, would diminish tourism, a major industry in Maryland. The study was expected to provide information on the cost and feasibility of replacing sand lost by erosion.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

For the second year in a row, developments in the State's industrial minerals sector were slowed by weak demand from the construction industry. In 1992, industrial minerals were produced in Maryland at about 110 operations, according to data reported to the USBM and listed in table 1. Sand and gravel was produced at 67 pits, crushed stone at 27 quarries, clay and

TABLE 3

MARYLAND: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1[1]		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[2]	—	—	4,963	32,081	1,165	5,020
Asphaltic concrete aggregates and road base materials[3]	—	—	2,058	8,411	282	431
Unspecified:[4]						
Actual	—	—	1,212	9,151	—	—
Estimated	—	—	953	6,321	1,355	7,883
Total[5]	—	—	9,187	55,963	2,802	13,334
Total[6 7]	—	—	8,334	55,963	2,542	13,334

[1]Withheld to avoid disclosing company proprietary data; included with District 2.
[2]Includes plaster and gunite sands.
[3]Includes fill, road and other stabilization (cement and lime), and other miscellaneous uses.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilogram or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value in thousand metric tons and thousand dollars.

shale at 7 pits, dimension stone at 5 quarries, cement at 3 plants, and industrial sand at 1 pit. Output of crushed stone, cement, and sand and gravel accounted for more than 95% of the State's total value of nonfuel mineral production of $339 million.

Sand and Gravel.—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Maryland construction sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 3 presents end-use statistics for Maryland's three districts.

In 1992, sand and gravel production of about 12 million short tons was the lowest reported since 1983. For the year, 48 companies operated 67 pits in 12 of Maryland's 23 counties. Prince Georges, Charles, and Cecil were the top three counties in production. Sand and gravel used for concrete aggregate accounted for about one-half of the total sales or about $35 million. The average price per ton (plant f.o.b.) has remained stable during the past 3 years, ranging between $5.60 and $5.78 per short ton.

During the year, one of the State's producers joined with a construction materials distributor in a recycling venture. Campbell Sand & Gravel Co. and Patuxent Materials Co. formed Campat Inc. in Crofton. Investment in the plant was about $1 million and included a new crusher, conveyor system, and screening equipment. Operations of this type are becoming more widespread because of diminishing landfill space, particularly in areas of high population. Disposal of a tractor-trailer load of construction material debris at a landfill costs about $325 in the Anne Arundel County area. Campat officials claim that the cost of 2-inch stone delivered in that area was about $3.00 per ton higher in price than the recycled material.

Stone.—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Production of crushed stone in 1992 of about 23.8 million short tons was the lowest reported since 1984. Despite the lower output, crushed stone remained the leading mineral commodity produced in Maryland, accounting for almost 60% of the State's value of nonfuel mineral production. In 1992, Maryland ranked 21st nationally in crushed stone production.

Metals

Metals discussed in this section were processed from materials received from both foreign and domestic sources. No metallic ores were mined in Maryland. Production and value data for these processed metals, which are not included in table 1, are given if available.

Metals were imported into Maryland primarily through the Port of Baltimore. Iron ore imports, which dropped by about 25% from 1990 to 1991, rebounded in 1992 to about 3.5 million short tons as demand for steel improved during the second half of the year. Ferroalloy shipments from overseas continued to decline, dropping to about 117,000 short tons in 1992 from 145,000 tons in 1991 and 177,000 tons in 1990.

Aluminum.—Eastalco Aluminum Co., a subsidiary of Alumax Inc., continued to produce aluminum at its smelter near Frederick. Output in 1992 remained about the same as that of 1991.

Copper.—Cox Creek Refining Co.,

Baltimore, which shut down operations in 1991, remained idle in 1992. Mitsubishi Materials America Corp., a subsidiary of Mitsubishi Metal Corp. of Japan, owned 80% interest in the company with Southwire Co. of Carrollton, GA, owning the other 20% of the company.

Iron and Steel.—Maryland's iron and steel industry was dominated by one producer, Bethlehem Steel Corp., at Sparrows Point. The Sparrows Point plant, which covers approximately 3,500 acres, is along the Chesapeake Bay near Baltimore. The principal products were hot- and cold-rolled sheets, tin mill products, coated sheets, plates, and semifinished steel products. The operation has a slab caster with a 3.6-million-ton capacity.

During the year, a $140 million steel sheet coating line began production. Combined with existing coating facilities, Bethlehem has 480,000 tons of capacity in this type of steelmaking.

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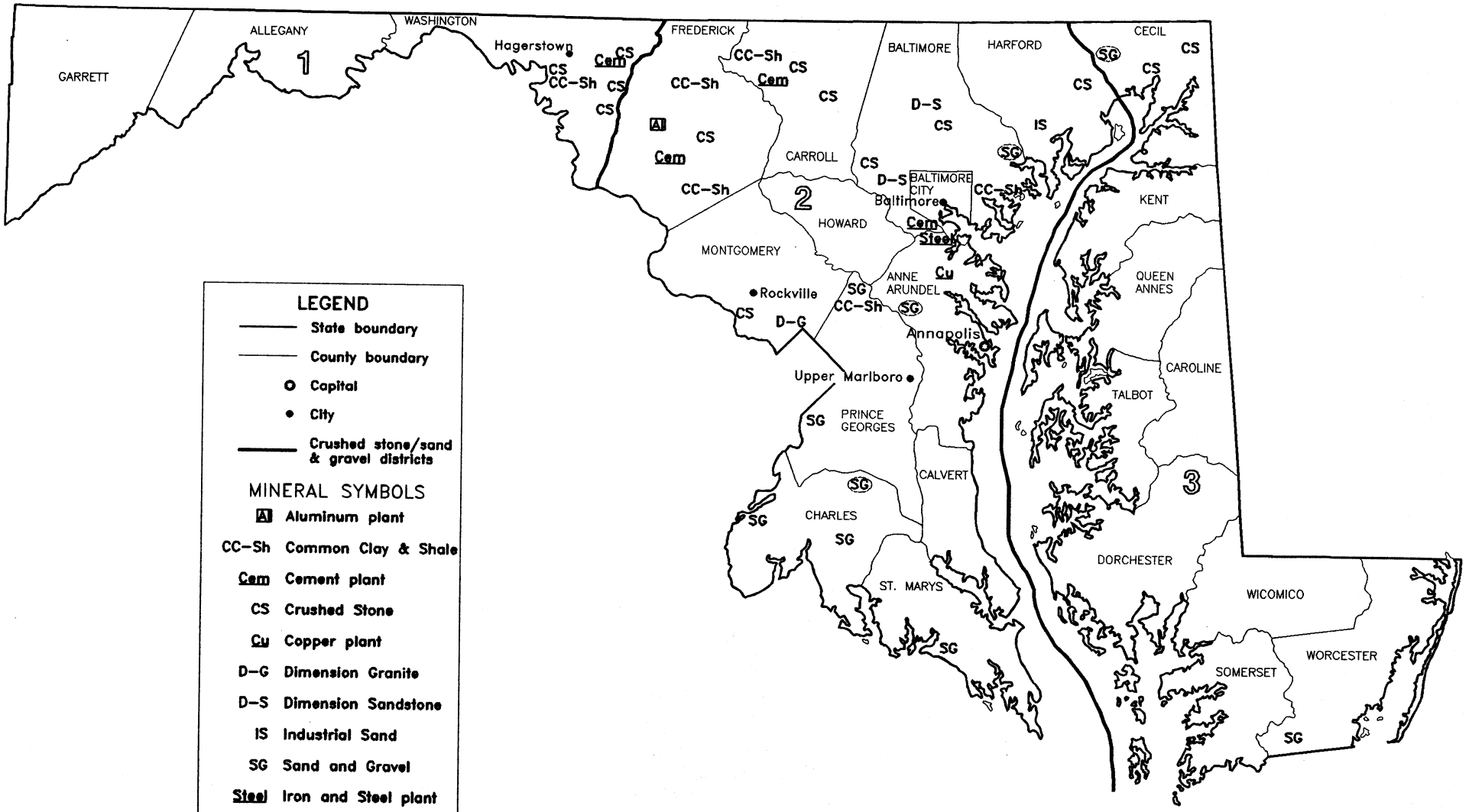
[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related industry and government experience and has covered the mineral activities in Maryland for 8 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]U.S. Department of Labor, Division. of Mining Information Systems. Mine Injuries and Worktime Quarterly, Jan.-Dec. 1992.

[3]Maryland Office of Labor Market Analysis and Information, Baltimore, MD. Personal communication. Aug. 26, 1993.

MARYLAND



Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Aluminum:			
Eastalco Aluminum Co. (Alumax Inc.)	5601 Manor Woods Rd. Frederick, MD 21701	Reduction plant	Frederick.
Cement:			
Portland:			
Essroc Materials Inc.[1]	Box D Frederick, MD 21701	Quarry and plant	Do.
Portland and masonry:			
Independent Cement Corp.[1] (St. Lawrence Cement Inc.)	Box 650 Hagerstown, MD 21740	do.	Washington.
Lehigh Portland Cement Co.[1 2] (Heidelberger Zement AG)	Box L Union Bridge, MD 21791	do.	Carroll.
Slag:			
Blue Circle—Atlantic (Blue Circle Industries PLC)	Box 6687 Sparrows Point, MD 21219	Plant (slag cement)	Harford.
Clays:			
Common clay and shale:			
Baltimore Brick Co.	9009 Yellow Brick Rd. Baltimore, MD 21237	Pit and plants	Frederick.
Cherokee Sanford Group Inc.	7100 Muirkirk Rd. Beltsville, MD 20705	Pit and plant	Prince Georges.
Cushwa Brick Inc.	Clearspring Rd. & Route 68N Box 160 Williamsport, MD 21795	do.	Washington.
Copper:			
Cox Creek Refining Co.	Box 3407 Baltimore, MD 21226	Refinery	Anne Arundel.
Gypsum:			
Byproduct:			
SCM Chemicals Inc.[3]	3901 Glidden Rd. Baltimore, MD 21226	Plant	Baltimore.
Calcined:			
National Gypsum Co., Gold Bond Building Products Div.	2301 South Newkirk St. Baltimore, MD 21224	do.	Do.
USG Corp.	500 Quarantine Rd. Box 3472 Baltimore, MD 21226	do.	Do.
Iron and steel:			
Bethlehem Steel Corp.	Sparrows Point, MD 21219	Mill (integrated)	Do.
Eastern Stainless Corp. (subsidiary of Cyclops Industries Inc.)	Box 1975 Baltimore, MD 21203	Melting furnace	Do.
Sand and gravel:			
Construction:			
Chaney Enterprises Ltd.	Box 548 Waldorf, MD 20604	Pits and plant	Anne Arundel, Charles, St. Marys.
Laurel Sand & Gravel Inc.[1]	5601 Van Dusen Rd., Box 719 Laurel, MD 20707	Pits and plants	Anne Arundel and Prince Georges.
Seven Star Aggregates Inc.	Box 1668 La Plata, MD 20646	Pit	Charles.
Silver Hill Aggregates & Concrete Co. (Evered Bardon USA Inc.)	4714 Barnabas Rd. Temple Hills, MD 20748	Pit and plant	Prince Georges.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued:			
Construction—Continued:			
Southern Maryland Sand & Gravel Corp.	8700 Ashwood Dr. Capitol Heights, MD 20743	Pit	Charles.
York Building Products Co. Inc.	Box 1708 York, PA 17405	Pit and plant	Cecil.
Industrial:			
Harford Sands Inc.	Box 25 40 Fort Hoyle Rd. Joppa, MD 21085	Pits	Harford.
Stone:			
Crushed:			
The Arundel Corp.[3] (Florida Rock Industries Inc.)	110 West Rd. Baltimore, MD 21204	Quarries and plants	Baltimore, Frederick, Harford.
Genstar Stone Products Co.[3] (Redland PLC)	Executive Plaza 4 11350 McCormick Rd. Hunt Valley, MD 21031	do.	Baltimore, Carroll, Frederick.
Martin Marietta Aggregates Corp.	Box 30013 Raleigh, NC 27612	Quarries	Washington.
Maryland Materials Inc.	Box W North East, MD 21901	Quarry and plant	Cecil.
H. B. Mellott Inc.	Box 188 McConnelsburg, MD 17233	Quarries and plant	Washington.
Phoenix Inc.	Box 676 Frederick, MD 21701	Quarry	Frederick.
Rockville Crushed Stone Inc. (Evered Bardon USA Inc.)	Box 407 13900 Piney Meetinghouse Rd. Rockville, MD 20850	do.	Montgomery.
D. M. Stoltzfus & Son Inc.	Box 11 Talmage, PA 17580	do.	Cecil.
Dimension:			
Piccirilli Quarries Inc.	795 Marriottsville Rd. Marriottsville, MD 21104	do.	Baltimore.
Stoneyhurst Quarries Inc.	15215 Shady Grove Rd. Rockville, MD 20850	do.	Montgomery.
Vinci Stone Products Inc.	10920 Marriottsville Rd. Marriottsville, MD 21104	do.	Baltimore.
Vermiculite (exfoliated):			
W. R. Grace & Co., Construction Products Div.	12340 Conway Rd. Beltsville, MD 20705	Plant	Prince Georges.

[1]Also crushed stone.
[2]Also clays.
[3]Also sand and gravel.

THE MINERAL INDUSTRY OF MASSACHUSETTS

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Commonwealth of Massachusetts, Executive Office of Environmental Affairs, for collecting information on all nonfuel minerals.

By Donald K. Harrison[1]

The value of nonfuel mineral production in 1992 was $147.4 million, an increase of $35 million compared with the 1991 value. The increase was largely attributable to greater sales of crushed stone and construction sand and gravel, the State's two leading mineral commodities. Together, these two mineral commodities accounted for 85% of the State's total mineral value. Other mineral commodities produced included common clay, industrial sand, dimension stone, lime, and peat. Nationally, the State ranked 40th in the production of nonfuel minerals. It ranked fifth of 34 States that produced dimension stone. Industrial minerals processed or manufactured in the State included abrasives, synthetic graphite, gypsum, perlite, and vermiculite.

TRENDS AND DEVELOPMENTS

Work began on both of the State's major construction projects, the $5 billion Boston Central Artery Project and the $5 billion cleanup of Boston Harbor. In the harbor cleanup project, a 6-mile-long, 11-foot-wide deep rock tunnel under Boston Harbor will transport sewage from Nut Island to new sewage treatment facilities on Deer Island. From Deer Island, a 9.5-mile-long, 24-foot-diameter tunnel will discharge treated wastewater into Massachusetts Bay through 55 diffusers located 110 feet below the surface. Construction was under way at both tunnels and the new primary treatment plant; the facilities' plan for the new secondary treatment plant on Deer Island also was completed.

In 1992, the value of total construction contracts in Massachusetts was 15% greater than that of 1991. This was the first rise since 1988, one of the peak building years during the building boom of the mid- to late 1980's. Although the value of nonbuilding contracts was down 8% from that of 1991, this was offset by increases in nonresidential building (up 36%) and residential construction (up 21%). The combination of the two $5 billion major construction projects and increases in overall construction activity in 1992 were at least two contributing factors in increased sales of crushed stone and construction sand and gravel. Estimated production of crushed stone was up 46% from 1991 levels; production of construction sand and gravel also rose by 19%.

EMPLOYMENT

In 1992, the average number of workers[2] employed in the mineral extractive industries in Massachusetts was 944, a total of 33 less than that of 1991. This included 376 workers in the sand and gravel industry, 277 in the stone industry, and 6 workers at other nonmetal mines. An average of 285 personnel were employed at mineral-related mills and preparation plants in the State.[3]

TABLE 1
NONFUEL MINERAL PRODUCTION IN MASSACHUSETTS[1]

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
Gemstones		NA	$1	NA	$1	NA	$1
Sand and gravel:							
Construction	thousand short tons	r13,143	r53,461	e10,100	e39,400	12,033	48,671
Industrial	do.	30	401	30	401	9	151
Stone:							
Crushed	do.	e9,200	e54,500	7,131	51,362	e10,400	e77,200
Dimension	short tons	r e54,566	r e9,684	69,332	11,646	e65,836	e9,292
Combined value of clays (common), lime, and peat		XX	10,138	XX	8,787	XX	12,086
Total		XX	r128,185	XX	111,597	XX	147,401

eEstimated. rRevised. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

REGULATORY ISSUES

In November, owners of the Salem Harbor Powerplant agreed to reduce smog and acid rain emissions by two-thirds over the next 2 years. The agreement between New England Power Co., the plant's owner, and the Massachusetts Department of Environmental Protection was the largest one-time reduction in pollutant emissions from a powerplant in State history. The coal- and oil-burning plant, built in 1951, is a wholesale generating plant that supplies 750 megawatts of power to the North Shore. It is the second highest single source of nitrogen oxide emissions in the State. Nitrogen oxide is a major source of smog and acid rain. Under a consent agreement, prompted by the threat of legal action by the State, the operators of the plant agreed to spend between $20 to $25 million in first-in-the-Nation pollution controls.[4]

Recontek Inc., a San Diego-based company, shelved plans to build a metallic hazardous waste recycling plant in Orange, about 40 miles northwest of Worcester. Plans for the plant faced stiff local opposition and were withdrawn near midyear when Recontek's request for a 90-day extension for submitting its preliminary project impact report was denied by a State environmental panel vote of 8 to 7. The Orange plant was one of eight such plants Recontek plans to build in the United States to reclaim metals from waste discarded by companies in the electronics, metal finishing, and aerospace industries.

LEGISLATION AND GOVERNMENT PROGRAMS

Public Law 102-587, the "Oceans Act of 1992," was signed into law in November. The law designated approximately 450 square nautical miles of ocean waters surrounding Stellwagen Bank of Massachusetts as the "Stellwagen Bank National Marine Sanctuary (SBNMS)." The law was designed to protect the ecological, recreational, and esthetic resources of the waters surrounding the SBNMS. The SBNMS is 6 miles off Provincetown in Massachusetts Bay. Section 2202, paragraph d of Public Law 102-587, states that exploration for, and mining of, sand and gravel and other minerals in the sanctuary is prohibited. In recent years, Massachusetts environmental groups lobbied heavily to protect the area by designating the bank as a marine sanctuary, the underwater equivalent of a national park.

The town of Grafton was awarded a $100,000 Federal grant to develop a former sand and gravel pit along the Blackstone River into a 55-acre park with an athletic field and hiking trails. The $100,000 grant came from the Federal Land and Water Conservation Fund of the U.S. Department of the Interior. A matching grant came from the Blackstone River Valley Heritage Corridor Commission. The former sand and gravel pit was donated to the town of Grafton many years ago.[5]

In November, Massachusetts voters decisively defeated a hotly debated packaging and recycling initiative that pitted environmental groups against manufacturers and business organizations. "An Act To Promote Packaging Reduction and Recycling" would have required that by July 1996 a wide variety of packaging used in Massachusetts either be reusable at least five times or contain increasing amounts of recycled or recyclable materials—50% by the year 2002. Although environmental groups generally supported the proposed act, most manufacturers and business organizations were against it.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Abrasives (Manufactured).—Norton Co., the world's leading manufacturer of abrasives, produced nonmetallic abrasive products at its plant in Worcester. The company manufactured bonded and coated abrasives primarily used in the surface conditioning, cutting, shaping, and finishing of many types of materials. Primary end users included foundries and steel mills, metal fabricators, glass and ceramic grinders, stonecutters, and the construction industry.

Clays.—One company, in Plymouth County, mined common clay for the manufacture of common and face brick.

Locally, several towns in the vicinity of Boston's "Big Dig" project have benefited from the project. The clay from the project, known as "Boston Blue Clay," had been tested and approved by the State Department of Environmental Protection as suitable for use to cap landfills. O'Donnell Sand & Gravel, the company that is removing the clay, made available to the town of Revere a total of 7,000 cubic yards of clay at no cost. The city, which is capping a local landfill, saved $700,000 to $1.1 million, the estimated cost of purchasing the clay. The capping is the result of a State Department of Environmental Protection mandate that the site be capped after tests by the city board of health qualified the area as a solid waste landfill. The capping program also will include the installation of nine wells to monitor ground water.

Graphite (Manufactured).—One company in Lowell, Middlesex County, produced high-modulus graphite fibers used primarily by the aerospace industry.

Gypsum (Calcined).—Crude gypsum, shipped into the State from company-owned mines in other States and Nova Scotia, was calcined by USG Corp. at Charlestown near Boston. The calcined gypsum was made into wallboard and shipped throughout New England, primarily for use in residential construction.

Lime.—Two companies manufactured lime in Berkshire County from locally quarried limestone. Lee Lime Corp. operated a quarry and plant in Lee and Minerals Technologies Inc. (MTI) operated a plant in Adams.

In October, MTI was officially spun

TABLE 2
MASSACHUSETTS : CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	4,222	$21,949	$5.20
Plaster and gunite sands	41	336	8.20
Concrete products (blocks, bricks, pipe, decorative, etc.)	165	823	4.99
Asphaltic concrete aggregates and other bituminous mixtures	927	3,094	3.34
Road base and coverings[1]	1,599	4,913	3.07
Fill	1,718	4,109	2.39
Snow and ice control	320	1,422	4.44
Railroad ballast	W	W	15.00
Other miscellaneous uses[2]	101	873	8.64
Unspecified:[3]			
Actual	504	1,628	3.23
Estimated	2,438	9,523	3.91
Total[4]	12,033	48,671	4.04
Total[5 6]	10,916	48,671	4.46

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

off from Pfizer Inc. MTI is a new company composed of substantially all of the net assets of what were formerly the specialty minerals business of Pfizer, which included the company's lime plant in Adams. The spinoff was the result of a decision by Pfizer to focus on health care, although Pfizer retained a 40% interest in MTI. The Adams operation, which employs 200 workers, produces lime from locally quarried limestone with reserves of at least 30 years. The ground up limestone, much of it precipitated calcium carbonate, has a variety of applications in such products as ceiling tiles, animal feed, scouring cleansers, glazing compounds, paint, and packaging for food products.

Peat.—Reed-sedge peat was produced by Sterling Peat Inc., Worcester County, and was used primarily for agricultural purposes. All of the material was sold in packaged form.

Perlite (Expanded).—Crude perlite, mined in New Mexico, was expanded by Whittemore Perlite Co. Inc. at a plant in Suffolk County. The expanded perlite was used for insulation, plaster aggregate, and as a horticultural medium.

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Massachusetts construction sand and gravel statistics are compiled by geographical districts as depicted by the State map. Table 3 represents end-use data for the State's three districts.

The value of construction sand and gravel accounted for the second largest portion (one-third) of the State's total mineral value. In 1992, production and value increased 19% and 24%, respectively, from the 1991 estimated levels. About 100 companies mined construction sand and gravel in 12 counties. Leading counties, in order of output, were Worcester, Plymouth, Norfolk, Bristol, and Hampden. The material was used mainly for concrete aggregate, fill and road base, and coverings.

Near yearend, the Dunstable Board of Selectmen unanimously voted to suspend the mining permit of Nashua River Land Corp.'s (NRLC) sand and gravel operation for violating the permit's conditions. The permit issued to NRLC required that excavation not go deeper than 8 feet above the water table. The board came to the decision based on the town engineer's report that the company had gone well below the 8-foot maximum limit. Although sand and gravel mining became illegal in the town after a 1986 zoning law prohibiting mining was passed, NRLC and four other pits in the town operated before 1986 and were, therefore, granted "grandfathered" status. According to the 1986 zoning law, removal of earth in excess of 15 cubic yards can only be done with a special permit granted by the Board of Selectmen. NRLC was operating under such a permit.

After nearly 5 months of meetings, hearings, and debates, the Uxbridge Board of Selectmen approved a permit in August to the Richardson North Corp. to remove 400,000 to 500,000 cubic yards of sand and gravel. Debate on the project began in February when selectmen first ruled that Richardson did not need a permit. A month later, however, the board rescinded that decision after visiting the site. The visit convinced them that removing the large amount of sand and gravel was not part of "normal farming operations," which is exempt from the bylaw. However, the unanimous decision by the four members of the board in August gave final approval for the sand and gravel removal.[6] Excavation by Kimball Sand & Gravel, Richardson's contractor, started the day after the permit was issued.

TABLE 3

MASSACHUSETTS: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	932	3,418	727	3,622	2,564	14,909
Plaster and gunite sand	W	W	W	W	23	213
Concrete products (block, bricks, etc.)	W	W	W	W	98	518
Asphaltic concrete aggregates and other bituminous mixtures	65	659	123	596	739	1,840
Road base and coverings[1]	136	744	482	1,945	981	2,224
Fill	276	1,223	461	996	981	1,889
Snow and ice control	119	578	158	571	44	274
Railroad ballast	—	—	—	—	W	W
Other miscellaneous uses[2]	33	301	93	372	55	627
Unspecified:[3]						
Actual	244	528	260	1,099	—	—
Estimated	402	948	127	487	1,909	8,088
Total[4]	2,210	8,399	2,430	9,688	7,392	30,583
Total[5 6]	2,005	8,399	2,205	9,688	6,706	30,583

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

Abutters of the project, who generally oppose the operation, have filed suit against the Board of Selectmen charging that an adequate buffer zone between the excavation and a brook that runs through the property was not established when the permit was issued.

Industrial.—Industrial sand was mined by one company in Plymouth County, primarily for use in molding and core, and in sandblasting.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—Crushed stone was the State's leading mineral commodity, accounting for 52% of the State's total nonfuel mineral value. Estimated stone production in 1992 was 46% higher than that of 1991. Traprock (basalt) accounted for the majority of the crushed stone produced. It was mined by 11 companies at 17 quarries in 7 counties. Crushed granite was produced by four companies at five quarries in Bristol, Middlesex, and Norfolk Counties. Most of the production was used for road base and concrete aggregates. Limestone and dolomite was mined by two companies in Berkshire County. Most of the rock was used to manufacture lime.

In May, voters in the town of Templeton overwhelmingly passed a bylaw that will not allow any quarry to operate or open within the town. This was the second time that a quarry bylaw came before voters at an annual town meeting. The first time was in 1990. That article, which would have prohibited quarries from being operated or opened, was originally approved by the voters and the State's Attorney General. However, the State fire marshall's office disallowed that bylaw because of this wording and definition of a quarry.

The fire marshall's office changed the wording of the 1990 bylaw and suggested it be brought before the voters again for a vote. As worded by the fire marshall and approved by voters in the May 1992 vote, the bylaw reads: "Section 1 - Definition of a Quarry: Any property, which may primarily be used as a source of mined products from the earth when the removal of such products requires the use of explosives to facilitate such removal."[7]

Dimension.—Nationally, Massachusetts ranked fifth of the 34 States that reported dimension stone production. Dimension granite was mined by six companies at six quarries in Berkshire, Middlesex, and Plymouth Counties. Most of the granite was used for curbing. Dimension marble, mined by one company in Berkshire County, was sold as rough blocks.

Vermiculite (Exfoliated).—W. R. Grace

& Co. exfoliated imported vermiculite a its Easthampton plant in Hampshire County. Major uses were for insulation and for concrete and plaster aggregates.

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[1]Regional Mineral Specialist, U.S. Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related experience and has covered the mineral activities in Massachusetts for 8 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Average number of workers is a summary of the average number of persons working at individual mining establishments during periods (not necessarily continuous) of active operations.

[3]U.S. Department of Labor, Mine Safety and Health Administration. Mine Injuries and Worktime, Quarterly, Jan.-Dec. 1992, 32 pp.

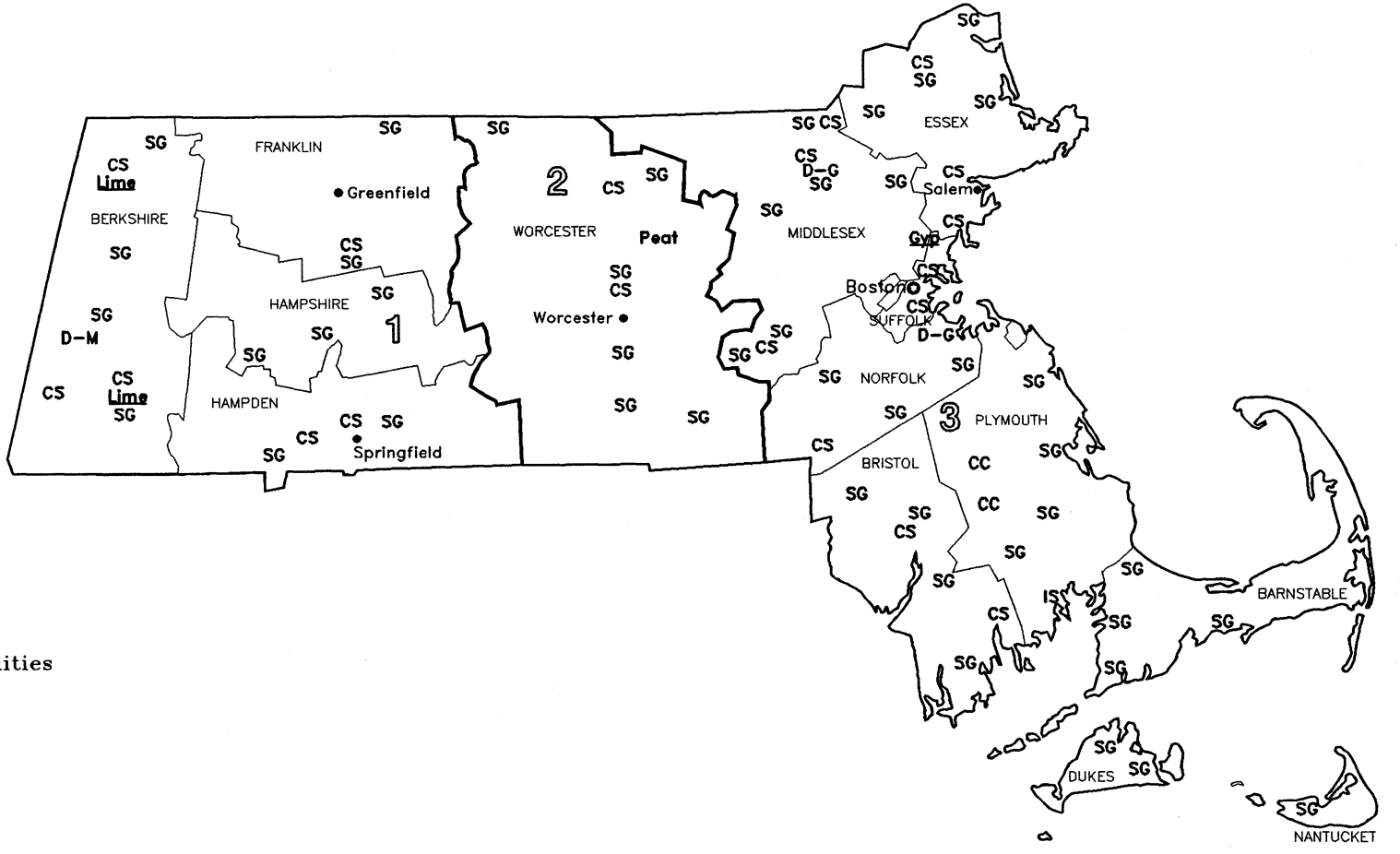
[4]Daily Evening Item (Lynn, MA). Salem Power OK's A Cleanup. Nov. 13, 1992.

[5]Milford (MA) Daily News. $100,000 Grant. Aug. 22, 1992.

[6]Telegram & Gazette (Worcester, MA). Gravel Permit in Uxbridge is Approved. Aug. 12, 1992.

[7]Gardner News. Templeton Passes Bylaw That Prohibits Quarries. May 13, 1992.

MASSACHUSETTS



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

CC	Common Clay
CS	Crushed Stone
D–G	Dimension Granite
D–M	Dimension Marble
Gyp	Gypsum plant
IS	Industrial Sand
Lime	Lime plant
Peat	Peat
SG	Sand and Gravel

Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Abrasives (manufactured):			
Norton Co.	Box 15008 Worcester, MA 01615-0008	Plant	Worcester.
Clays:			
Stiles & Hart Brick Co.	Box 367 Bridgewater, MA 02324	Pit	Plymouth.
Graphite (synthetic):			
Textron Specialty Materials	2 Industrial Ave. Lowell, MA 01851	Plant	Middlesex.
Gypsum (calcined):			
USG Corp.	101 South Wacker Dr. Chicago, IL 60606	do.	Suffolk.
Lime:			
Lee Lime Corp.[1]	Marble St. Lee, MA 01238	Plant and quarry	Berkshire.
Pfizer Inc.[1]	260 Columbia St. Adams, MA 01220	do.	Do.
Peat:			
Sterling Peat Inc.	64 Greenland Rd. Sterling, MA 01564	Bog	Worcester.
Perlite:			
Whittemore Perlite Co. Inc.	79 Beacon Ave. Lawrence, MA 01843	Plant	Essex.
Sand and gravel:			
Construction:			
Cape Cod Aggregates Corp.	Box 96 Hyannis, MA 02601	Pits	Barnstable.
Egerton PLC Emeral Corp.	Box 488 North Grafton, MA 01536	do.	Hampden and Worcester.
Evered Bardon USA Inc.	544 Whitton St. Tauton, MA 02780	Pit	Bristol.
O'Donnell Sand & Gravel	Marion Drive, Box 243 Kingston, MA 02364	Pit	Plymouth.
S. M. Lorusso & Sons Inc.[1]	230 West St. Walpole, MA 02081	Pit	Norfolk.
Worcester S&G Co.	183 Holden St. Shrewsburg, MA 01545	Pits	Worcester.
Industrial:			
Whitehead Bros. Co. Inc.	Box 259, River Rd. Leesburg, NJ 08327	Pit	Do.
Stone (1991):			
Crushed:			
Keating Materials Corp.	2140 Bridge St. Dracut, MA 01826	Quarries	Middlesex and Worcester.
John S. Lane & Son Inc.	730 East Mountain Rd. Westfield, MA 01085	do.	Berkshire, Hampden, Hampshire.
Simeone Corp.	1185 Turnpike St. Stoughton, MA 02072	do.	Bristol and Norfolk.
Tilcon Inc.	Box 114 Acushnet, MA 02743	Quarry	Bristol.
Trimount Bituminous Products Co.	1935 Revere Beach Parkway Everett, MA 02149	Quarries	Essex.

See footnote at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone—Continued:			
Dimension:			
Fletcher Granite Co.	Groton Rd. West Chelmsford, MA 01863	Quarries	Middlesex.
Guilmette Brothers Corp.	57 Ledge Rd. North Chelmsford, MA 01863	Quarry	Do.
LeMasurier Granite Quarry Inc.	Box 71, Ledge Rd. North Chelmsford, MA 01863	do.	Do.
Williams Stone Co. Inc.	Box 278 East Otis, MA 01029	do.	Berkshire.
Vermiculite (exfoliated):			
W. R. Grace & Co.	62-T Whittemore Ave. Cambridge, MA 02140	Plant	Hampshire.

[1]Also stone.

THE MINERAL INDUSTRY OF MICHIGAN

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Geological Survey Division, Michigan Department of Natural Resources, for collecting information on all nonfuel minerals.

By Robert H. Wood II[1] and Milton A. Gere, Jr.[2]

Michigan's 1992 nonfuel mineral production was valued at $1.6 billion, a 6% increase from the value reported in 1991. Total value increases were reported for sales of calcium chloride, copper, dimension stone, gypsum, iron ore, lime, portland cement, potash, salt, sand and gravel, and silver. Total value decreases were reported for the sales of clays, crushed stone, gemstones, iron oxide pigments, magnesium compounds, masonry cement, and peat. The State contributed nearly 5% of the total U.S. mineral value in 1992.

In order of value, Michigan's leading mineral commodities in 1992 were iron ore (usable), cement (portland), sand and gravel (construction), and stone (crushed). Michigan continued to rank fourth nationally in value of nonfuel minerals produced. It continued to be the leading producer of calcium chloride, crude iron oxide pigments, and magnesium compounds; it ranked second in production of iron ore, peat, and sand and gravel (construction); third in industrial sand; and fourth in cement (portland and masonry), gypsum, and potassium salts. Industrial minerals provided about 60% of the State's nonfuel mineral value.

TRENDS AND DEVELOPMENTS

Cement companies' practice of burning hazardous waste was a matter of political concern. Cement companies have been burning hazardous waste in cement kilns, under carefully monitored conditions (without apparent health or safety problems), for a number of years. Burning hazardous waste in cement kilns reduces fuel costs and provides a "safe" disposal method for eliminating hazardous waste. About 6.6% of the energy used in making cement in the United States and Canada comes from burning waste fuels.

TABLE 1
NONFUEL MINERAL PRODUCTION IN MICHIGAN[1]

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
Cement:							
Masonry	thousand short tons	272	$23,880	e225	e$22,440	234	20,381
Portland	do.	5,906	263,607	e4,935	e222,075	5,509	262,063
Clays	metric tons	1,201,542	4,094	2,061,861	8,770	1,264,692	4,345
Gemstones		NA	11	NA	10	NA	1
Gypsum (crude)	thousand short tons	2,000	11,511	1,721	13,052	1,770	13,889
Iron ore (usable)	thousand metric tons	10,034	W	e12,741	W	12,881	W
Lime	thousand short tons	622	30,898	613	30,959	636	31,253
Peat	do.	280	6,264	249	6,442	199	5,894
Sand and gravel:							
Construction	do.	r51,761	r155,559	e44,800	e132,200	47,994	143,107
Industrial	do.	2,310	19,285	2,093	18,464	1,897	19,506
Stone (crushed)	do.	e43,100	e129,000	40,989	129,490	e38,600	e125,500
Combined value of calcium chloride (natural), copper, iron oxide pigments (crude), magnesium compounds, potash, salt, silver, stone (dimension), and values indicated by symbol W		XX	r796,354	XX	919,366	XX	961,038
Total		XX	r1,440,463	XX	1,503,268	XX	1,586,977

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Opponents want more studies and a moratorium on such practices. If such practices were not allowed, not only would millions of gallons of waste fuels burned weekly at cement kilns require disposal elsewhere, additional nonrenewable energy resources would be used.[3]

The U.S. Environmental Protection Agency's (EPA) plan to improve the Great Lakes water quality could halt mining and paper mill industry expansion in the region. The mining and paper mill industries are the two major industries in Michigan's Upper Peninsula. Implementation of water quality standards for the Great Lakes and all tributaries would set limits on substances discharged from municipal and industrial wastewater systems. Total cost to municipalities and companies along the Great Lakes for complying with EPA's proposed water quality standards was estimated at $2.7 billion.

Cleveland-Cliffs Inc. (CCI) managed both of Michigan's only active iron ore mines, the Tilden near Ishpeming and the Empire near Palmer. Reserves at both mines were estimated by CCI to last at least another 30 years; however, continued recession in the steel market could change what is currently considered ore. Sharon Steel Corp., a CCI customer that normally buys about 86,400 metric tons (85,000 long tons) of iron ore pellets per month, filed for chapter 11 bankruptcy protection in September.[4] Efforts to help McLouth Steel Co. survive, another CCI customer that buys about 127,000 metric tons (125,000 long tons) of iron ore pellets per month and represented 13% of CCI's operating revenues in 1992, are expected to adversely affect 1993 profits as well.[5] CCI employs about 2,200 workers between the 2 mines and related facilities. About 10 years ago, close to 4,000 people were employed in Michigan's iron mining industry when the Republic Mine and associated Humbolt plant were still operating, along with the Empire and Tilden Mines. The Republic Mine near Republic remained on standby status during the year.

The untimely death of a youth who worked his way past fencing into an abandoned iron mine renewed awareness of Michigan's abandoned mines. Efforts to renew fencing and capping activities at old mines continued at various levels of government and industry.

EMPLOYMENT

According to statistics released by the Michigan Employment Security Commission, the State's civilian labor force totaled 4.61 million, slightly higher (1.3%) than that of 1991. The State's unemployment rate decreased from 9.2% to 8.8%. In the Upper Peninsula, where mining is an important occupation and the only area in the State with reported metal production, the unemployment rate rose from 10.4% to 10.8%.[6] The increased unemployment rate was partially related to the April layoff of 47 of the 1,104 workers at the White Pine Mine.

An average of 9,000 persons were engaged in mining throughout the State, the same as that reported in 1991. Mining employment in the Upper Peninsula totaled 3,400 persons, also reflecting no change from statistics released in 1991. Average hourly pay for Michigan miners, including nonmetallic mining and oil and gas production industries, was $14.64, compared with $13.72 in 1991. Michigan metal mine workers had average hourly wages of $15.59, a $2.33 increase over those of 1991.[7]

As reported by the U.S. Department of Labor, 6.9 million employee-hours worked at Michigan's underground and surface mining operations in 1992 resulted in 1 fatality, 198 injuries causing lost workdays, and 131 injuries with no workdays lost. At mills and preparation plants associated with mining operations, an additional 146 injuries to workers resulted in lost workdays and 81 injuries resulted in no lost workdays. A total of 11.3 million employee-hours were worked at the State's mines and related mills and plants during the year.[8]

ENVIRONMENTAL ISSUES

In August, the National Wildlife Federation and Michigan United Conservation Clubs filed a citizens suit under the Clean Air Act (CAA) against Copper Range Co. The lawsuit alleged that the company smelter violates the Federal Clean Air Act. The State of Michigan filed an intent to sue under the CAA also. The EPA announced preparation to initiate an enforcement action. According to an EPA official, the company could be fined up to $25,000 per day for exceeding State and Federal air pollution standards. In October, the Attorney General and the Director of the Department of Natural Resources filed a pleading to intervene in the lawsuit against the company. Copper Range operated the only working copper mine in the Upper Peninsula. About 1,050 workers were employed at the White Pine Mine, the region's largest employer.

Cleanup options and the party that would be responsible to pay the estimated $6.1 million cost to clean up the Torch Lake Superfund site on the Keweenaw Peninsula, Houghton County, were not decided at year's end. The EPA contended that except for an offshore area near the former Calumet & Hecla smelter and coal dock, the risk to public health posed by contaminants in Torch Lake are within the range generally acceptable to the EPA.

The Michigan Technological University (MTU) was awarded a $134,500 grant from the Michigan Great Lakes Protection Fund to study the effects of past copper mining on the plants and animals of Lake Superior and the Portage Lake Waterway. The study is aimed at helping the public make sound environmental decisions regarding copper mining in the State.

It will cost the Mueller Brass Products Co. more than $2 million in the first settlement arranged under the State's "polluters pay" law. The 75-year-old brass foundry was discharging metals (chrome, copper, and zinc) into the Black River. The company's "noncontact" cooling effluent has been diverted from the Black River to the Port Huron sanitary system after a filtration process. The company also was required to build a $500,000 treatment plant to cleanse

rainwater that flows from company property into the Black River. In addition to a $1 million civil penalty, the company agreed to buy marshland valued at $800,000 for game and fish management, a $128,000 mobile laboratory for the Department of Natural Resources (DNR), and provide the University of Michigan $130,000 to establish an environmental education program in Port Huron's high schools.

More than 60 residents of Palmer, MI, filed suit against CCI and the Empire Iron Mining Partnership concerning dust and blasting associated with the adjacent Empire Mine. In 1991, CCI reportedly built a $600,000 mine entrance road to allow truck traffic to bypass Palmer. In 1992, CCI washed 200 houses and made house paint available to residents who wanted it.

Partial fueling of cement kilns by whole or processed scrap tires has been successfully tested at some kiln operations. Facilities testing tire-derived fuel did not exceed air emissions standards; in fact, a net reduction in sulfur and nitrogen oxides and particulate matter was indicated. This was attributed to several factors: tires are manufactured using a narrow range of materials; 88% of a tire is composed of carbon, hydrogen, nitrogen, and oxygen; tires contain less than 1% moisture and about 1.5% sulfur; and tires contain about 14,000 British thermal units per pound.[9]

EXPLORATION ACTIVITIES

The 1992 State Metallic Mineral Lease Sale was held in May and resulted in six companies and individuals bidding $18,975.40 in bonus bids on 10,420 acres of State-owned mineral lands in six counties. Successful bidders included BPH Minerals International Exploration, Inc.; Crystal Exploration, Inc.; John Dziedzic; Noranda Exploration, Inc.; Terrance W. Quigley; and Western Mining Corp. (USA). Leased lands are in Baraga, Dickinson, Iron, Keweenaw, Marquette, and Menominee Counties. Lands offered included 59,960 acres in seven counties. The bonus bids ranged from $1.10 to $6.00 per acre, averaging $1.82 per acre. Also in 1992, companies released 12 State leases amounting to 3,496 acres of land. Late in 1992, nominations of State mineral lands for the 1993 lease sale were received for areas in six counties from five companies and individuals. Michigan received more than $800,000 as its 1992 share of revenues associated with mineral leases on Federal lands within the State.

Drilling activities for minerals in the Upper Peninsula were performed by 8 companies in 7 counties for a total of 150 drill holes representing 17,519 feet of drilling. Mineral exploration accounted for 124 of the holes and 14,525 feet of drilling. Special soil borings and special use holes totaled 26 holes and 2,994 feet of drilling.

Ashton Mining of Australia acquired 51% interest with Crystal Exploration, Inc. of their Great Lakes diamond exploration project centered in the Upper Peninsula of Michigan. Ashton agreed to spend $3.75 million over 3 years doing more testing in the project area. Dow Chemical Co. started the project and retains an interest. Published accounts reported 25 kimberlite pipes found by several companies. Of the 12 pipes reported by Crystal, 9 were tested, and 7 contained microdiamonds.

Western Mining Corp., an Australian-based company, continued to operate its exploration office in Michigan. It continued precious-metal exploration efforts previously done in a joint venture with the Callahan Mining Corp. Callahan Mining Corp. was purchased by Coeur d'Alene Mines Corp. during the year. The purchase included Callahan's interest in the closed Ropes Gold Mine and mill facility in Marquette County.

Noranda Exploration Inc. started an exploration effort for copper mineralization in Michigan's Keweenaw Peninsula. This was a part of a 1991 agreement with Great Lakes Minerals to explore some of its leased lands. Later in 1992, however, Noranda ceased its exploration effort in the Upper Peninsula as part of the company's reduction of U.S. exploration.

LEGISLATION AND GOVERNMENT PROGRAMS

During the year, the President approved legislation that created a new National Park 10 miles south of Calumet in Michigan's Keweenaw Peninsula. The park will commemorate the area's mining industry. Parts of the historic city of Calumet and the Quincy Mine steam hoist were included in the area designated for the new park.

The Michigan Department of Natural Resources, Geological Survey Division's (DNR/GSD) Geological Core and Sample Repository, at Marquette, continued to add materials to its collection. Three companies donated drill core from 68 drill holes. Information and core donated by USX Corp. was from the former U.S. Steel Co. mines and exploration work conducted in Michigan. Core housed in the "rock library" represent mineral exploration work, oil and gas wells, and engineering studies. Several hundred mine maps, geologic maps, and related materials have been donated to the collection housed at the repository. As of August 1, 1992, the repository inventory included 563 drill holes containing 207,581 feet of actual core stored in 13,250 boxes. In addition to the core, 1,556 boxes contained abbreviated core that represented 108,000 feet of drilling and 500 boxes of cuttings represented 63,000 feet of drilling. Materials in the repository were open to industry, government, academia, and the general public by appointment for geological research. Visitors using the rock library during the year represented four mining and exploration companies, one Federal agency, one mining consultant, one private citizen, and two State agencies for a total of 32 visitor days of use.

The Lansing DNR/GSD headquarters office maintains collections of all Michigan water well records, oil and gas well records, and significant oil and gas cuttings samples. Several district offices also maintain oil and gas well records for wells drilled within their boundaries.

The Escanaba DNR/GSD office houses copies of all Upper Peninsula water well

records and a collection of significant water well cuttings samples. These are helpful in areas of ground water supply problems.

Several Michigan papers and posters were presented at a regional industrial minerals workshop sponsored by the U.S. Geological Survey (USGS), U.S. Bureau of Mines (USBM), and Minnesota Geological Survey in cooperation with the Geological Surveys of Illinois, Indiana, North Dakota, Ohio, South Dakota, and Wisconsin. Michigan possesses a wealth of known mineral resources, has great potential for discovery of new industrial mineral resource deposits, and has the Great Lakes available for worldwide shipping of these bulk commodities. Mineral resource demands and availability, land use conflicts, and research needs in the region were major topics evaluated at the September meeting in Minneapolis. The "Program with Abstracts" from that meeting (USGS Open File Report 92-514) provides information about the Midwest and Great Lakes States, a list of State and Federal agencies involved with these resources, and abstracts of presentations. The report also included a section on State regulations affecting mining of industrial minerals.

A Cooperative Mapping effort to produce the Chippewa County geologic map portfolio was initiated by Lake Superior State University, Chippewa County Environmental Health Department, and the DNR/GSD. The maps and geologic cross-sections will be based on data from water well logs and oil and gas test well logs entered into part of the statewide Groundwater Data Base system.

A project to identify and delineate rock deposits with the potential to become commercial sources of dimension stone continued. This project was a joint effort of the Department of Mining Engineering at MTU, the U.S. Forest Service, and the GSD of the Michigan DNR.

Studies performed at MTU indicate that bioleaching, the use of microorganisms to dissolve unwanted material in valuable minerals or to produce acids that dissolve the material, is technically feasible. It has not been determined if the bioleaching process developed by MTU researchers is economically feasible for large-scale commercial operations.

The synthesis of data collected during the Greenstone Belt mapping project in prior years was continued by members of the MTU Department of Geological Engineering, Geology, and Geophysics. This project includes the Negaunee N.W. Quadrangle, Marquette County, and was sponsored in part by the USGS and DNR/GSD.

A thermal modeling study of part of the Midcontinent Rift System and related copper deposits was done by the Department of Geological Engineering, Geology, and Geophysics at MTU. The research was sponsored by the American Chemical Society's Petroleum Research Fund.

The Mineral Technology Research Group, MTU Department of Mining Engineering continued its field lab studies to evaluate graphitic slate and other rocks for possible substitutes in cement manufacture. Another continuing study of the MTU Mineral Technology Research Group was the study of a bioleaching process to remove phosphorus from iron ore concentrate. Phosphorus makes iron and steel brittle, and processors are striving to obtain ore concentrates with an even lower phosphorus content.

A study was continued by MTU's Mineral Technology Research Group on foundry and glass sand materials. Several aspects of processing and using industrial sand were being researched during the year.

The MTU experimental mine in Hancock was closed in March. Rising costs, diminishing benefits, and lower enrollment in their mining program were cited as reasons for the closure.

A fund raising drive was planned for the Mineral Education Fund (MINE Fund) by the Upper Peninsula Chapter, Society of Mining, Metallurgy, and Exploration Inc. of the American Institute of Mining Engineers (AIME). The MINE Fund goal was to provide three scholarships in mineral-related studies at MTU, one each in mining engineering, metallurgical engineering, and geological engineering.

The DNR/GSD and Parks Divisions continued support of the Gerald E. Eddy Geology Center in Washtenaw County. Located within the Waterloo Recreation Area, the facility provides displays featuring the mineral resources and geology of the State.

Mineral education outreach activities again were provided by the A.E. Seaman Mineralogical Museum at MTU by providing mineral displays at several major rock and mineral hobby shows throughout the United States. This museum has the official title of "The Mineralogical Museum of Michigan" and is internationally recognized for its mineral displays.

FUELS

Michigan ranked 16th among the 31 oil-producing States in 1992. Estimated crude oil production was 15 million barrels (42 gallons each), a decrease of about 14% from that of 1991.[10] Natural gas production was 189,250 million cubic feet in 1992, down less than 1% from the previous year's production reported by the Department of Energy.

Permits for new oil and gas wells in the Michigan Basin (1,792) were up more than 79% from 1991 levels; however, well completions were down more than 42% from 1991 levels. A yearend surge of drilling activity was not reflected in 1992 reported completions. Drilling levels were higher during the second half of the year as the December 31 deadline for Section 29 tax credits approached. Of 395 wells drilled, 11 were oil producers and 323 produced natural gas, indicating a success rate of about 97%. A shift in interest in drilling in the State's shallow Antrim gas play (Devonian age) was reflected by gas wells outnumbering oil producers by a ratio of 29:1. By yearend, 46 new field wildcat wells were reported in the Michigan Basin.[11]

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Calcium Chloride.—Michigan was the Nation's leading producer of natural calcium chloride, far outranking California, the only other producing State. Output and value increased slightly from 1991 levels. Dow Chemical Co. produced calcium chloride pellets, flake, and liquid from well brines at its Ludington plant in Mason County. Wilkinson Chemical Corp. marketed calcium chloride solution from brines at its Mayville plant in Lapeer County.

Calcium chloride was used for melting snow and ice from streets and highways, for dust control, road base stabilization, thawing coal and other bulk materials, concrete set acceleration, and other miscellaneous uses. Although the principal use for calcium chloride was for snow and ice control on roads, it is more expensive and not as effective as sodium chloride (rock salt).

Cement.—Portland cement was the second largest contributor to the total value of Michigan's nonfuel mineral production in 1992. Michigan accounted for about 7.6% of total U.S. portland cement production. Sales and output of portland cement increased an estimated 18% and 12%, respectively, over those of 1991. Masonry cement production increased 4%, while sales declined 9% from those of the previous year. Michigan ranked fourth among the 37 States reporting portland and masonry cement production, accounting for 8% of the total National output.

Gray portland cement was produced at each of Michigan's five cement plants. Holnam Inc. was the only company producing portland pozzolan cement and the only company not producing masonry cement. Lafarge Corp. and Medusa Cement Co. operated dry-process plants; Holnam Inc. and St. Mary's Peerless Cement Co. operated wet-process plants. Essroc Materials Inc. operated a grinding plant only.

According to Lafarge Corp.'s 1992 annual report, the company was planning a 3-year raw material conversion to increase capacity at its 2-million-ton Alpena, MI, facility. Lafarge also produced and marketed a new masonry cement product at its Alpena plant, the company's largest facility.

Clays.—Michigan slipped from fourth to seventh rank nationally among the 43 States with reported common clay production. Common clay production was down considerably in output (39%) and attendant value (50%) from 1991 levels. Five companies operating a total of five pits in four counties reported common clay production. Cement companies produced and consumed most of the State's common clay production; the remainder was used in pottery and brick manufacture and for miscellaneous refractor uses.

Salem Township (Washtenaw County) conditionally approved Plymouth City (Wayne County) officials' request to mine 4,000 cubic meters (150,000 cubic feet) of clay needed to cap the city's closed landfill. The city would have lost a $600,000 State grant if the landfill had not been capped.

Gypsum.—After last year's reported losses, both output and value of crude gypsum increased slightly, 3% and 6% respectively. Michigan continued to rank fourth among the 20 producing States, accounting for about 11% of the total U.S. production. Crude gypsum was produced in two counties by five companies. Domtar Gypsum Inc. and Georgia-Pacific Corp. operated underground mines near Grand Rapids in Kent County, and Michigan Gypsum Co., Lafarge Corp., and U.S. Gypsum Corp. (USG) operated open pit mines in Iosco County. Domtar Gypsum, Georgia-Pacific, and Lafarge all operated calcining plants at or near the mine sites. Gypsum rock from USG's Alabaster Mine in Iosco County was calcined at its Detroit plant in Wayne County or shipped to other States for processing. Gypsum is commonly used in cement, wallboard, and other building products in addition to use as agricultural fertilizer, in dental casting and toothpaste, and as a filler in food products, glass, and plastics.

Lime.—Michigan continued to rank 10th of 32 States with reported lime production. Reported output and attendant value increased slightly from those of 1991. Quicklime was produced by five companies from eight plants in six counties. Marblehead Lime Co. also produced hydrated lime in addition to quicklime at the Wayne County plant; Wayne County led the State's production.

Magnesium Compounds.—Michigan ranked first of six producing States in production of magnesium compounds, far outranking California, the next largest producer. Total output and value declined from those of 1991. Magnesium compounds were produced from well brines by three companies in Manistee and Mason Counties in the west-central part of the State. Compounds produced included caustic-calcined magnesia, magnesium carbonate, magnesium hydroxide, and refractory magnesia.

Peat.—Michigan led the Nation in peat sales among the 20 producing States in 1992, contributing about 35% of the Nation's total peat sales. In terms of output and rank, the State dropped to second behind Florida, accounting for nearly 28% of the Nation's total production. Combined production from the two States accounted for more than one-half of domestic peat production. Ten companies reported peat production from bogs in nine counties. Production and value declined 20% and 9%, respectively, from 1991 levels, with one less company reporting production during 1992.

Most of the U.S. producer sales were for general soil improvement and horticulture use. Peat was used for turf maintenance and greens construction at golf courses, as an ingredient in potting soils, for mushroom beds, for vegetable growing, as an earthworm culture, by and nurseries. Reed-sedge was the

predominant type of peat harvested, followed by humus and sphagnum.

In January, plans were submitted to mine peat on a 94-acre parcel in Whiteford Township, Monroe County. The proposed peat mining would create a 40-acre, 12-foot-deep lake. Concerned residents were opposed to the peat mining operation because it would endanger wildlife and overburden local roads and drains. At yearend, the Whiteford Planning Commission granted an extension on the proposed peat mine pending a determination from DNR as to whether the site is a wetland regulated by State and Federal laws. Appleman Farms Inc. mined peat from the area in the 1970's creating a 12-acre lake.

Potassium Salts.—Michigan ranks last among the four States with reported potassium salt recovery. Reported output and value increased significantly from that of 1991. Kalium Chemicals Ltd. operated the State's only potassium salt (potash) recovery plant. The company's Hersey pilot plant is a 36,000-metric-ton-per-year test facility in southwestern Osceola County. The plant was constructed to demonstrate the technical ability to extract and refine potash from deposits in the Michigan Basin. Potash was recovered by solution mining the 2,400-meter-deep (7,875-feet-deep) ore body.

Salt.—Michigan ranked ninth among the 14 States with reported salt production in 1992. Sales increased about 7% in quantity and increased 6% in value. Salt was solution-mined by Akzo Salt Inc. in Manistee and St. Clair Counties and by Morton International Inc. in Manistee County. Salt was recovered from the brines using a vacuum pan process.

Salt was sold for a variety of uses, including animal feed, chemical-industrial processing, highway deicing, human consumption, and water treatment. The highest percentage of domestic salt use was for deicing roads. Results of a four State (Illinois, Minnesota, New York, and Wisconsin) study by Marquette University researchers during the 1990-91 winter found that deicing pays for itself within 2 hours after salt is spread on a two-lane highway. According to the university study, winter accidents were reduced by 88.3% in the 4-hour period following application of salt on ice- and snow-covered roads.[12]

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991. Michigan continued to rank second, behind California, among the 49 States with reported sand and gravel production. The State's annual production contributed about 5% of the Nation's total output. Tonnage and value of construction sand and gravel produced in 1992 increased 7% over 1991 estimates, but decreased 7% from data collected in 1990. Similarly, attendant value increased 8% over 1991 data and decreased 8% from data obtained in 1990. Construction sand and gravel accounted for more than 9% of the State's nonfuel mineral value. Only iron ore and portland cement contributed a greater percentage of the State's total nonfuel mineral value during the year.

The Thompson-McCully Co. was allowed to resume production after the Plainfield Township Board (Kent County) conditionally approved its controversial sand and gravel mining permit. Although mining had been going on at the site for more than 35 years, the township recently required permits for such operations. Other sand and gravel mining permits were approved for Sandman Inc. in Oxford Township (Oakland County), 3-Way Sand and Gravel Co. in Imlay Township (Lapeer County), O.E. Bieri & Sons in the city of Lowell (Kent County), Burrough's Materials in Groveland Township (Oakland County), Dykema Extractors Inc. in Cascade Township (Kent County), Haven Ridge Sand and Gravel in Lenox Township (Macomb County), Northeast Gravel Co. in Plainfield Township (Kent County), and Mathews Gravel Co. in the Genesee County Park.

Permits were denied for Huizinga Gravel Co. in Georgetown Township (Ottawa County), Donavon Carl in Napolean Township (Jackson County), Holloway Sand and Gravel in Northville Township (Wayne County), and Pickney Sand and Gravel in Putnam Township (Livingston County).

Industrial.—Michigan continued to rank third among the 38 States with reported production of industrial sand and gravel, contributing about 7% to the Nation's total output. California and Illinois were the only States reporting more production. Michigan's industrial sand production continued to decline, down 9% in quantity over 1991 estimates. Attendant value increased about 6% over 1991 estimates. The demand for industrial sand in Michigan decreased for several reasons: reduced demand for foundry sand required for the depressed automotive industry (users of a large percentage of the State's industrial sand production), thinner walls used in glass containers, thinner safety glass used in automobiles, recycled glass, and replacement of glass containers with aluminum and plastic.

The main source of the State's industrial sand production was from coastal dunes along Lake Michigan. Coastal barrier dune sand production from designated sand dune areas is regulated and permitted under Michigan's 1976 Sand Dune Protection and Management Act (Act 222). Permitting sand dune mining is a function of the DNR/GSD. Local ordinances also regulate sand production in some parts of the State.

Seven companies reported industrial sand production from 17 pits in 10 counties. In terms of value of production, the three leading counties were Muskegon, Ottawa, and Wexford. Michigan's industrial sand was sold for a variety of uses, including foundry sand (a use that consumed most of the production), fiberglass manufacture, glassmaking, golf courses, pottery, sandblasting, refractories, and traction

TABLE 2

MICHIGAN: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	8,118	$28,370	$3.49
Plaster and gunite sands	48	200	4.17
Concrete products (blocks, brick, pipe, decorative, etc.)	409	1,569	3.84
Asphaltic concrete aggregates and other bituminous mixtures	5,160	18,054	3.50
Road base and coverings[1]	12,296	31,265	2.54
Fill	6,507	9,515	1.46
Snow and ice control	677	1,457	2.15
Railroad ballast	W	W	5.57
Other miscellaneous uses[2]	416	2,249	5.41
Unspecified:[3]			
Actual	9,086	32,990	3.63
Estimated	5,277	17,438	3.30
Total	47,994	143,107	2.98
Total[4 5]	43,539	143,107	3.29

Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

sand.

A controversial sand mining permit was approved by the Caledonia Township Board allowing a 54-acre expansion of the Jousma-Den Hartigh sand mining operation west of Alaska in Kent County. Mining operations on the 54-acre site were delayed at yearend pending the outcome of a lawsuit filed by local residents against the township and members of their association for allowing the expansion.

Other industrial sand mining permits were approved for Robert Sommerfeldt in Benton Township (Berrien County) and Randy and Anna Saddison in Friendship Township (Emmet County). Sand mining applications were undecided for Construction Aggregates Corp. in Spring Lake Township (Ottawa County) and Dykema Excavators Co. in Grand Rapids Township (Kent County) at yearend.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—The estimated output and attendant value of Michigan's crushed stone production decreased about 6% and 3%, respectively, from data collected in 1991. Most of the State's crushed stone sales were limestone-dolomite, with marl, sandstone, traprock, marble, and quartzite accounting for virtually all of the remainder. Michigan slid from 13th to 14th rank among the 49 States reporting crushed stone production. Crushed stone production for 1992 was estimated from 10 companies that were canvassed during the year.

Pfizer Specialty Minerals Inc., a subsidiary of Pfizer Inc., completed its modernization project and started producing and shipping both metallurgical high calcium and dolomitic limestones from Port Inland, in Schoolcraft County near Gulliver. The company purchased the operation from Inland Steel Co. in September 1990. Pfizer has rebuilt about 75% of the old site and computerized the limestone mining and processing operation. The newly automated facility employs about 60 workers compared with the 190 employees formerly required by Inland. Production reported for 1992 amounted to about 1 million tons of dolomite and 2.7 million tons of high calcium limestone.[13]

Late in 1992, the minerals division of Pfizer Inc. became a separate corporation, Minerals Technologics Inc., with a public stock offering on the New York Stock Exchange. The Michigan operations became part of Specialty Minerals Inc.'s operation, a division of Minerals Technologics Inc.

Osborne Materials Co., Drummond Island, Chippewa County, operated the Drummond Dolomite Quarry. In 1992, they improved its dock facility to allow larger cargo vessels to land.

Following an expensive 2-year legal battle, a Federal court decided that the France Stone Co. could mine dolomite at a 200-acre site in Monroe Township (Monroe County). France Stone Co. announced that its 186-acre quarry on East Dunbar Road in Monroe Township will close by yearend and become a lake with development around it. France's new limestone mining operation will commence next year.

The Berlin Township Board approved an operating license for Thompson-McCully Co. to open a limestone quarry near the village of Estral Beach in Monroe County. The company is planning a 90-acre quarry, which would have a life expectancy of 35 years.

Quarry expansions were approved for the Michigan Stone Co. on 22 acres in Whiteford Township (Monroe County) and for Michigan Limestone Operations on 320 acres in Rogers Township (Presque Isle County).

Dimension.—A modest increase was estimated for the State's dimension stone production and value over data collected in 1991. Two companies reported

TABLE 3
MICHIGAN: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	312	1,523	1,025	3,403	6,781	23,443
Plaster and gunite sands	W	W	W	W	36	159
Concrete products (blocks, brick, etc.)	21	105	71	325	317	1,138
Asphaltic concrete aggregates and other bituminous mixtures	64	280	790	2,999	4,306	14,775
Road base and coverings[1]	879	2,155	1,707	4,315	9,709	24,795
Fill	593	657	497	1,004	5,417	7,854
Snow and ice control	135	272	244	437	298	747
Railroad ballast	—	—	—	—	W	156
Other miscellaneous uses[2]	19	99	190	768	219	1,267
Unspecified:[3]						
Actual	—	—	56	179	9,031	32,811
Estimated	1,254	3,540	1,024	2,653	2,999	11,246
Total[4]	3,277	8,632	5,604	16,084	39,112	118,391
Total[5 6]	2,973	8,632	5,084	16,084	35,482	118,391

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses.
[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

building stone production in the State. The Jude Stone Quarry Co. quarried sandstone for curbing near Napoleon in Jackson County, and Inwood Stone Products Co. produced dolomite in Schoolcraft County for use as veneer.

Other Industrial Minerals.—Small quantities of unpurified bromine were produced as a byproduct from the Dow Chemical Co.'s well brine operation near Ludington in Mason County. The unpurified bromine was reprocessed in Arkansas before being used or sold to consumers.

The value of gemstones and mineral specimens collected by mineral dealers, rockhounds, and other hobbyists continued to be erratic. Gemstones and mineral specimens collected in Michigan included agates, ankerite, chlorastrolite, domeykite, jasper, laumontite, native copper, Petoskey stones (fossilized coral), prehnite, Kona dolomite, and various iron minerals. Lake Superior beaches, old mine dumps, and gravel pits were commonly the sources of materials collected.

Raw materials for producing expanded perlite and sulfur in Michigan were obtained from out-of-State sources. Perlite was expanded at Harborlite Corp's. Vicksburg plant in Kalamazoo County for use in filter aids and by the Celotex Corp. in Baraga County for use in acoustic tile. Two companies continued recovery of byproduct sulfur at their petroleum refineries in Manistee and Wayne Counties.

Michigan ranked fourth among 28 States processing iron and steel slag in 1992. Iron and steel slag was processed from steel mills in Wayne County. Steel slag was processed from electric arc furnaces in Jackson and Monroe Counties. The material was marketed mainly for road base material, with lesser amounts for a variety of other uses. Reported output and value increased slightly during the year.

Metals

Copper and Silver.—Michigan ranked fifth among 12 States with reported copper production and seventh among 18 States in silver production. Copper Range Co.'s White Pine Mine, smelter, and refinery complex in Ontonagon County reported most of the State's copper and silver production. Copper Range is owned by Metall Mining Co., a Canadian-based subsidiary of Metallgesellschaft A.G. of the Federal Republic of Germany. A small percentage of Michigan's copper and silver was produced by Red Metal Explorations Inc. at the Caledonia Mine in Ontonagon County. Reported production of copper and silver, in terms of recoverable metal, was slightly higher than that in 1991. Copper production was the highest since 1985, when Copper Range reopened its White Pine Mine. Copper prices averaged $1.07 per pound in 1992, compared with $1.09 per pound in 1991. Silver prices dropped for the

TABLE 4

MICHIGAN: USABLE IRON ORE[1] PRODUCED (DIRECT SHIPPING OF ALL FORMS OF CONCENTRATES AND AGGLOMERATES), BY RANGE

(Thousand metric tons, gross weight, unless otherwise specified)

Year	Marquette Range	Menominee Range (Michigan part)	Gogebic Range (Michigan part)	Total		
				Gross weight		Iron content (percent)
				Ore	Iron content	
1854-1986	584,578	[2]321,307	[3]253,631	1,159,515	NA	NA
1987	12,491	—	—	12,491	6,911	64
1988	14,589	—	—	14,589	7,956	64
1989	15,611	—	—	15,611	9,063	62
1990	9,468	—	—	9,468	9,778	63
1991	12,645	—	—	12,645	7,829	62
1992	13,947	—	—	13,947	8,659	62
Total	663,329	[4]321,307	[4]253,631	1,238,266	NA	NA

NA Not available.
[1]Exclusive after 1905 of iron ore containing 5% or more manganese.
[2]No production after 1981.
[3]No production after 1979.
[4]Distribution by range partly estimated before 1906.

fifth consecutive year to $3.94 per troy ounce, compared with the 1991 average of $4.04.

Great Lakes Minerals Inc.'s (GLM), a Canadian-based company, plans to mine chalcocite copper ore were delayed at the 543-S site in Keweenaw County near Gratiot Lake. The mine was to operate under GLM's subsidiary, Keweenaw Copper Co., Inc., of Calumet, MI. The DNR asked the company to do an environmental review on the proposed mining site, which delayed the mining project. In response, the company started a water quality testing study to lead to a water discharge permit for its 543-S copper sulfide deposit. This permit will be needed for the opening of the proposed mine. The company expects permits to be approved early next year. The deposit at the 543-S site reportedly contains a minable reserve of 1.28 million metric tons of 4.41% copper. Production costs were estimated at $0.75 per pound for a 250,000-ton-per-year operation.[14] About 40 new jobs will be created during the 5- to 8-year mining operation. Great Lakes Minerals has plans for developing four other sites in Keweenaw County near Gratiot Lake as well.

Copper Range Co., Ontonagon County's largest employer, announced that the company's copper production in 1992 increased 5% (18% including processing of concentrates from outside the firm). The company is expecting a 10% production increase in 1993 when employees will achieve 20% ownership in the firm. Of the $96 million spent in 1992 by the company on payroll and purchases, 21% was in Ontonagon County.[15]

The U.S. House of Representatives and Senate approved the Nation's newest park, commemorating the mining industry in Michigan's Keweenaw Peninsula. The park includes parts of the city of Calumet and the Quincy Mine steam hoist 10 miles south of Calumet.

Iron Ore.—Michigan continued to rank second, behind Minnesota, in shipments of iron ore. Iron ore produced in Michigan is the State's most valuable nonfuel mineral commodity. Shipments during the year totaled 12.9 million metric tons, an increase of less than 1% over shipments reported in 1991.

CCI continued to manage Michigan's only active iron mines, the Tilden near Ishpeming and the Empire near Palmer. The company reported its 1992 pellet production was 8.2 million metric tons at the Empire Mine and 5.6 million metric tons at the Tilden Mine. Production was slightly more than the rated capacity of 8.1 million metric tons per year at the Empire Mine and less than the annual capacity of 6.8 million metric tons at the Tilden Mine. Magnetite ore was mined at the Empire Mine and magnetite and hematite ore was produced at the Tilden Mine. Developments at the Empire Mine during the year included an improvement in metallurgical efficiency by increasing flotation capacity and acquisition of three 170-ton production trucks and a 12-cubic-yard production loader. The Tilden Mine also acquired a 12-cubic-yard production loader.[16]

Tilden Mine was shut down for about 2 weeks in November to adjust 1992 iron ore production. About 700 workers were laid off. Tilden Production fell from 6.1 million metric tons of pellets to 5.6 million metric tons owing to lower orders from customers and partner-owners in 1992.

In late 1992, CCI reported that it stopped shipping iron ore pellets to Sharon Steel Corp. owing to Sharon's idled blast furnace. Sharon Steel usually

received 85,000 tons of pellets per month, about 11% of CCI's production. In December, McLouth Steel Products Co., a major customer of CCI, announced a business recovery plan, which adversely affected CCI's last quarter revenues for 1992.

CCI continued its tax disagreement with Republic and Humboldt Townships. The company went before the Michigan Tax Tribunal concerning published price or prevailing price of iron ore and the production capacity used in calculating the tax for the Republic Mine. The mine has not operated for 11 years.

In December, a fire at the Empire Mines screening plant damaged the $250,000 machine that sifted debris from iron ore pellets. The machine, owned by A. Lindberg and Sons, cleans the pellets under a contract with the owners of the Empire Mine. Pellet production was not affected because most pellets do not require the sifting process.

Michigan continued to rank first among the five States reporting sales of crude iron oxide pigments. Reported quantity and attendant value of Michigan's iron oxide pigment shipments decreased about 10% from those of 1991. All shipments were red iron oxide from a stockpile at CCI's Mather Mine in Marquette County.

Iron and Steel.—According to the 1992 Annual Report of the American Iron and Steel Institute, Michigan mills produced 7.8 million short tons of raw steel in 1992, about 12% more than the 7 million short tons produced in 1991. Michigan ranked fourth among the 37 States with reported raw steel production, contributing about 8.4% to the Nation's total output in 1992. Most steel produced at Michigan mills was used by the automobile industry.

The Governor authorized a $5 million loan to McLouth Steel to save its 1,650 jobs through the end of the year. Earlier in the year, McLouth agreed on a partnership with Thyssen Steel, a German-based world-class steel company. In the agreement, McLouth would get Thyssen's technical marketing expertise and Thyssen would sell McLouth steel to fill out the low-end of its orders. The partnership, which would not start until 1993, was dependent on McLouth making it through the year.

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[1]State Mineral Officer, U.S. Bureau of Mines, Denver, CO. He has 16 years of mineral-related government experience.

[2]Regional geologist, Geological Survey Division, Michigan Department of Natural Resources, Marquette, MI.

[3]Drake, R. Waste-Burning Moratoriums: NIMBY in Disguise. Pit & Quarry, Apr. 1992, p. 16.

[4]Hammerstrom, E. Mine Company Profits Drop $21 Million. Min. J., Marquett, MI, Jan. 30, 1993.

[5]Skillings' Mining Review. Customer's Recovery Affects Cliffs' Operating Revenues. Jan. 2, 1993, p. 17.

[6]Michigan Employment Security Commission, Bureau of Research & Statistics. Civilian Labor Force & Employment Estimates, 1992.

[7]Work cited in footnote 3.

[8]U.S. Department of Labor. Mine Injuries and Worktime, Quarterly. Jan.-Dec. 1992.

[9]Blumenthal, M. The Rational for Using Whole Tires. Rock Products, July 1992, pp. 48-50.

[10]Petroleum Supply Monthly. Energy Information Administration, Apr. 1993.

[11]Petroleum Information Corp. Resume 1992, 378 pp.

[12]Skillings' Mining Review. Research Validates Use of Salt on Snow Covered Roads. Jan. 16, 1993, p. 12.

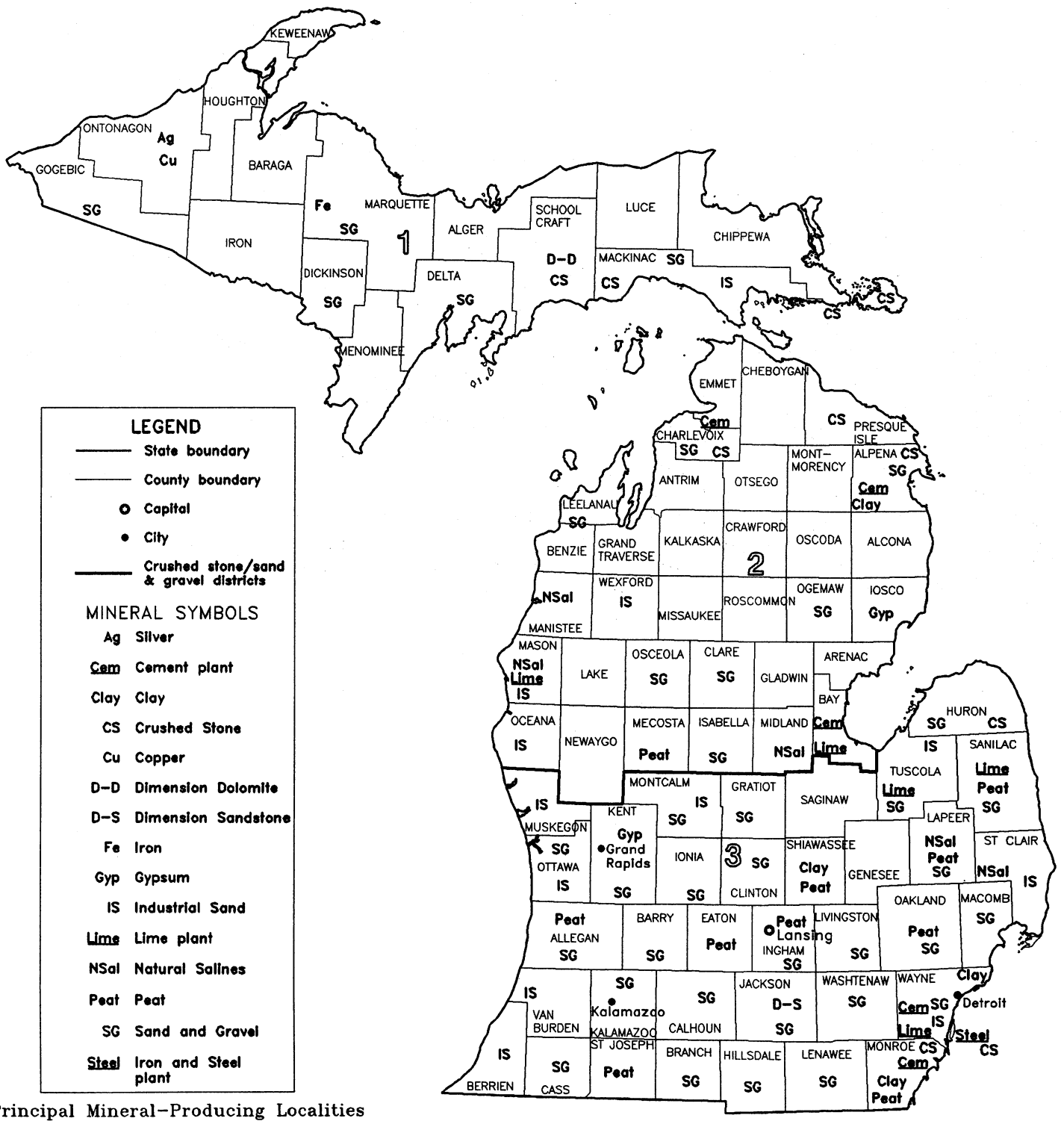
[13]———. Specialty Minerals Inc. Completes Its First Full Year of Dolomite and High-Cal Limestone Production at Port Inland. Dec. 1, 1992, pp. 4-6.

[14]Mining Business Digest. Copper Range To Process 543-S Ore. Feb. 1993.

[15]The Daily Globe (Ironwood). Copper Range. Feb. 24, 1993.

[16]Cleveland-Cliffs Inc. 10K Annual Report for 1992. 92 pp.

MICHIGAN



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Ag	Silver
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
Cu	Copper
D-D	Dimension Dolomite
D-S	Dimension Sandstone
Fe	Iron
Gyp	Gypsum
IS	Industrial Sand
Lime	Lime plant
NSal	Natural Salines
Peat	Peat
SG	Sand and Gravel
Steel	Iron and Steel plant

Principal Mineral-Producing Localities

TABLE 5
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Essroc Materials Inc., a subsidiary of Societe des Ciments Francais	Box 80 Essexville, MI 48732	Grinding plant	Bay.
Holnam Inc., Dundee Div., a subsidiary of Holderbank Financiere Glaris SA[1 2]	6211 Ann Arbor Rd. Dundee, MI 48131	Quarry, clay pit, plant	Monroe.
Lafarge Corp., Great Lakes Region[1 2 3]	4000 Town Center Suite 200 Southfield, MI 48075	do.	Alpena.
Medusa Cement Co., a division of Medusa Corp.[1 2]	Box 5668 Cleveland, OH 44101	do.	Charlevoix.
St. Mary's Peerless Cement Co., a division of St. Mary's Cement Ltd.	9333 Dearborn St. Detroit, MI 48209	Plant	Wayne.
Clays:			
F. W. Ritter Sons Co.	12670 North Dixie Hwy. South Rockwood, MI 48179	Clay pit and plant	Monroe.
U.S. Brick Inc., Michigan Div., a subsidiary of Canada Brick Co.	3820 Serr Rd. Corunna, MI 48817	do.	Shiawassee.
Copper:			
Copper Range Co.[4]	Box 100 White Pine, MI 49971	Underground mine, concentrator, smelter, refinery	Ontonagon.
Gypsum:			
Domtar Gypsum Inc.	1401 Water St. Long Beach CA 90802	Underground mine and plant	Kent.
Georgia-Pacific Corp.	133 Peachtree St., NE Atlanta, GA 30303	do.	Do.
USG Corp.	125 South Franklin St. Chicago, IL 60606	Open pit mine	Iosco.
Do.	do.	Plant	Wayne.
Iron ore:			
Cleveland-Cliffs Iron Co.[5]	504 Spruce St. Ishpeming, MI 49849	Open pit mines and plants	Marquette.
Iron and steel:			
McLouth Steel Products Corp.	1650 West Jefferson Trenton, MI 48183	Plant	Wayne.
National Steel Corp., Great Lakes Steel Div.	1 Quality Dr. Ecorse, MI 48229	do.	Do.
Rouge Steel Co.	3001 Miller Rd. Dearborn, MI 48121	do.	Do.
Lime:			
Detroit Lime Co., a subsidiary of Edward C. Levy Co.	8800 Dix Hwy. Dearborn, MI 48823	do.	Do.
The Dow Chemical Co., Lime Div.	South Madison St. Ludington, MI 49431	do.	Mason.
Marblehead Lime Co., a division of General Dynamics Corp.	222 North LaSalle St. Chicago, IL 60601	Plants	Wayne.
Michigan Sugar Co.	Box 1348 Saginaw, MI 48605	do.	Huron, Saginaw, Sanilac, Tuscola.
Monitor Sugar Co.	2600 South Euclid St. Bay City, MI 48706	Plant	Bay.
Peat:			
Al-Par Peat Co.	5900 Henderson Rd. Elsie, MI 48831	Bog and plant	Shiawassee.
Douglas Farms	0-998 Chicago Dr. Jenison, MI 49428	do.	Allegan.

See footnotes at end of table.

TABLE 5—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Peat—Continued:			
Fletcher & Rickard	25800 Haas Rd. New Hudson, MI 48165	Bog and plant	Oakland.
Hyponex Corp.	14111 Scottslawn Rd. Marysville, OH 43031	Bogs and plants	Lapeer and Shiawassee.
Michigan Peat Co.	2840 Bay Rd. Saginaw, MI 48601	do.	Sanilac.
Perlite (expanded):			
Harborlite Corp.	Box 458 Escondido, CA 92025	Plant	Kalamazoo.
Potassium salts:			
Kalium Chemicals Ltd.	11461 South 135th St. Hersey, MI 48640	Solution mine and plant	Osceola.
Salines (natural):			
The Dow Chemical Co.[6 7]	2020 Dow Center Midland, MI 48640	Brine wells and plant	Mason.
Martin Marietta Corp., Magnesia Specialties Div.[7]	Executive Plaza II Hunt Valley, MD 21030	do.	Manistee.
Morton International Inc.[7]	110 North Wacker Dr. Chicago, IL 60606	do.	Do.
Wilkinson Chemical Corp.[6]	8290 Lapeer Rd. Mayville, MI 48744	do.	Lapeer.
Salt:			
Akzo Salt Inc.	916 South Riverside St. Clair, MI 48079	Brine wells and plants	Manistee and St. Clair.
Morton International Inc.	110 North Wacker Dr. Chicago, IL 60606	Brine wells and plant	Manistee.
Sand and gravel:			
Construction:			
CSR America Inc.	6540 Sand Lake Rd. Dayton, OH 45414	Pits and plants	Kalamazoo, Livingston, Macomb, Oakland.
Edward C. Levy Co., Lyon Sand & Gravel Co.	4780 South Hill New Hudson, MI 48165	Pit and plant	Oakland.
Grand Rapids Gravel Co.	Box 9160 Grand Rapids, MI 49509	do.	Kent and Ottawa.
Holloway Sand & Gravel Co. Inc.	29250 Wixom Rd. Wixom, MI 48096	do.	Oakland and Washtenaw.
Hubscher & Son Inc.	Box 411 Mt. Pleasant, MI 48858	do.	Clare, Gogebic, Gratiot, Isabella.
Portable Aggregates Producers	1401 Souter Blvd. Troy, MI 48084	Pits and plants	Do.
Bill Smith Sand & Gravel Inc.	Box 23 Otsego, MI 49078	do.	Allegan and Cass.
Spartan Aggregates Inc.	Box 25 Holt, MI 48843	do.	Ingham and Tuscola.
Tri-City Aggregates Inc.	Box 182 Holly, MI 48442	do.	Oakland.
Whitaker & Gooding Co.	5800 Cherry Hill Rd. Ypsilanti, MI 48197	do.	Lapeer, Oakland, Washtenaw.
Industrial:			
Cheyenne Sand Corp., a subsidiary of Construction Aggregates Corp.	Box 68 Ferrysburg, MI 49409	do.	Ottawa.

See footnotes at end of table.

TABLE 5—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued:			
Industrial—Continued:			
Manley Bros. of Indiana Inc.	Box 538 Chesterton, IN 46304	Pits and plants	Berrien and Van Buren.
Nugent Sand Co. Inc.	Box 1209 Muskegon, MI 49443	do.	Muskegon.
Sargent Sand Co.	Box 6280 Saginaw, MI 48209	do.	Mason, Tuscola, Wexford.
Slag (iron and steel):			
International Mill Service Co.	1818 Market St. Philadelphia, PA 19103	Plants	Jackson and Monroe.
Edward C. Levy Co.	8800 Dix Ave. Detroit, MI 48209	do.	Wayne.
Stone:			
Crushed:			
Limestone-dolomite:			
Beazer USA	1850 Koppers Bldg. Pittsburgh, PA 15219	Quarry and plant	Monroe.
Crane Co.	757 Third Ave. New York, NY 10017	Quarry	Charlevoix.
Michigan Mineral Associates	1035 Calcite Road Rogers City, MI 49779	do.	Mackinac and Presque Isle.
Pfizer Specialty Minerals Inc.	County Road 432 Gulliver, MI 49840	Quarry and plant	Scoolcraft.
Presque Isle Corp.	Box 426 Alpena, MI 49707	do.	Presque Isle.
Stoneco Inc., a division of S. E. Johnson Co.	Box 29A Maumee, OH 43537	Quarries and plants	Monroe.
Marl:			
Poehlman & Son	Route 2 Cassopolis, MI 49031	Pit	Cass.
Quartzite:			
A. Lindberg & Sons Inc.	500 Mather Ave. Ishpeming, MI 49849	Quarry and plant	Marquette.
Traprock:			
George Hocking Construction Co.	Box 488 South Range, MI 49963	do.	Houghton.
Dimension:			
Limestone-dolomite:			
Inwood Stone Products Co.	Box 24 Cooks, MI 49817	do.	Schoolcraft.
Sandstone:			
Jude Stone Quarry Co.	338 Austin Rd. Napoleon, MI 49261	do.	Jackson.
Sulfur (recovered):			
Marathon Oil Co.	1300 South Fort St. Detroit, MI 48217	Elemental sulfur recovered as a byproduct of oil refining	Wayne.
Shell Western E&P Inc.	Box 1523 Houston, TX 77251	do.	Manistee.

[1]Also clays.
[2]Also crushed limestone.
[3]Also gypsum.
[4]Also silver.
[5]Also crude iron oxide pigments.
[6]Calcium chloride.
[7]Magnesium compounds.

THE MINERAL INDUSTRY OF MINNESOTA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Minnesota Geological and Natural History Survey for collecting information on all nonfuel minerals.

By Robert H. Wood II[1] and Kathy A. Lewis[2]

Minnesota's mineral production in 1992 was valued at about $1.4 billion, an increase of about $75 million over that reported in 1991. The 5.8% increase in value of minerals produced from that of the previous year was a reflection of increased reported sales in all of the State's leading mineral commodities. Only sales of clay and estimated sales of building stone were down from 1991 levels. Sales of expanded perlite and recovered sulfur, not included in the U.S. Bureau of Mines (USBM) estimates for State mineral value, also were down from 1991 levels. Minnesota increased from seventh to sixth rank nationally in value of nonfuel minerals produced during the year. The State contributed about 4.3% of the total U.S. mineral value in 1992.

In order of value, Minnesota's three leading mineral commodities in 1992 were iron ore, construction sand and gravel, and crushed stone. Construction sand and gravel and crushed stone collectively contributed about 10% of the State's total mineral production value.

Minnesota ranked third nationally in the production of metals and continued to lead the Nation in production of iron ore. The State contributed more than 75% of the total U.S. iron ore production. Of nonmetallic mineral commodities produced in the State, peat ranked 4th among 19 States reporting production; dimension stone, 9th of 34; industrial sand and gravel, 10th of 38; lime, 22d of 32; crushed stone, 30th of 49; and clay, 38th of 43.

TRENDS AND DEVELOPMENTS

Minnesota continued to be the Nation's leader in iron ore production with taconite remaining as the State's principal mineral commodity produced. Trends in the State's iron ore industry disclosed considerable change in that industry during the year. Lower demand for iron ore, foreign competition, and competition from steel mills that produce steel from scrap (minimills) caused companies to lower production, reduce employment, and even temporarily shut down operations at most of the State's seven taconite operations. Cyprus Northshore Mining Corp., Eveleth Mines, Hibbing Taconite Co., Inland Steel Mining Co., LTV Steel Mining Co., National Steel Pellet Co., and U.S. Steel Corp. either shut down operations for a few weeks to several months or announced other plans to reduce costs or production. Some of the industry is using technology to upgrade the quality of taconite pellets.

Technological advances during the year were noted at Eveleth Mines (completion of a primary crusher upgrade), U.S. Steel (installation of a scrubber system), and at Cyprus (announcement of plans for a direct reduction facility). Public and private

TABLE 1
NONFUEL MINERAL PRODUCTION IN MINNESOTA[1]

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
Gemstones		NA	$46	NA	$62	NA	$686
Iron ore (usable)	thousand metric tons	45,139	1,308,920	42,966	e1,157,920	42,348	W
Peat	thousand short tons	48	2,972	35	1,910	40	2,764
Sand and gravel (construction)	do.	r39,616	r91,363	e24,500	e58,800	37,604	98,673
Stone:							
Crushed	do.	e9,100	e31,900	8,378	30,624	e10,500	e39,500
Dimension	short tons	r e54,705	r e19,487	45,795	13,962	e36,192	e11,436
Combined value of clays (common, kaolin), lime, sand and gravel (industrial), and value indicated by symbol W		XX	27,746	XX	25,607	XX	1,210,880
Total		XX	r1,482,434	XX	1,288,885	XX	1,363,939

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; values included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

sectors have been investing in mineral research projects in recognition of the importance of the mineral industry to the State's economic growth.

For the first time, the State agreed to royalty rate reductions for taconite leases. Inland Steel Mining Co. was granted a royalty reduction on 1 State lease for 2 years and LTV Steel Mining Co. was granted a royalty reduction for 5 years in an extension agreement covering 29 State leases. The royalty reduction provisions were combined with production guarantee commitments.[3]

EMPLOYMENT

According to statistics released by the Minnesota Department of Jobs and Training, the State's average nonfarm employment increased 2.3% in 1992, indicating that the economy was starting to recover from the recession of 1991. Six of the eight major industry divisions reported increased employment during the year, amounting to nearly 50,000 new jobs for the State. The service industry division, the State's largest employing division, contributed to 65% of Minnesota's employment increase. More than 27% of the total State's employment in 1992 was in the services sector. Only two of the divisions reported job losses, Mining and the Transportation, Communications, and Public Utilities Division.[4]

Employment in Minnesota's mining industry averaged 7,621 in 1992, a decrease of about 3.2% from the 1991 figure. The average number of workers employed in the metal mining sector was 6,017, down 274 workers from that reported in 1990. Industry's attempts to control taconite production costs attributed to most of the jobs lost in the State's mining industry.[5]

About 760 mine workers were laid off with the temporary closure of the Eveleth taconite mine beginning in November. Some of the miners will not be recalled when the mine is scheduled to reopen in March 1993. It is anticipated that iron ore production at the mine will be decreased by at least 16%.

The Minnesota Department of Jobs and Training reported that average hourly earnings for all mine workers in Minnesota during December 1992 was $16.12, a $0.42 increase over December's figures of the previous year. Minnesota metal mine workers had average hourly wages of $16.72, a $0.50 increase over 1991.[6]

As reported by the U.S. Department of Labor, 7.5 million employee-hours worked at Minnesota's mining operations in 1992 resulted in no fatalities, while 159 injuries resulted in lost workdays, and 80 injuries resulted in no workdays lost. At the State's mills and preparation plants associated with mining operations, an additional 119 injuries to workers resulted in lost workdays and 100 injuries resulted in no lost workdays. A total of 13.4 million employee-hours was worked at the State's mines and related mills and plants during the year.[7]

ENVIRONMENTAL ISSUES

U.S. Steel Corp. completed installing a $12 million scrubber system at its Minntac taconite plant in Mountain Iron. The new scrubber is designed to limit the amount of dust created when iron ore is converted into pellets. The Minnesota Pollution Control Agency gave the company until March 1993 to install the scrubbers.

The American Iron Ore Association sponsored a second updated study of 3,444 taconite miners and millers who were exposed to taconite. The new study examined the potential for adverse effects from exposure to crystalline silica and extended the time period of the two previous studies, which were concerned with exposure to amphibole minerals that have similar characteristics to asbestos. No evidence of asbestos-related disease or increased risk of silicosis and lung cancer was found among the taconite miners studied.

Stearns County has agreed to purchase an abandoned granite quarry from Cold Spring Granite Co. for four times the assessed value. The quarry will be developed into a park.

EXPLORATION ACTIVITIES

Exploration in Minnesota during the year was reported by the Minnesota Department of Natural Resources (DNR) and is summarized in this section.[8] Exploration in the State was very slow during the year. Much of the current interest has shifted from gold to base metals such as copper and nickel. BHP Minerals was in the process of evaluating the Long Nose hard-rock ilmenite deposit north of Duluth near the Mesabi Range. Nerco Minerals Co. was considering opening a 50,000-short-ton-per-day copper, nickel, gold, and platinum open pit mine 6 miles south of Babbitt. Several companies showed interest in the Minnesota River kaolin deposits, apparently for use in the manufacture of paper.

Twenty-six parties were registered to conduct exploratory drilling in the State during 1992, which reflects no net change from 1991. There was a significant decrease in drilling during 1992, down 85% from that in 1991. In northern Minnesota, four holes were drilled in bedrock for a total of 1,573 meters (5,160 feet) and three holes were drilled through overburden for a total of 193 meters (632 feet). Drilling activity for base and precious metals was down 80% from the previous year and much lower than it has been for more than 10 years. Only two companies conducted drilling in the Archean greenstone terrains of northern Minnesota. In central Minnesota, two companies evaluated kaolin clay resources drilling 19 holes totaling 456 meters (1,496 feet). No drilling was conducted during the year for taconite development outside active operations.

A moderate increase in interest for State-issued metallic mineral exploration and mining leases was reflected in two lease sales held by the DNR in April and October. Areas considered for the lease sales covered portions of Aitkin, Beltrami, Cass, Crow Wing, Itasca, Koochiching, Lake of the Woods, Morrison, Roseau, St. Louis, and Todd Counties. Cominco American Resources

Inc., Newmont Exploration Ltd., and American Shield Co. were the three successful bidders for the 3,075-hectare (7,599-acre) April lease sale, which covered portions of Aitkin, Koochiching, St. Louis, and Todd Counties. Phelps Dodge Exploration East, Giants Range Minerals, and Exmin Corp. were the three successful bidders for the October lease sale. At the beginning of 1993, there were 150 State metallic mineral leases in effect covering 26,586 hectares (65,695 acres).

LEGISLATION AND GOVERNMENT PROGRAMS

Two primary changes in the State's taconite production law were enacted by the 1992 legislature. The first change froze the taconite production tax rate for 1992 and 1993 at $2.054 per taxable ton. Taxable tons are defined as the average tonnage produced during the current and previous 2 production years. The law's tax escalator normally would take effect unless the rate is frozen or changed through legislative action.[9]

The second change created a taconite economic development fund to help the State's iron ore mining companies. Each of the seven taconite mining companies will be able to borrow up to $2 million (at a low-interest rate) for capital improvements or research and development. The money can only be used on Minnesota-based projects in the area of mining technology, or taconite, iron, or steel production technology. Another condition of the funds required project approval by a labor-management committee. The loan and grant program will be funded by a portion (10.4 cents per ton) of the iron ore production tax. Excess funds from the 2-year program would go to the State's Taconite Environmental Protection Fund, the Northeast Minnesota Economic Protection Trust Fund, and the Iron Range Resources and Rehabilitation Board. The Iron Range Resources and Rehabilitation Board will administer the economic development funds. The goal of the program is to make Minnesota taconite more competitive in the marketplace.[10]

An annual report prepared by the Minnesota Department of Natural Resources summarizes statewide mineral activities, including: mineral-related legislative actions, rulemaking, State Mineral leases, exploration, and research.[11] The following section is a compilation of the reports.

Two government-sponsored committees were created in 1992 in regard to the State's iron ore industry. The Governor established a "Task Force on Minerals" to review issues facing Minnesota's taconite industry. The Taconite Enhancement Committee was established to obtain funding for cooperative research projects between the University of Minnesota, other government entities, and private industry.

The DNR is in the final stages of adopting nonferrous metallic minerals mineland reclamation rules. Public hearings were conducted in December 1992 on the proposed rules. The rules are expected to be in effect by April 1993 following a report by an administrative law judge. Testimony was submitted by the nonferrous metallic minerals exploration industry, the environmental community, the Minnesota taconite industry, labor organizations, the Minnesota Pollution Control Agency, and the DNR. Rules proposed by DNR would regulate the extent of reclamation required of operators of metal mines where the predominant metals mined are those other than iron ore and taconite. Iron ore and taconite mines, operating under existing reclamation regulations, were the only active metal mines in the State.

Formulation of leasing rules for industrial minerals was another focus of attention for the DNR during the year. The first draft of proposed rules was available for comment in December 1992, and a revised draft will be available for comment in 1993. These leasing rules are directed at the leasing of sites for dimension stone, kaolin clay, and gemstones.

Another function of the DNR is in managing the Iron Ore Cooperative Research Program. This program provides for State money and matching nonstate money for research projects. Members of the program include the seven Mesabi Range taconite companies and five State-based research facilities (Cliffs' Mining Services' Hibbing Research Laboratory, the Midland Research Center, the State's Natural Resources Research Institute's Coleraine Mineral Lab, the University of Minnesota's Corrosion Research Center, and the USBM's Twin Cities Research Center). Projects under way at company and university laboratories include efforts in the areas of: improving classification efficiency, liberation of problem ores, oxygen injection for enhanced magnetic oxidation, grate bar corrosion modeling, optimization of column flotation, on-line moisture analysis, increased bentonite effectiveness, interlab metallurgical test comparisons, and pellet metallurgical property improvement.

The DNR worked with fluid dynamics software to evaluate its utility as a research tool for analysis of mass energy flow in pellet induration systems. A progress report describing a three-dimensional analysis of the drying zone of the Eveleth pelletizing machine will be delivered at the annual Minnesota Section A.I.M.E. Mining Symposium in January 1993.

Several projects concerning mine waste characterization and drainage quality prediction were in progress in the State during 1992. Experiments were directed at describing the dependence of drainage pH and trace metal concentrations on the sulfur content of Duluth complex rocks. Acid and trace metal release, primarily from greenstone belt rocks, was examined over a 2-year period in a dissolution experiment. Dissolution experiments initiated in 1990 continued through the year to examine the effectiveness of disposing of potentially acid-producing mine waste in a subaqueous environment, such as an abandoned open pit. Experiments using anaerobic sulfide-reducing bacteria in treating acid mine drainage as it flowed through readily available organic substrates (yard waste and municipal compost) were very effective, removing more than 90% of the

metal content.

Status reports on mine waste characterization and drainage quality prediction are available from the St. Paul office of the DNR, Division of Minerals. The DNR also published "A Handbook for Reclaiming Sand and Gravel Pits in Minnesota" during the year.

The USBM, in cooperation with the Minnesota Geological Survey, University of Minnesota, and DNR, conducted research to determine the suitability of in situ mining to recover manganese from Minnesota's low-grade deposits. Minnesota has demonstrated manganese resources of 9.1 million metric tons and inferred resources of another 9.4 million metric tons in the Cuyuna range and Emily district in Crow Wing County.

The Minnesota Geological Survey, U.S. Geological Survey (USGS), and USBM sponsored a regional industrial minerals workshop in cooperation with the Geological Surveys of Illinois, Indiana, Michigan, North Dakota, Ohio, South Dakota, and Wisconsin. Mineral Resource demands and availability, land use conflicts, and research needs in the region were major topics evaluated at the September meeting in Minneapolis. The "Program With Abstracts" from that meeting (USGS Open File Report 92-514) provide information about the Midwest and Great Lakes States, a list of State and Federal agencies involved with these resources, and abstracts of presentations. The report also included a section on State regulations affecting mining of industrial minerals.

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Minnesota continued as the Nation's leader in iron ore production, and taconite remained the principal iron ore commodity produced in the State. Minnesota contributed about 76% of the total domestic usable iron ore shipments in 1992. Iron ore accounted for almost 90% of the State's total mineral value during the year. Estimated iron ore shipments from 1884 through 1992 were nearly 4 billion tons.[12] Iron ore shipments in 1992 were 42,348 metric tons, slightly less than shipments reported the previous year.

According to the Minnesota Department of Revenue, the State's taconite operations paid more than $97 million in State and local taxes during 1992. The State's taconite production tax rate was $2.054 per taxable ton, representing the largest tax paid by the mining industry. The tax is a major source of revenue for the counties, municipalities, and school districts where taconite mining exists.[13]

During the year Minnesota taconite companies were striving to cut taconite production costs and inventories. LTV Steel Mining Co. (currently under bankruptcy protection) shut down operations at the Hoyt Lakes taconite operation for 1 month during the summer to reduce inventories. The company planned to reduce production by 1 million tons. In June, Cyprus Northshore Mining Corp. laid off workers from its operations in Babbit and Silver Bay for a 3-month period and at yearend the company was evaluating options to sell its Northshore operations. National Steel Pellet Co. in Keewatin announced that it would have to close if costs could not be cut by 20% ($8.00 per ton). By yearend, National was able to trim $4.70 per ton from its $40.00 per ton cost. Hibbing Taconite Co. shut down operations for 2 weeks at the end of September to reduce inventory. In October, U.S. Steel Corp. reduced production by shutting down one of its five pellet production lines at the Minntac plant in Mountain Iron. Eveleth Mines shut down for at least several months beginning in November because Armco Steel Co. purchased 600,000 tons of iron ore pellets from Brazil. Armco announced that it would order its 1993 pellets from Cyprus Northshore Mining Co., rather than from its own plant in Eveleth. The production costs of iron ore pellets at the Eveleth plant is reportedly the highest in the Mesabi Range. During the year, Eveleth Mines completed a $7.5 million reconstruction of its primary crusher in February. After the extensive upgrade, the crusher's capacity increased from 38,000 to 60,000 tons per day. In December, Inland Steel Mining Co. announced plans to lay off 60 workers over the next 18 months at its Minorca plant in Virginia. Several companies announced yearend losses.

Cyprus Northshore Mining Co. announced plans to build a direct reduction facility at its Silver Bay plant. The direct reduction process removes oxygen from iron ore (taconite) pellets, upgrading the iron content from 65% to 95%. The new product will be marketed directly to steel mills that produce steel from scrap. The purpose of using direct reduction iron along with scrap is to reduce copper content. When the new facility is completed, the Cyprus Northshore plant will be the only U.S. plant producing a direct-reduced iron product.

National Steel Pellet Co. announced plans to purchase an $875,000 silica analyzer. The silica analyzer will further enhance pellet quality through improved process control. Funding will include about $500,000 from the Taconite Economic Development Fund.

LTV Steel Mining Co.'s McKinley Extension (originally the Donora ore body) shipped a total of 507,338 gross tons of iron ore concentrate in the final full year of activity at the mine, a natural ore property in Hoyt Lakes. In September 1991, the company announced that the ore reserves were exhausted. Crude ore stockpiles were depleted in July 1992, and remaining concentrate stockpiles will be shipped in 1993.

Industrial Minerals

Clays.—Minnesota's production of common and kaolin clays in 1992 decreased slightly in value and quantity compared with that of 1991. Two firms operating pits in Brown and Redwood Counties accounted for the State's entire reported annual output.

In August, the Redwood County Planning Commission recommended approval of a conditional use permit for Ochs Brick and Tile to continue its kaolin mine operation in Horner Township.

TABLE 2
MINNESOTA: PRODUCTION AND SHIPMENTS OF USABLE IRON ORE[1]

(Thousand metric tons, gross weight, unless otherwise specified)

Year	Production				Shipments			
	Natural ore and concentrates	Pellets	Total[2]	Iron content (percent)	Natural ore and concentrates	Pellets	Total[2]	Proportion of pellets to total ore (percent)
1987	1,516	32,748	34,264	64.22	1,663	32,610	34,273	95.15
1988	825	40,624	41,449	63.95	760	39,974	40,734	98.13
1989	613	40,758	41,370	63.84	613	40,432	41,044	98.51
1990	535	44,625	45,160	63.69	498	44,642	45,140	98.90
1991	789	42,203	42,991	63.75	829	42,137	42,966	98.07
1992	650	40,421	41,071	63.70	673	41,675	42,348	98.41

[1]Exclusive of ore containing 5% or more manganese.
[2]Data may not add to totals shown because of independent rounding.

Some concerns were expressed over the company's reclamation plans.

During the year, the Minnesota River Valley Coalition of Kaolin was seeking a $210,000 grant to fund the hiring of a full-time coordinator for the coalition. The coalition wanted someone knowledgeable in resource development. The Natural Resources Research Institute was helping the coalition lobby for the grant. The coalition also proposed a study that would examine existing facilities and future transportation development projects directly tied to kaolin production and export. A new $1 million rail spur to the kaolin mines north of Belview to allow direct loading of kaolin onto rail cars was one future transportation project under consideration.

Gemstones.—The estimated value of gemstones produced in Minnesota increased significantly over 1991's estimated value. A precise value could not be determined for gem material collected by rock hounds, mineral collectors, and other hobbyists, and no commercial gemstone mining operations were reported in Minnesota during the year. Lapidary materials found in the State include thomsonite, jasper, catlinite, silkstone, binghamite, and Lake Superior agates in addition to a variety of mineral and fossil specimens.

Lime.—Lime production in the State rose more than 20% in quantity and 15% in value compared with 1991 figures. Two sugar-beet processing companies, American Crystal Sugar and Southern Minnesota Sugar, produced and consumed all of the State's reported lime production. Limestone used to manufacture the quicklime produced by the companies was obtained from out-of-State sources. Apparently, lime used for other purposes was shipped in from out-of-State also.

Nutralime, a new fertilizer developed from spent lime generated at municipal water-treatment plants and sewage sludge incinerator ash was being successfully tested on a farm in Isanti County. Stiffer regulations on new landfills had forced the Metropolitan Waste Control Commission to find ways to utilize waste products generated from sewage and water-treatment facilities.

Peat.—Minnesota's annual peat sales rose more than 14% in quantity and about 45% in value compared with 1991 figures. Average unit value of peat produced in the State increased from about $55 per short ton in 1991 to $70 per short ton. Most peat harvested in Minnesota was of the sphagnum variety; the remainder was principally reed-sedge with only a small amount of hypnum being produced. Minnesota's peat was used for soil improvement, as a packing material for plants, and as a seed inoculant. Eight companies reported peat production in the State.

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This annual report contains actual data for 1990 and 1992 and estimates for 1991.

Substantial increases were realized in the quantity (53%) and value (68%) of Minnesota's construction sand and gravel compared with 1991 estimates. Compared with actual data reported for 1990, the quantity decreased 5% and value increased 8%.

Controversy over construction sand and gravel operations continued throughout the year. Four construction sand and gravel mining permits reportedly were approved during the year. The Washington County Planning Commission granted gravel mining permits to BTG Property Co., Northern Con-Ag. Co., and the Washington County Public Works. The Wright County Planning Commission approved Maurice LaTour's gravel mining permit.

Industrial.—Output and value of industrial sand increased about 11% and 21%, respectively, from data compiled in

TABLE 3

MINNESOTA : CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	8,298	$26,538	$3.20
Plaster and gunite sands	146	722	4.95
Concrete products (blocks, brick, pipe, decorative, etc.)	585	1,715	2.93
Asphaltic concrete aggregates and other bituminous mixtures	4,294	14,444	3.36
Road base and coverings[1]	15,756	35,532	2.26
Fill	2,751	5,280	1.92
Snow and ice control	314	783	2.49
Railroad ballast	81	416	5.14
Other miscellaneous uses[2]	39	258	6.62
Unspecified:[3]			
Actual	2,254	6,024	2.67
Estimated	3,084	6,960	2.26
Total[4]	37,604	98,673	2.62
Total[5 6]	34,114	98,673	2.89

[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

1991. Two companies reported production of industrial sand during the year. Industrial sand was mined at operations in Le Sueur, Scott, and Washington Counties.

The Le Sueur County Board approved an expansion request for UNIMIN Corp.'s silica sand operation. The company will be allowed to work within 65 feet of county Highway 23. Mining the additional 35 feet of land near the road will generate about $11,000 in additional tax revenue for the county.

Stone.—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This annual report contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—USBM personnel estimated that crushed stone production in 1992 increased 25% in quantity and 29% in value over the statistical data collected in 1991. The average unit value increased about $0.10 over the previous year. Limestone accounted for more than 75% of the total crushed and broken stone sales in the State. Most of Minnesota's crushed stone is used by the State's construction industry.

Dimension.—Minnesota's estimated dimension stone output decreased by 21% in quantity and 18% in value from actual data reported in 1991. Granite and limestone are the principal types of dimension stone quarried in the State.

Cold Springs Granite Co. evaluated three possible dimension stone sites on federally owned lands in northern Minnesota. The company conducted drilling operations and extracted large granite blocks for test marketing. Depending on favorable test results, the company plans to open quarries at all three sites. Cold Springs was awarded an exploration contract in October 1991 on the three sites that were discovered by DNR personnel during a building stone inventory in the northern part of the State. The DNR continued evaluating Minnesota's building stone resources during the year.

Other Industrial Minerals.—Expanded perlite and sulfur were produced in the State from raw materials obtained from out-of-State sources. Perlite was expanded at the USG Interiors, Inc. acoustical products plant in Cloquet. The reported quantity and value of the expanded material produced decreased moderately from levels reported in 1991.

Sulfur was recovered by Koch Refining Co. at its refinery in Pine Bend and by Ashland Petroleum Co. at its refinery in St. Paul Park. During 1992, recovered sulfur increased 5% in quantity but decreased 39% in value compared with 1991 figures.

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[1]State Mineral Officer, U.S. Bureau of Mines, Denver, CO. He has 16 years of mineral-related work with the Government and had covered the mineral activities in Minnesota for 2 years.

[2]Attorney, Mineral Leasing Manager, Minnesota Department of Natural Resources, St. Paul, MN.

[3]Lewis, K. A. State Activities 1992—Minnesota. Min. Eng., v. 45, No. 5, May 1993, pp. 472-473.

[4]Minnesota Department of Jobs and Training. Minnesota Labor Market Trends. Spring 1993, 34 pp.

[5]Work cited in footnote 4.

[6]Minnesota Department of Jobs and Training. Minnesota Labor Market Review. Feb. 1993, 8 pp.

[7]U.S. Department of Labor. Mine Injuries and Worktime, Quarterly. Jan.-Dec. 1992.

[8]Brice, W. C., and K. A. Lewis. Mineral Research and Management Activities of the Minnesota Department of Natural Resources. Skillings Mining Review, v. 82, No. 3, Jan. 16, 1992, pp. 18-22.

Work cited in footnote 3.

[9]Minnesota Department of Revenue. Minnesota Mining Tax Guide. Oct. 1992, 49 pp.

[10]Work cited in footnote 9.

[11]Work cited in footnote 8.

[12]Department of Natural Resources, Department of Revenue, Iron Range Rehabilitation Board, and D. N. Skillings Inc., eds. Minnesota Mining Directory, 1992. Skillings D. N., 1992, 135 pp.

[13]Work cited in footnote 9.

TABLE 4

MINNESOTA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	1,107	3,177	845	3,122	1,381	4,518
Plaster and gunite sands	25	72	45	313	W	W
Concrete products (blocks, brick, etc.)	18	55	W	W	8	80
Asphaltic concrete aggregates and other bituminous mixtures	968	3,736	268	594	1,555	5,217
Road base and coverings[1]	1,719	4,154	801	1,684	3,034	5,656
Fill	351	668	235	297	104	126
Snow and ice control	50	112	60	156	65	151
Railroad ballast	—	—	W	104	—	—
Other miscellaneous uses[2]	7	50	47	105	13	129
Unspecified:[3]						
Actual	160	288	2	3	169	374
Estimated	783	1,699	245	551	361	1,025
Total[4]	5,188	14,013	2,548	6,930	6,691	17,276
Total[5 6]	4,706	14,013	2,312	6,930	6,070	17,276

	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	749	2,718	3,459	9,933	758	3,070
Plaster and gunite sands	8	37	W	W	34	(7)
Concrete products (blocks, brick, etc.)	W	W	480	1,293	57	201
Asphaltic concrete aggregates and other bituminous mixtures	614	1,407	660	1,967	228	1,522
Road base and coverings[1]	1,751	3,879	7,677	18,757	775	1,401
Fill	156	412	1,476	3,094	429	684
Snow and ice control	37	112	W	W	99	227
Railroad ballast	W	W	—	—	11	(7)
Other miscellaneous uses[2]	58	345	45	189	—	—
Unspecified:[3]						
Actual	—	—	1,878	5,255	44	104
Estimated	300	597	1,073	2,488	322	600
Total[4]	3,673	9,508	16,748	42,977	2,756	7,971
Total[5 6]	3,332	9,508	15,194	42,977	2,500	7,971

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses.

[1]Includes road and other stabilization (cement and lime).

[2]Includes filtration.

[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.

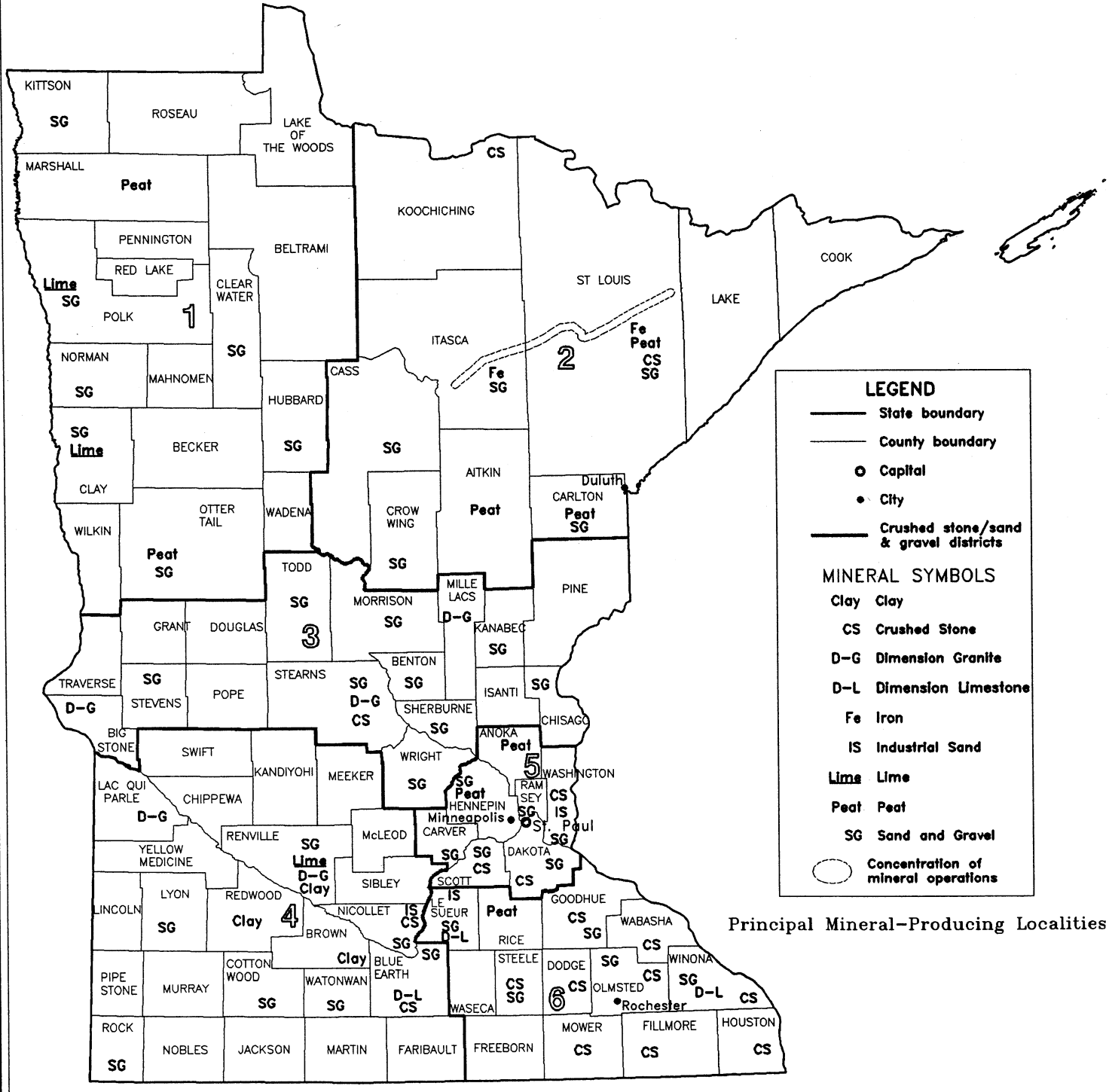
[4]Data may not add to totals shown because of independent rounding.

[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.

[6]Total quantity and total value in thousand metric tons and thousand dollars.

[7]Withheld to avoid disclosing company proprietary data; included with "Total."

MINNESOTA



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Clay	Clay
CS	Crushed Stone
D-G	Dimension Granite
D-L	Dimension Limestone
Fe	Iron
IS	Industrial Sand
Lime	Lime
Peat	Peat
SG	Sand and Gravel

Concentration of mineral operations

Principal Mineral-Producing Localities

TABLE 5
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Clays:			
Northwestern States Portland Cement Co.	Box 1008 Mason City, IA 50401	Pit	Redwood.
Ochs Brick & Tile Co.	Box 106 Springfield, MN 56087	Pit and plant	Brown.
Do.	do.	Pit	Redwood.
Iron ore:			
Cyprus Northshore Mining Corp.	10 Outer Dr. Silver Bay, MN 55614	Mine and primary crusher Concentrator and agglomerator	St. Louis. Lake.
Inland Steel Mining Co. Minorca Mine and Plant	30 West Monroe St. Chicago, IL 60603	Mine, concentrator, agglomerator	St. Louis.
LTV Steel Co., Northwest Ore Div. McKinley Extension	Box 196 Aurora, MN 55706	Mine and concentrator	Do.
National Steel Pellet Co.	Box 217 Keewatin, MN 55753	Mine, concentrator, agglomerator	Itasca and St. Louis.
Oglebay Norton Co. Eveleth Mines	1100 Superior Ave. Cleveland, OH 44114	do.	St. Louis.
Pickands Mather & Co. (a subsidiary of Cleveland-Cliffs Inc.):			
Hibbing Taconite Co.	Box 900 Hoyt Lakes, MN 55750	do.	Do.
LTV Steel Mining Co.	do.	do.	Do.
USX Corp., Minnesota Ore Operations, Minntac	Box 417 Mountain Iron, MN 55768	do.	Do.
Lime:			
American Crystal Sugar Co.	101 North 3d St. Moorhead, MN 56560	Plants	Clay and Polk.
Southern Minnesota Sugar Co-op	Box 500 Renville, MN 56284	Plant	Renville.
Peat:			
Aitkin Agri-Peat	Fleming Route, Box 35 Aitkin, MN 56431	Bog and plant	Aitkin.
Davidson Peat Co.	Route 3, Box 6 Kenyon, MN 55946	Bog	Rice.
Minnesota Sphagnum Inc.	Box 58 Goodhart, MI 49737	Bog and plant	St. Louis.
Peatrex Ltd.	10162 93d Ave. North Maple Grove, MN 55369	do.	Carlton.
Perlite (expanded):			
USG Interiors Inc., a subsidiary of USG Corp.	Arch St. Cloquet, MN 55720	Plant	Do.
Sand and gravel:			
Construction:			
Barton Contracting Co.	10633 89th Ave. North Maple Grove, MN 55369	Pits and plants	Hennepin and Washington.
Cemstone Products Co.	2025 Centre Pointe Blvd. Suite 300 Mendota Heights, MN 55120	Pit and plant	Washington.
Fairway Construction Co.	Box 426 Hector, MN 55342	Pits and plants	Meeker and Renville.
Fischer Construction Co. Inc.	6801 West 150th St. Apple Valley, MN 55124	do.	Dakota.

TABLE 5—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued:			
Construction—Continued:			
C. S. McCrossan Inc.	7865 Jefferson Hwy. Maple Grove, MN 55369	Pits and plants	Dakota and Hennepin.
Northwestern Aggregates, Model Stone	400 West 61st St. Minneapolis, MN 55419	Pit and plant	Dakota.
J. L. Shiely Co.	1101 North Snelling Ave. St. Paul, MN 55108	Pits and plants	Dakota, Hennepin, Washington.
Industrial:			
Twin City Silica Ltd.	499 Cottage Grove Dr. Woodbury, MN 55125	Pit and plant	Washington.
UNIMIN Corp.	258 Elm St. New Canaan, CT 06840	Pits and plants	Le Sueur and Scott.
Slag, iron and steel:			
International Mill Service Co.	1818 Market St. Philadelphia, PA 19103	Plant	Washington.
Stone:			
Crushed:			
Granite:			
Meridian Aggregates Co.	Box 69 St. Cloud, MN 56301	Quarries and plants	Stearns and Yellow Medicine.
Limestone and dolomite:			
Bryan Rock Products Inc.	Box 215 Shakopee, MN 55379	do.	Scott and Washington.
Edward Kraemer & Sons Inc.	1020 West Cliff Rd. Burnsville, MN 55337	Quarry and plant	Dakota.
Mathy Construction Co., Patterson Quarries Div.	Route 3, Box 15 St. Charles, MN 55972	Quarries and plants	Fillmore, Houston, Olmsted, Wabasha, Winona.
Roverud Construction Inc.	601 Highway 44 E. Box 606 Spring Grove, MN 55974	do.	Houston and Fillmore.
J. L. Shiely Co.	1101 North Snelling Ave. St. Paul, MN 55108	do.	Scott and Washington.
Quartzite:			
New Ulm Quartzite Quarries Inc.	Route 5, Box 21 New Ulm, MN 56073	Quarry and plant	Nicollet.
Traprock (basalt):			
Del Zotto Construction Inc.	2300 Commonwealth Ave. Duluth, MN 55806	do.	St. Louis.
Dimension:			
Granite:			
Cold Spring Granite Co.	Cold Spring, MN 56320	Quarries	Big Stone, Mille Lacs, Renville.
Do.	do.	Quarries and plant	Stearns.
Limestone:			
Biesanz Stone Co. Inc.	Box 768 Winona, MN 55987	do.	Winona.
Minnesota Quarries Inc.	Box 1358 Mankato, MN 56002	do.	Blue Earth.
Vetter Stone Co.	Route 5, Box 41 Mankato, MN 56001	do.	Blue Earth and Le Sueur.
Sulfur (recovered):			
Ashland Petroleum Co., a division of Ashland Oil Inc.	Box 391 Ashland, KY 41101	Elemental sulfur recovered as a byproduct of oil refining	Washington.

TABLE 5—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sulfur (recovered)—Continued:			
Koch Refining Co., a division of Koch Industries Inc.	Box 2302 Wichita, KS 67201	Elemental sulfur recovered as a byproduct of oil refining	Dakota.

THE MINERAL INDUSTRY OF MISSISSIPPI

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Office of Geology, Mississippi Department of Environmental Quality, for collecting information on all nonfuel minerals.

By Doss H. White, Jr.,[1] S. Cragin Knox,[2] and Michael B. E. Bograd[3]

The value of nonfuel mineral production in Mississippi in 1992 increased $18.1 million to $119.9. Increased sales (value) were reported for all nonfuel mineral commodities excluding ball clay (only one of the two ball clay producers reported) and industrial sand. Nationally, the State ranked 41st in total nonfuel mineral value.

TRENDS AND DEVELOPMENTS

Because of the State's geologic history, the major mineral commodities mined in Mississippi were clays and sand and gravel. Most of Mississippi, excluding the northeast corner, was covered by the Gulf of Mexico during the Cretaceous Period. Since then a number of river systems and deltas have deposited sediments in the State, while the sea again made incursions during the Eocene and Oligocene epochs. This resulted in a surface material throughout much of Mississippi consisting primarily of sands, clays, and chalk.

The State is a major sand and gravel producer and a leader in the Southeast in the production of specialty clays. It is the only State in the United States with a ball clay, bentonite, common clay, and fuller's earth industry. Two of the four acid-activated bentonite processing plants in Central and North America are in Mississippi.

In the industrial minerals sector, three 13,600-metric-ton (mt) or 15,000-short-ton (st) ilmenite storage tanks were completed at the Port of Gulfport. The ilmenite was raw material for the E. I. du Pont de Nemours & Co.'s DeLisle titanium dioxide pigment plant. The tanks complemented an existing 45,360-metric-ton (50,000-short-ton) storage tank.[4]

EMPLOYMENT

In 1992, Mississippi's mineral industry, including the petroleum and natural gas sector, employed 5,200 workers, a slight decline from the previous year. In 1991, the mineral industry employment was 5,700.[5] Employment in the industrial minerals sector, according to the U.S. Mine Safety and Health Administration, totaled 1,364.

LEGISLATION AND GOVERNMENT PROGRAMS

The 1992 Mississippi Legislature passed two bills that were of potential interest to the Mississippi mineral industry. These included Senate bills 2562 and 2936. The former revised and reenacted the Mississippi Individual On-site Wastewater Disposal Law, and the latter provided for the creation of the Mississippi Water Resources Management Planning Council.[6]

A bill was introduced that would tax mineral interests separated from the surface land estate. A provision in the

TABLE 1
NONFUEL MINERAL PRODUCTION IN MISSISSIPPI[1]

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
Clays[2]	short tons	817,828	$16,196	1,172,213	$34,382	1,119,568	$38,090
Gemstones		NA	1	NA	1	NA	1
Sand and gravel (construction)	thousand short tons	r12,839	r44,682	e9,900	e33,000	11,467	44,124
Stone (crushed)	do.	e1,400	e5,500	1,632	6,603	e2,500	e10,400
Combined value of cement, clays [ball (1990-92), fuller's earth (1990), kaolin (1991)], and sand and gravel (industrial)		XX	44,799	XX	27,873	XX	27,349
Total		XX	r111,178	XX	101,859	XX	119,964

eEstimated. rRevised. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" figure.

bill called for severed mineral interests to revert back to the original surface estate if mineral owners failed to pay tax assessments. Also included was a tax on mineral interests severed from the original estate. The bill did not pass, but may be reintroduced in the 1993 legislative session.[7]

During 1992, the Office of Geology of the Mississippi Department of Environmental Quality continued research into the surface and subsurface geology and mineral resources of the State. Regulatory responsibilities for surface mining permitting and reclamation and for mineral leasing on State-owned lands also continued. The Director of the Office of Geology serves as a member of the Environmental Quality Permit Board, which has permitting authority for air and water quality matters and grants water withdrawal permits.

The Surface Geology Division continued two mapping projects in east-central Mississippi. Potentially economic clay deposits and potentially important deposits of lignite and bauxite occur within the study area. Results of this work will be made available in the open file report series as geologic quadrangles at 1:24,000 scale and will be used in the planned revision of the State geologic map. The Environmental Geology Division provided support for the office's field investigations by drilling and coring test holes. The division upgraded one of its four wire line logging units to full digital capability. During 1992, 85 test holes and/or water wells throughout the State were geophysically logged; depths ranged from 10.7 meters (35 feet) to 576 meters (1,890 feet).

The Energy Section of the Energy and Coastal Geology Division maintained the core and sample library, made several professional presentations, and published a number of articles on petroleum geology. The section oversaw the leasing involving State lands; permitting of seismic lines; and collection of royalties, bonuses, and delay rental payments. The Coastal Geology Section worked on acquiring field data, including shore profiles, vivracores, seismic, aerial photographs, and detailed bathymetry, to document coastal erosion, sediment transport, and framework geology.

The Mining and Reclamation Division oversaw the State's mining industry. During 1992, a total of 1,141 inspections were performed, 115 permits were issued, and 96 notices of exempt operations were issued; 361 hectares (893 acres) was reclaimed that resulted in partial bond releases, while 17 hectares (41 acres) was reclaimed resulting in final bond releases. The State currently has 530 mining permits covering 5,370 hectares (13,268 acres).

The U.S. Bureau of Mines (USBM) was one of five Federal agencies funding research on Geographic Information Systems (GIS) at Jackson State University. GIS is a computerized means of collecting, organizing, and displaying geographic and "geo-referenced" data, basically any data that can be represented on a map or chart.

GIS research ongoing during 1992 included data base compilation on routes for transporting fuel and hazardous materials from the coast to inland destinations, monitoring saltwater intrusion into freshwater marshlands on the Mississippi gulf coast, and using satellite information to survey the State's mineral deposits and to develop courses in Geographic Information Systems/Remote sensing technologies.

Other agencies involved included the U.S. Bureau of Land Management, the U.S. Geological Survey, U.S. Department of Energy (DOE), and the NASA/Stennis Space Center.

In November, DOE completed an Environmental Impact Statement comparing the Richton salt dome in Perry County to four other domes proposed for oil storage sites in Louisiana and Texas. In 1990, Congress required DOE to expand the Nation's oil reserve (the Strategic Petroleum Reserve) to 1 billion barrels from the 570 million barrels then in storage. The Richton dome, the largest of Mississippi's 53 shallow piercement salt domes, would store 160 million barrels if developed for storage. The storage cavity would be developed by solution mining.[8]

FUELS

The State's petroleum and natural gas sector produced 25.1 million barrels of oil and 163.3 billion cubic feet of natural gas from 4,381 producing wells.[9] Severance tax collections were $24.8 million on oil and $12.8 million on gas.[10]

In March, Plantation Petroleum Inc. began test drilling for coalbed methane at a site in northeastern Clay County. The drilling was to determine if commercial quantities of methane occurred in the Mississippi portion of the Black Warrior Basin. The test was reported to cost $181,000.[11] The well intersected about 1.8 meters (6 feet) of coal with a low gas content that was noncommercial.

A $50 million natural gas processing plant was announced for Pascagoula. The plant, part of a project to develop natural gas reserves off the coast of Mississippi and Alabama, will be constructed at the Chevron refinery complex.[12]

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

In 1992, Mississippi's mineral industry consisted of 530 permitted operations. As in past years, more than three-quarters were sand and gravel producers; the remaining were cement, clays, and crushed stone producers.

Cement.—One company, Holnam Inc., manufactured cement at a plant at Artesia in Lowndes County. Holnam purchased the plant from United Cement Co. in 1990. The wet-process facility produced clinker using locally mined chalk and sand and iron scale obtained from Alabama. The material was mixed, slurried, and reacted at elevated temperatures to form a material termed "clinker." The clinker was ground with Spanish gypsum to form cement. The gypsum and coal for kiln fuel was trucked to the plant from the Lowndes County Port on the Tennessee-Tombigbee Waterway. Production and value

TABLE 2
MISSISSIPPI: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	5,239	$19,964	$3.81
Plaster and gunite sands	W	W	4.02
Concrete products (blocks, brick, pipe, decorative, etc.)	101	405	4.01
Asphaltic concrete aggregates and other bituminous mixtures	2,131	10,343	4.85
Road base and coverings[1]	1,505	5,457	3.63
Fill	408	678	1.66
Other miscellaneous uses[2]	132	682	5.17
Unspecified:[3]			
Actual	131	355	2.71
Estimated	1,819	6,240	3.43
Total	[4]11,467	44,124	3.85
Total[5 6]	10,403	44,124	4.24

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for monrespondents.
[4]Data do not add to total shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

increased over 1991 levels.

Clays.—The State maintained its 11th place ranking in tonnage and ranked 5th in value among the 44 clay-producing States. Clay was the second leading mineral commodity, in terms of value, produced in Mississippi and accounted for approximately 32% of the State's 1992 mineral value. Output of all types, excluding ball clay, totaled 1.1 million mt (1.2 million st) valued at $38 million.

Ball Clay.—Mississippi was one of four States with ball clay production. Two companies, Kentucky-Tennessee Clay Co. and United Clays Inc., mined and processed ball clay, a fine-grained, highly plastic kaolinitic sediment, in the northwestern part of the State near the community of Sledge. Only one firm responded to the USBM canvass form.

The clay was mined by surface methods and trucked to the processing facility where it was air dried, ground, and bagged. Mississippi's ball clay was sold mainly to the tile and asphalt filler markets. Output and value fell below the 1991 levels.

Bentonite.—Mississippi ranked second among the 13 bentonite-producing States. Sales of bentonite, a clay with superior absorbent and green strength properties, accounted for about 0.5% of the State's clay sales. Production and value totaled 200,000 mt (220,000 st) valued at $7 million.

The State's bentonite producers, Applied Industrial Minerals Corp. (AIMCOR), American Colloid Co., and Engelhard Corp., operated three surface mines in east-central Mississippi. Arizona bentonite was shipped to the American Colloid and Engelhard plants for processing.

Calcium bentonite was produced by AIMCOR from a mine and processing complex in Monroe County near Aberdeen in the northeastern part of the State. After mining, the crude bentonite was trucked to the processing complex, air dried, shredded, sized, and bagged. Markets included the foundry industry, where it was used as a binder in mold making, and the animal feed industries for a binder in pellet production.

A second Aberdeen company, American Colloid Co., also mined bentonite. The clay was trucked to the plant where it was treated as described above and by acid treatment. The clays, both Mississippi- and Arizona-mined bentonites, were treated with sulfuric acid, washed, dried, sized, and bagged. The conventionally processed bentonites were sold to the foundry industry. The acid-treated Arizona clays were sold to the desiccant industry, and the acid-treated Mississippi bentonite was sold to the vegetable oil industry as a filter to remove impurities.

Engelhard Corp. operated a plant in Jackson and mines in Monroe and Smith Counties. The plant processed Mississippi and Arizona bentonite by conventional and sulfuric acid activation methods. The Arizona clays underwent conventional processing to produce a product marketed for desiccant applications. The acid-activated clays were sold to the vegetable oil and petrochemical industries.

Common Clay.—The value derived from common clay production accounted for approximately 15% of the State's clay value. The 1992 value totaled $6.2 million; 575,000 mt (633,000 st) was produced. Mississippi ranked 13th among the 43 States with common clay production.

Mississippi's common clay industry was composed of 9 companies operating 14 mines in the eastern part of the State. Two companies operated mines in West Alabama to supplement their Mississippi mine output. A company in Louisville mined and sold clay in Mississippi, Alabama, and Louisiana. Principal clay uses were for the manufacture of common and face brick, concrete block, structural concrete, and highway surfacing.

Fuller's Earth.—The Ripley-Blue Mountain area of north-central Mississippi was the site of the State's fuller's earth industry. Oil-Dri

TABLE 3

MISSISSIPPI: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[1]	2,021	7,719	2,036	8,416	1,312	4,352
Asphaltic concrete aggregates and other bituminous mixtures	778	3,744	1,051	5,789	301	810
Road base and coverings[2]	543	1,815	784	2,707	177	935
Fill	112	214	47	96	249	367
Other miscellaneous uses[3]	—	—	90	490	12	74
Unspecified:[4]						
Actual	50	75	41	218	40	62
Estimated	75	279	1,619	5,618	126	343
Total[5]	3,579	13,847	5,669	23,334	2,219	6,943
Total[6 7]	3,247	13,847	5,143	23,334	2,013	6,943

[1]Includes plaster and gunite sands.
[2]Includes road and other stabilization (cement).
[3]Includes filtration.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value in thousand metric tons and thousand dollars.

Production Co. Inc. and AIMCOR mined and processed fuller's earth, a high absorbency clay used primarily for animal and industrial waste absorbents and agricultural products carriers. Production and value, 345,000 metric tons (380,000 short tons) and $24.9 million, increased over the 313,000 metric tons (313,000 short tons) and $21 million reported in 1991.

Oil-Dri operated a mine and processing plant north of Ripley to market industrial waste absorbents and agricultural products carriers. Processing included shredding, air drying, calcining, sizing, and bagging. Oil-Dri also operated a plant south of the community of Blue Mountain to produce a pet waste absorbent.

AIMCOR's plant, north of Blue Mountain, produced both pet and industrial waste absorbents and an agricultural carrier. Both companies sold a limited amount of dust collected by the plant environmental systems for binder applications.

Sand and Gravel.—Sand and gravel was the leading mineral commodity, valuewise, mined in Mississippi. The State's sand and gravel industry accounted for approximately 37% of the State's total mineral value in 1992.

Construction.—Production of construction sand and gravel is surveyed by the U.S. Bureau of Mines for even numbered years only; data for odd-numbered years are based on annual company estimates. This report contains actual data for 1990 and 1992 and estimates for 1991.

Sand and/or gravel production was reported by 58 companies operating 85 mines in 31 counties. Production, 10.4 million metric tons (11.4 million short tons), was valued at $44.1 million. In 1991, production was estimated at 8.98 million metric tons (9.9 million short tons) that was valued at $33 million.

In industry news, Madison County supervisors denied, for a second time, the request by a Brandon businessman to continue mining from a southeastern Madison County pit. Twice the Planning and Zoning Commission approved plans for the pit, and twice, because of vehement resident protests, the Board of Supervisors denied the application.[13]

Waterway Materials Co., Mobile, AL, awarded a gravel contract to the R&S Sand & Gravel Co. of Tremont. R&S contracted with Parker Towing Co. in Fulton to ship the gravel from Port Itawamba on the Tennessee-Tombigbee Waterway to Mobile.[14]

Industrial.—The production and sales of sands for industrial applications were reported by two firms. Sales were for molding and blasting applications. Production and value declined below the 1991 tonnage and value.

Stone.—The production of stone is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This report contains estimated data for 1990 and 1992 and actual data for 1991.

Production was estimated at 2.3 million metric tons (2.5 million short tons) valued at $11.4 million. In 1991, the State's stone industry reported production at 1.4 million metric tons (1.6 million short tons) and value of $6.6 million. The estimated value was approximately 9% of the State's 1992 mineral value.

The leading producer in 1991, the last year with actual data, was Holnam Inc., which produced chalk for cement manufacture. The State's single "hard-rock" operation was Vulcan Materials Co., which operated a crushed stone quarry near Iuka in northeastern Mississippi. Stone from the Iuka quarry was sold for concrete and bituminous aggregate, railroad ballast, road base surface stone, stone sand, and agricultural lime. Three firms mined chalk to produce an agricultural lime product.

Sulfur (Recovered).—Mississippi ranked fifth among the 26 States with sulfur recovery from petroleum and natural gas refineries. Refineries in Clarke, Jackson, Lamar, and Rankin Counties produced 679,000 metric tons (748,000 shorrt tons) valued at $32 million. The 1991 output and value were 695,000 metric tons (766,098 short tons) and $47 million, respectively. The decline reflects the State's declining hydrocarbon production.

Other Industrial Minerals.—Several industrial minerals, not listed in table 1, were produced as a byproduct in materials processing and shipped into the State for raw material or for manufacturing into a higher value product.

Anhydrous ammonia, produced from natural gas, was marketed by Mississippi Chemical Corp. in Yazoo City. Cobalt, manganese oxide, and iron oxide pigments were shipped into Mississippi by the brick industry for brick colorants. The brick industry also purchased barite from Georgia for use in brick manufacturing.

Ilmenite and synthetic rutile, used in the production of titanium dioxide pigments, was shipped to DeLisle and Hamilton by E. I. du Pont de Nemours & Co. Inc. and Kerr-McGee Chemical Corp. The ilmenite, exported from Australia, was shipped to the DeLisle plant, and the synthetic rutile was from a Kerr-McGee plant near Mobile, AL.

Lime, mica, perlite, rock salt, and dimension stone were other industrial minerals shipped into Mississippi. Falco Lime Inc., Vicksburg, marketed lime obtained from a Missouri company for a soil stabilization agent, to pulp and paper mills, and to water-treatment plants. Falco also marketed calcium carbonate and kiln dust. Mica produced in North Carolina was shipped to Atlas Roofing Co. to use in shingle manufacture. Mansville Products Corp. expanded perlite at a plant in Natchez, and USG Interiors Inc. operated a perlite expansion plant at Greenville. Sales were to the formed products, roof, and insulation board industries. KemaNord Inc., Columbus, purchased rock salt from Louisiana to manufacture a product used by paper companies for bleaching. Several stone companies shipped dimension stone in various shapes into the State for cemetery monument and architectural applications.

Metals

Iron and Steel.—Birmingham Steel Corp., Flowood, near Jackson, operated a 190,500-metric-tons (210,000-short-tons) melting capacity minimill. Birmingham Steel announced plans to modernize its electric furnace and continuous caster at the Jackson mill. The project will expand the melt shop's capacity.[15]

Manganese.—Kerr-McGee Chemical Corp., Hamilton, produced electrolytic manganese metal from manganese ore imported from sources such as West Africa. Output was sold to the aluminum industry.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 32 years of mineral-related industry and government experience and has covered the mineral activities in Mississippi since 1989. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, Editorial Assistant.

[2]Director, Mississippi Office of Geology, Jackson, MS.

[3]Geologist, Mississippi Office of Geology, Jackson, MS.

[4]Biloxi-Gulfport Sun Herald. Port Adds Ore Tanks for Use in Du Pont Blending. Feb. 13, 1992.

[5]Mississippi Employment Security Commission, Labor Market Information Department. Telephone communication with senior author. July 20, 1992.

[6]Mississippi Environmental News. New Mississippi Environmental Legislation, Department of Environmental Quality. V. 12, No. 2, Aug. 1992, pp. 1 and 3.

[7]Brookhaven Daily Leader. Mineral Rights Would Be Taxed Under New Bill. Feb. 27, 1992.

[8]Baton Rouge Morning Advocate. Mississippi Salt Dome Eyed for Oil Storage. Nov. 20, 1992.

[9]Mississippi State Oil and Gas Board. Annual Production Report of the Oil and Gas Reservoirs of Mississippi, Year Ending Dec. 31, 1992.

[10]Mississippi State Tax Commission, Severance Tax Department. Telephone communication, M. B. E. Bograd. Sept. 20, 1993.

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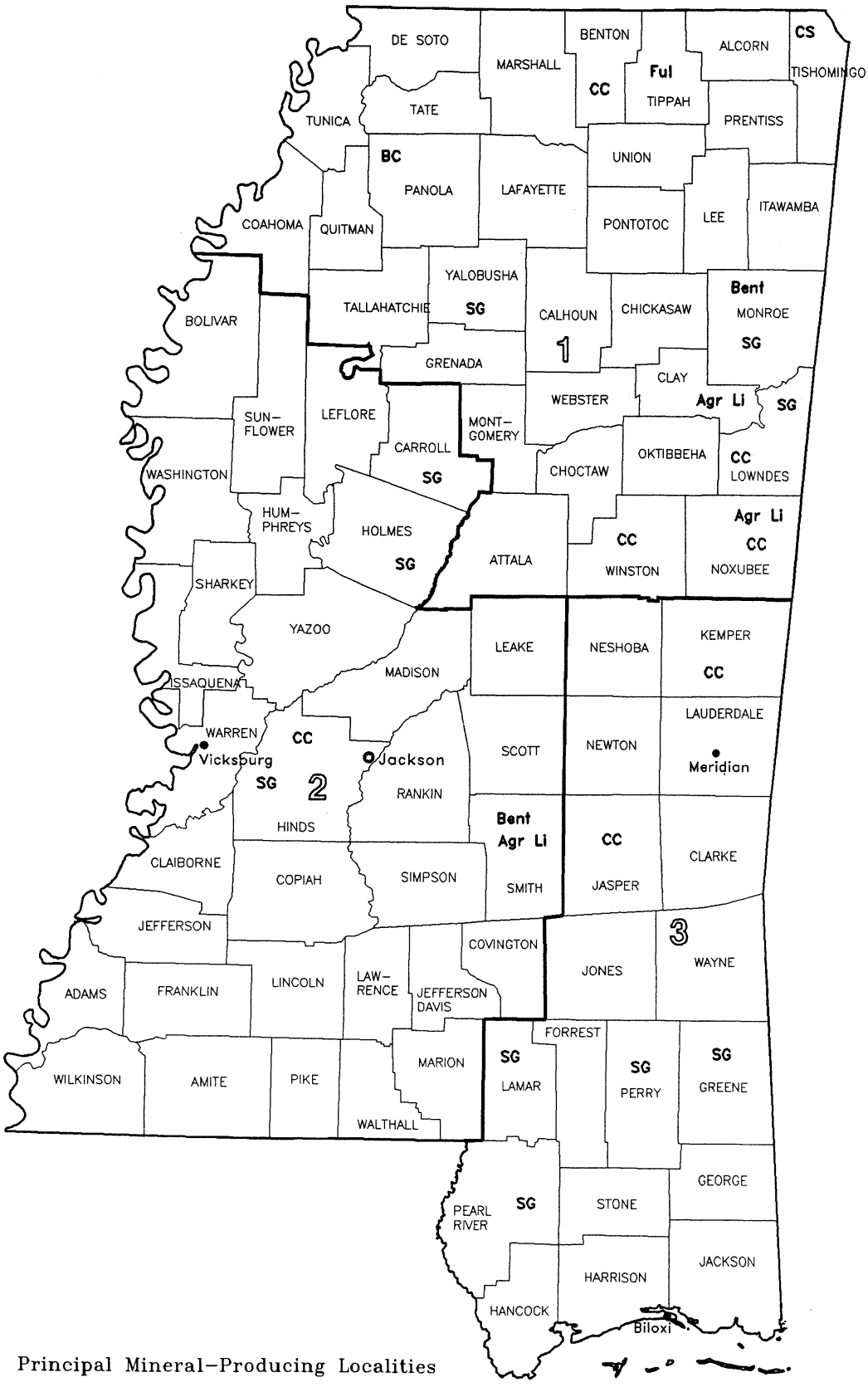
MISSISSIPPI



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Agr Li	Agricultural Lime
BC	Ball Clay
Bent	Bentonite
CC	Common Clay
Cem	Cement plant
CS	Crushed Stone
Ful	Fuller's earth
SG	Sand and Gravel

Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
United Cement Co.	Box 185 Artesia, MS 39736	Plant	Lowndes.
Clays:			
Ball:			
Kentucky-Tennessee Clay Co.	Box 449 Mayfield, KY 42066	Mine and plant	Panola and Quitman.
Bentonite:			
Applied Industrial Minerals Corp.	Route 4, Box 366 Aberdeen, MS 39730	do.	Monroe
American Colloid Co.	Drawer 608 Aberdeen, MS 39730	do.	Do.
Engelhard Corp.	Box 8337 Jackson, MS 39204	do.	Monroe, Smith, Hinds.
Common:			
Columbus Brick Co. Inc.	Box 866 Columbus, MS 39703	Mine and plant	Clay and Lowndes.
Delta Brick Div., Boral Bricks Inc.	Box 431 Macon, MS 39341	do.	Kemper, Noxubee, Jones, Winston.
Tri-State Brick & Tile Co. Inc.	Box 31768 Jackson, MS 39206	do.	Hinds.
Fuller's earth:			
Applied Industrial Minerals Corp.	Box 37 Blue Mountain, MS 38610	do.	Tippah.
Oil-Dry Production Co. Inc.	Box 476 Ripley, MS 38633	do.	Do.
Sand and gravel:			
Construction:			
Blain Sand & Gravel Co.	Box 278 Mount Olive, MS 39119	Mines and plants	Adams, Copiah, Lowndes, Marion.
Green Bros. Gravel Co. Inc.	Route 2, Box 625 Crystal Springs, MS 39059	Mine and plant	Copiah.
Memphis Stone and Gravel Co.	Box 1683 Memphis, TN 38101	Mines and plants	DeSoto, Panola, Yalobusha.
Industrial:			
Henry Stockstill Inc.	Box L Picayune, MS 39466	Pit	Pearl River.
Tri-Sands Inc.	Route 1, Box 17 Trafford, MS 35172	Mine and plant	Tishomingo.
Stone (crushed):			
Vulcan Materials Co.	Box 418 Iuka, MS 38852	Quarry and plant	Do.
Limeco Inc.	Route 1, Box 431 West Point, MS 39773	do.	Clay.
United Cement Co.	Box 185 Artesia, MS 39736	do.	Lowndes.

THE MINERAL INDUSTRY OF MISSOURI

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Missouri Department of Natural Resources, Division of Geology and Land Survey, for collecting information on all nonfuel minerals.

By Jeanne Zelten[1] and Ardel Rueff[2]

The value of Missouri nonfuel mineral production was nearly $897.2 million in 1992, an increase of $16.8 million over that reported to the U.S. Bureau of Mines (USBM) by State mineral producers in 1991. The value of the three leading mineral commodities, lead, portland cement, and crushed stone, increased nearly $18 million from the 1991 total, an increase of about 3%, and accounted for almost 69% of the estimated State total nonfuel mineral value reported for 1992. Missouri ranked 11th nationally in total nonfuel mineral value. The State was 12th nationally in the production of industrial minerals, yielding about 2.8% of the $20.7 billion of revenues received. In the production of metals, Missouri ranked 10th nationally, contributing about 3.1% of the $11 billion total. Missouri ranked first in the Nation in the production of lead and lime; second in crude iron oxide pigments; and third in the production of barite, fire clay, and finished iron oxide pigments. Estimated sales increased in 1992 for nine of the mineral commodities produced in the State. The most substantial increases occurred in sales of portland cement, construction sand and gravel, crushed stone, and zinc. Increases also occurred in the production of barite, lime, industrial sand and gravel, and dimension stone. Lead continued as the State's leading mineral commodity, accounting for almost 26% of the estimated total nonfuel mineral value.

TRENDS AND DEVELOPMENTS

The recession and anticipated slow recovery were expected to continue to influence the construction industry. Consolidation of operations and divestitures of extended company holdings were expected to increase as

TABLE 1
NONFUEL MINERAL PRODUCTION IN MISSOURI[1]

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
Cement (portland)	thousand short tons	4,481	$180,090	e4,276	e$171,040	4,725	$196,073
Clays[2]	metric tons	1,347,558	12,864	2,001,537	11,060	1,195,412	8,327
Copper[3]	do.	W	W	W	W	10,766	25,497
Gemstones		NA	W	NA	W	NA	862
Iron ore (usable)	thousand metric tons	1,002	W	e224	W	19	W
Lead[3]	metric tons	380,781	386,345	351,995	259,841	300,589	232,602
Sand and gravel:							
Construction	thousand short tons	9,243	25,097	e7,400	e20,100	9,024	26,457
Industrial	do.	W	W	W	W	710	10,931
Silver[3]	metric tons	42	6,434	35	4,483	32	4,084
Stone (crushed)	thousand short tons	e53,100	e190,900	47,938	167,233	e52,200	e187,400
Zinc[3]	metric tons	48,864	80,355	42,506	49,453	44,031	56,670
Combined value of barite, cement (masonry), clays (fuller's earth), iron oxide pigments (crude), lime, sand and gravel (industrial), stone (dimension), and values indicated by symbol W		XX	r223,034	XX	197,141	XX	148,286
Total		XX	r1,105,191	XX	880,351	XX	897,189

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" figure.
[3]Recoverable content of ores, etc.

company strategies shifted to adapt to changing economic conditions. Compliance with Federal, State, and local regulations undoubtedly will occupy a larger percentage of operators' time and resources. Environmental opposition to exploratory drilling, as well as to both new and expanded mining, continued throughout the State.

Investigation into the use of waste products as fuel in cement kilns increased as companies attempted to decrease their fuel costs, thus decreasing a major part of operating expenses. Industrial wastes and old tires were among alternate fuels considered.

EMPLOYMENT

Employment in the mining industry in December 1992 totaled 4,700 workers, unchanged from the December 1991 total. The stone, clay, and glass products sector decreased from 10,400 in December 1991 to 10,000 in 1992. The primary metals sector decreased 1,100 workers to 11,100 in 1992. Employment in the mineral-related construction industry increased from 86,100 in 1991 to 91,200 in 1992.[3]

According to the U.S. Department of Labor, injuries resulting in lost workdays reported from nearly 4.8 million hours worked in nonfuel surface and underground mines in 1992 totaled 118 (27 from underground mines, 91 from surface operations). Included were 72 injuries with no lost workdays (29 from underground mines, 43 from surface operations) and 2 fatalities (underground mines). During nearly 5.5 million hours worked at mills and preparation plants, an additional 138 injuries resulting in lost workdays and 128 injuries resulting in no days lost occurred. In addition, surface coal mines reported 30 injuries resulting in lost workdays and 12 injuries with no days lost during 863,531 hours worked. One injury resulting in no lost workdays was reported during more than 103,000 hours worked at coal plants.[4]

ENVIRONMENTAL ISSUES

The Occupational Safety and Health Administration (OSHA) ruled that six nonasbestiform minerals, including actinolite, tremolite, and anthophyllite, would no longer be treated as forms of asbestos in health and safety regulations. These minerals, commonly found in aggregates, will be regulated as particulates. The ruling could save operators $7 million annually in control measures to deal with the minerals. The rule became effective May 29, after 6 years of debate.

The U.S. Environmental Protection Agency (EPA) issued two regulations to implement air pollution controls required by the Clean Air Act Amendments of 1990. These included regulation of a number of mineral-products industries for toxic air pollutants and the implementation of permitting requirements for all major sources of air pollution. Also, new standards were set for particulate matter that apply to calciners and dryers at plants processing or producing construction products, including lightweight aggregate. EPA anticipated product price increases resulting from the new standards probably would be less than 0.5%, but could be as much as 1.75% for the lightweight aggregate industry.

EPA studied both the process and affects of using waste products as fuel in cement kilns. The studies were in response to public opposition and in an effort to reduce regulatory burdens on industry and to redefine a waste. EPA determined that there was no threat to human health or to the environment from the emissions created by burning certain hazardous wastes in cement kilns. Studies also indicated that cement products did not contain measurable increases of toxic metals. New regulation, expected in late 1994, would eliminate excessive regulations prohibiting the use of hazardous waste in the production of cement and other building materials.

Several industries saw increased competition from alternative products, especially waste products, which often were sold at prices undercutting the prices of mined materials. Because of increasing need to dispose of large quantities of waste material, the trend was expected to increase in coming years. Bottom ash, the residue produced at coal-burning powerplants, was sold for use as a lightweight aggregate in masonry applications. Byproduct lime and gypsum from water-treatment facilities and flue gas desulfurization were used for soil conditioning, gypsum-board manufacture, and portland cement. Alkaline fly ash was used for stack gas cleaning. Concrete and road asphalt also were recycled.

In response to the Clean Air Act Amendments of 1990, research was carried out by Federal and State agencies in an attempt to substitute various materials for traditional mined materials to produce usable byproducts. For example, phosphate was used to replace limestone in flue gas desulfurization, resulting in a salable fertilizer byproduct. Innovative use and handling of waste products, along with demand for a number of industrial minerals and a variety of chemicals, was expected to increase as operators modify their facilities to comply with the new regulations.

Twenty-three sites in Missouri are on the EPA National Priorities List (NPL). Two of these Superfund sites, the Oronogo-Duenweg Mining Belt site and the Big River Mine Tailings/St. Joe Minerals Corp. site, are directly related to past mining.

The Oronogo-Duenweg Mining Belt site covers 6,400 acres and is part of the Tri-State Mining District. Halliburton Co., E. I. du Pont de Nemours and Co., and more than a dozen other companies were cited by EPA in connection with mine cleanup in the Tri-State District. The district encompasses Jasper County, MO, Cherokee County, KS, and Ottawa County, OK. Preliminary studies revealed lead contamination in soils and waste piles. Excessive levels of lead, zinc, and cadmium were detected in surface and ground water. By 1994, EPA planned to complete analysis of the site to determine whether the high levels of metals were the result of mining or from other sources and to review alternatives for cleanup. The cost of the study to determine the extent of environmental damage will be shared by

Halliburton, Du Pont, and seven other companies. Cleanup could reach the tens or even hundreds of millions of dollars.

The Big River Mine Tailings/St. Joe Minerals Corp. site, located in the "Old Lead Belt" in the southeastern part of the State, is approximately 110 square miles in size. St. Joe Minerals Corp. donated land containing mine tailings to St. Francois County, and a landfill is on part of the tailings. Elevated levels of lead were detected in fish in the Big River, which bounds the site, and in surface water. High levels of lead, cadmium, and zinc were detected in the tailings, surface water, air, and soil in the area. Investigation to determine the nature and extent of contamination and to make recommendations for cleanup began late in the year.

A number of workshops and training courses were sponsored by the Missouri Limestone Producers Association, National Stone Association, and private companies to educate operators on environmental regulations and to provide information on emissions control.

LEGISLATION AND GOVERNMENT PROGRAMS

A variety of legislation that would have an impact on the minerals industry was introduced. Some of the bills passed, while others did not. Defeated bills could be reintroduced in subsequent legislative sessions.

House bill 1006 provided appropriations for the Missouri Department of Natural Resources. In February, the State legislature began consideration of a proposal to eliminate the Division of Geology and Land Survey from the budget as a result of proposed budget cuts by the Missouri General Assembly. The Missouri Limestone Producers Association, the Mining Industry Council of Missouri, and numerous other organizations and individuals were instrumental in ensuring that the Division was funded and assisted in preventing two geologist positions from being deleted from the budget.

House bill 1247 increases the fuel tax by $0.06, increasing $0.02 per year every other year until the full $0.06 is implemented in 1996. Revenues generated will contribute to the planned 15-year Road and Bridge Program and nearly double available Federal matching funds. The bill contains provisions that funds will not be used for administration purposes by the State Highway Department. If changes are made in the Federal Surface Transportation Act such that the full $0.06 tax is not needed, or if the General Assembly determines that funds are not being used for the intended purposes, the voters may determine whether to continue implementing the tax or if it should be repealed.

Senate Committee Substitute House bill 1732 revises the Missouri solid waste law in a variety of areas. Counties are provided the opportunity to transfer to different solid waste management regions. Solid waste facilities must comply with local zoning requirements. The length of time during which landfill operators are responsible for monitoring and caring for landfills is increased from 25 to 30 years after closure of the landfill. Fees collected for the transportation of infectious wastes for disposal will be placed in the Solid Waste Management Fund for hazardous waste remediation. The bill also revises the surface mining law. Operators who apply for permits to mine less than 10,000 short tons per year must agree in writing to grant access to the Department of Natural Resources or the Land Reclamation Commission.

Senate Committee Substitute Senate bill 480 relates to hazardous substances emergencies. Employers storing, using, or producing hazardous substances are required to register annually with the local fire protection service, local emergency planning committee, and the Department of Natural Resources. Annual fees on such facilities will be placed in the Chemical Emergency Preparedness Fund for use in chemical emergency planning, prevention, and training. State departments and commissions are no longer required to encourage the location of hazardous waste treatment facilities in the State.

Senate bill 544 revises Missouri's Air Conservation Law to comply with new Federal requirements under the Clean Air Act Amendments of 1990. Guidelines concerning permits, fees, and penalties are established. The bill establishes emissions fees of $25 per ton, requires 5-year operating permits, and specifies that the provisions of the State air quality compliance regulations be no stricter than Federal requirements. Charcoal producers are protected from excessive fees through a provision allowing kiln operators to come into compliance over the next several years.

House bill 924 did not pass. The bill would have established a mine map repository in the Department of Natural Resources, Division of Geology and Land Survey. The repository would have contained mine maps of all closed underground mines and mineral rights ownership maps for all active underground mines in the State. The maps would be open for examination by all interested parties.

House bill 1533 did not pass. The bill would have expanded the use of abandoned mine reclamation funding to include surface coal mining operations if available reclamation or abatement funds from bonds or other financial guarantees are insufficient to adequately reclaim the site.

The U.S. Senate Finance Committee rejected a House-passed proposal to abolish the depletion allowance for producing asbestos, lead, mercury, and uranium. The elimination of the depletion allowance would have cost Missouri lead producers millions of dollars annually and resulted in a loss of many jobs.

The U.S. Army Corps of Engineers stated that artificially created lakes and ponds excavated from dry land, including those created by aggregate producers, are not included under the definition of jurisdictional wetlands. With less regulatory restriction, operators are allowed greater flexibility in quarry development and reclamation.

EPA and Congress considered a variety of approaches to reduce lead consumption and the amount of lead in the environment and to encourage

secondary recovery. Proposed was an excise tax of $0.75 per pound on primary lead and $0.35 per pound on secondary lead production and imports. Revenues would be used toward grants to State and local governments for lead paint abatement programs. The USBM analyzed the impact of such a tax on the domestic lead industry, including the impacts on primary and secondary lead production, lead recycling, production of coproducts and byproducts of the industry (bismuth, cadmium, germanium, indium, silver, and zinc), and the effect on price. This study indicated that a primary lead tax could have serious impacts on the domestic primary lead industry and may not meet stated objectives of the legislation. Using the average 1991 lead price of about $0.30 per pound, domestic production would be significantly reduced or cease at the proposed tax levels. The proposed primary lead tax is approximately twice the 1992 selling price for lead. Production of coproduct and byproduct metals would be drastically reduced or eliminated, causing an economic ripple effect through many associated industries. Lead imports would replace uneconomic primary production. Recycling would remain at current levels. Thousands of jobs, both directly and indirectly related to the industry, would be lost. And increased prices would result in the battery manufacturing industry losing much of its competitive world position, a further imbalance in the balance of trade. Such a tax would decimate the lead industry in Missouri.[5]

Several ongoing State and Federal Government programs provided information beneficial to mineral producers in the State. Maps identifying crushed stone, dimension stone, and construction sand and gravel resources in Laclede County were completed.

Scientists with the Missouri Department of Natural Resources, Division of Geology and Land Survey, continued an evaluation of the Pea Ridge, Boss-Bixby, and nearby copper, gold, iron, and rare-earth deposits in the St. Francois Mountains of southeastern Missouri. Mapping at the Pea Ridge Mine was published by the U.S. Geological Survey (USGS). Logging of 100,000 feet of core from Cominco American Inc.'s Boss-Bixby deposit and from the Camels Hump deposit continued. The study is a cooperative program with the USGS and private industry to identify and quantitatively assess new subsurface targets for polymetallic (Olympic Dam-type) deposits in the Midcontinent Region. Geologic conditions in this part of the State nearly duplicate those found at Olympic Dam, Australia. The program was coordinated by the USGS to define the mineral resource potential of a 433,000-square-mile area covering 16 States in the central United States. The first phase of the project included an inventory of geologic data identifying geologic terranes and known mineral deposits. Phase 2, nearly complete by yearend, focused on the origin and extent of mineralizing systems. Throughout the study, the potential for new deposit types was evaluated. The USBM cooperated with Pea Ridge to determine if rare-earth minerals at the mine could be exploited commercially. At least seven different rare-earth minerals have been identified in breccia pipes, veins, or carbonate pods along the edges of the massive magnetite ore bodies. Monazite, xenotime, and allanite are three of the most abundant. This was the fourth year of the 5-year study.

Under sponsorship of the USGS Conterminous United States Mineral Assessment Program (CUSMAP), the Paducah 2° Quadrangle study was completed and results published. The project, the fifth quadrangle in Missouri, was completed through the cooperation of the State Geological Surveys of Illinois, Indiana, Kentucky, and Missouri. Clays, coal, fluorspar, lead, limestone, other metallic minerals, oil, and sand and gravel have been produced from the quadrangle. Research indicated the presence of large quantities of undiscovered resources of these and other minerals, including barium, clay, cobalt, copper, natural gas, sand and gravel, silver, and zinc.

Passage in May of the National Geologic Mapping Act of 1992, Public Law 102-285, could result in improved mapping coverage for Missouri. The State map component of the act identifies State geological surveys as the lead agencies to establish mapping priorities in their respective States. States must compete for funding, and equal distribution among States is not guaranteed. States are required to match the awarded funds. For 1993, full authorization of $18 million to States was funded at only $1.39 million. The Missouri Division of Geology and Land Survey assembled a Geologic Mapping Advisory Committee, consisting of 12 members from a variety of State and Federal agencies, private industry, educational institutions, and professional organizations, to identify issues of concern and to establish mapping needs and priorities in the State.

Under the State Mining and Mineral Resources Research Institute Program Act (Public Law 98-409), the USBM awarded a basic allotment grant of $16,000 to the University of Missouri-Rolla. The monies were used to perform basic and applied research related to the State's mineral resources and for the general benefit of the Nation's mineral industry. The University matched this grant on a 2:1 basis.

The USBM completed a preliminary zinc study as part of a program to evaluate the environmental implications associated with the production, consumption, and disposal of metals in the United States. Options to reduce losses include reworking mill tailings, using tailings for backfill, and use in fertilizers and animal feeds. Mined rock, tailings, and smelter slag are used in construction and road building.

The USBM hosted a meeting on August 28 with representatives of the Missouri Division of Geology and Land Survey, the Missouri Limestone Producers Association, and the Mining Industry Council of Missouri. The purpose of the meeting was to learn about the interests and needs of the mining industry in the State and to obtain ideas for future USBM research projects.

FUELS

Coal, oil, and gas were produced in Missouri in 1992, primarily for use as fuels.

Senate bill 606, passed in 1992, requires that State institutions that purchase coal use coal mined in Missouri or an adjoining State if the cost, including transportation, is not greater than the cost of coal mined in any other State. Not included in the bill are municipalities, political subdivisions, and public schools.

In 1992, a total of nearly 2.8 million short tons of high volatile bituminous coal was produced from surface mines in Barton, Bates, Ralls, Randolph, and Vernon Counties. The State ranked 20th nationally in coal production. Production increased about 21% from the 1991 production of about 2.3 million short tons.[6] Prior to the 1992 increase, coal production in Missouri had decreased steadily since 1984, when production was at a high of more than 6.7 million short tons. Most of the coal was used to supply 48 coal-fired electric generating units in the State.[7]

After a year of continued controversy, Associated Electric Cooperative Inc. developed a plan of action to bring its Thomas Hill Energy center, New Madrid, into compliance with new Clean Air Act requirements. Beginning in January 1995, low-sulfur western coal will be used in two of three generating units at the center. Coal from the Thomas Hill Mine will be blended with western coal in the third unit. In 1997, the decision will be reevaluated to determine whether to continue using Missouri coal or to close the mine and switch completely to western coal. The decision could be made prior to 1997, if warranted by annual evaluations. Late in the year, Associated Electric signed an amendment to its 1991 agreement with Rochelle Coal Co., Wright, WY, increasing the tonnage of low-sulfur coal supplied by Rochelle for use in the Thomas Hill plant. The Thomas Hill Mine ranked 53d nationally of surface coal mines, reporting production of more than 2.5 million short tons of coal.[8]

Coal occurs in Pennsylvanian formations in the northern and western regions of the State. Eastern Missouri is supplied from nearby Illinois coal fields.

In a cooperative program with the USGS and the State Geological Surveys of Iowa, Kansas, and Nebraska, the Missouri Division of Geology and Land Survey is the lead agency in a proposed 4-year study of coalbed methane in the Forest City Basin, in the northwestern corner of the State. If commercial quantities of coalbed methane occur, the possibilities for production will be evaluated. Together with the USGS, the four states applied to the U.S. Congress for $8 million, to be used during the study. A 6-month pilot study was approved by Congress in October.

The Interstate Oil and Gas Compact Commission and the Southern States Energy Board co-sponsored a conference, "Coal and Natural Gas: Partner for Progress," to explore opportunities in co-firing utilities and other industries. Increased environmental regulations will present opportunities for co-firing, particularly at powerplants. Education and cooperation will be essential if such programs are to succeed.

Production of crude oil in 1992 was nearly 142,000 barrels.[9] Crude production in 1991 was 150,000 barrels. Commercial gas production in 1992 was 2.7 million cubic feet (mmcf), a 1.2 mmcf-increase over 1991 production.[10] According to Petroleum Information Corp., no new drilling occurred in the State in 1992.[11] Most oil and gas fields are in the western part of the State. Production was from the Cherokee and Forest City Basins, primarily from Jackson and Cass Counties. Areas of interest for future exploration include the Forest City Basin in the northwestern corner of the State, the Lincoln Fold area in the northeastern corner, and the Mississippi Embayment area in the southeastern corner.

REVIEW BY NONFUEL MINERAL COMMODITIES

A variety of industrial minerals and metals were mined, manufactured, or recovered as byproducts in 1992. Missouri's industrial mineral sector accounted for well over one-half the State's nonfuel mineral value produced. Lead continued as the leading nonfuel mineral commodity, in terms of value, followed by portland cement, crushed stone, and lime. The four accounted for almost 67% of the State's 1992 nonfuel mineral value.

Industrial Minerals

Production of industrial minerals in 1992 was influenced by gradual increases in the construction industry as the economy began to recover. Crushed stone and cement production increased in 1992, mostly because of increased funding for highway construction provided by the $151 billion Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). Good weather also was a factor. As a result of ISTEA, Missouri increased transportation-related construction and anticipated further increases in 1993, as did most States. ISTEA funds are allocated over 6 years for improvements to highways and bridges. More than one-half of the funding could be used for mass transit and other nonhighway purposes. About $18 billion of the authorized $20.5 billion was appropriated to the U.S. Department of Transportation for fiscal year 1993.

Environmental and zoning regulations were cited as the primary reasons for making it increasingly difficult for the construction aggregates industry to expand existing quarries and to develop new quarry operations. As operations are forced to move further from market areas, transportation costs increase, ultimately affecting aggregate prices and competition.

A number of construction projects in Kansas City began in 1991 and were expected to continue throughout the 1990's, providing much-needed business to the construction industry and mineral producers supplying the area. Included are expansions at the city's convention center, the Kansas City International Airport, the zoo, flood control and

beautification work, housing, and a variety of business and recreational projects.

In 1992, the value of authorized construction was more than $3 billion, an increase of 23.5% above 1991. The number of single- and multi-family residential units increased 17.7% to 20,781, and the value of nonresidential construction exceeded $1.3 billion, 14.5% higher than 1991. Nonbuilding construction, including highways, totaled more than $15 million, less than one-half of the $34 million in 1991.[12]

Anticipated increases in residential construction, highways, environmental work, and public works projects in 1993 could increase the demand for aggregate and portland cement by up to 6% in 1993. Residential construction was beginning to rebound at yearend and also was expected to increase in 1993.

Barite.—Missouri ranked third of five States producing barite, and producers accounted for approximately 3.8% of the national tonnage and about 3.5% of the value. While historically low, reported production and value were 25% and 10%, respectively, above those reported in 1991. Production was expected to continue to increase as the economy recovers and demand increases. Barite is a barium sulfate mineral used primarily as an oil-well drilling mud additive to control gas pressure. Chemical-grade barite was used as a pigment and filler in paint and rubber manufacture and as a glass flux. Other uses were the preparation of barium compounds; as fillers and extenders in inks, paper, textiles, asbestos, and linoleum products; and as ballast in the tires of heavy construction equipment.

Baroid Drilling Fluids Inc., a division of NL Petroleum Services Inc., reported production from a surface mine in Potosi, Washington County. The barite was crushed and ground at the company's two plants for use as fillers, extenders, and well drilling muds. The company is the third largest domestic producer, with mines in Missouri and Nevada. In Washington County, MO, the blanketlike, residual deposits average 10 to 15 feet in thickness and cover wide areas.

Cement.—Portland and masonry cements constituted the second leading mineral commodity produced in the State, accounting for about 22% of Missouri's 1992 mineral value. The State retained its fifth place ranking in portland cement production among 37 portland cement-producing States. Portland cement production and value, estimated at more than 4.7 million short tons valued at more than $196 million, were 449,000 short tons and $25 million above totals estimated by the USBM for the industry in 1991 and 244,000 short tons and nearly $16 million above that reported by the cement industry in 1990. The increase was attributed to the turnaround of the recession and an increase in housing construction. Masonry cement production and value decreased about 10% and 11%, respectively, below 1991 estimates and more than 16% below totals reported by the industry in 1990.

Cement plant locations are determined by the availability of raw materials (limestone, clay or shale, and sandstone) near river and rail transportation, which provide access to the Mississippi-Missouri-Ohio Rivers markets. In 1991, the last year for which data are available, major sales were to ready-mix plants (72.4%), concrete products manufacturers (12.1%), and highway contractors (9.2%). Masonry cement was used in bricklaying and other masonry applications.

Continental Cement Co. of Hannibal, in Marion County, produced portland and masonry cement by wet-process methods. Holnam Inc., Dundee Cement Div., of Clarksville, Pike County, produced portland and pozzolan cement by wet-process methods. Portland and masonry cement were produced by dry-process methods by Lone Star Industries Inc. of Cape Girardeau, Cape Girardeau County, and by Lafarge Corp., in Sugar Creek, Jackson County. River Cement Co. of Festus, Jefferson County, also produced portland cement by dry-process methods.

Cement plant operators continued to explore the use of waste products as fuel in cement kilns. Faced with low cement prices and a recovering economy, the industry investigated ways to cut fuel costs, which constituted approximately 25% of operating expenses. The high temperatures needed in cement kilns were used to burn waste materials, such as waste fuels, industrial wastes, spent organic solvents, and used tires. Canned wastes and tires were placed directly into the cement kilns along with the other raw materials; the high temperature completely decomposed the organic material. Because portland cement clinker requires a certain amount of iron, the metal containers and the steel radial belts from the tires are simply incorporated into the clinker. Hazardous wastes have been burned in cement kilns for years, and in 1992, waste fuels accounted for about 6.6% of the energy used for making cement in the United States. It appeared to be an environmentally safe and efficient way to dispose of hazardous waste and other materials that have long been a problem, thereby eliminating the need to mine other resources to satisfy fuel requirements.

Lone Star Industries Inc. converted its Cape Girardeau plant, Cape Girardeau County, to utilize liquid waste as fuel in cement kilns and evaluated the use of waste tires as fuel.

Clays and Shale.—Missouri ranked ninth among 44 States reporting clay and shale production. Fire clay, common clay, and fuller's earth were mined.

Among nine States producing fire clay, Missouri ranked third. Five companies reported production of 177,901 metric tons, valued at nearly $3.9 million, from 16 pits in 6 counties. Reported sales were to the refractories industry and for highway surfacing. Fire clays, the common name for refractory clays, are resistant to high temperatures without change, other than dehydration. They are the most valuable clays produced and are found as filled sink and bedded deposits in the east-central part of the State. Uses included refractory brick, high-temperature-resistant mortar, crucibles, zinc retorts and condensers, and miscellaneous uses in foundries and

steelworks.

The State ranked ninth of 43 States producing common clay. Reported production, 1,017,511 metric tons valued at more than $4.4 million, accounted for a major portion of the total clay and shale tonnage. Common clay production was reported by seven companies operating nine pits in six counties. The leading counties, Pike, Platte, and Ralls, accounted for about 84% of the total. Principal products manufactured from clay and shale included lightweight aggregate, common and face brick, flower pots, and portland cement. These clays are present principally in the western and northern parts of the State in Pennsylvanian, Devonian, and Middle Ordovician formations.

Fuller's earth was produced by Golden Cat Corp. from two pits in Stoddard County. Sales were mainly to the absorbent industry for such applications as pet litter, oil absorbents, pesticide carriers, and related products.

Two companies manufactured brick at plants in the State in 1992. Face, common building, and paving brick were produced by Kasten Clay Products Inc., at a plant in Jackson, Cape Girardeau County. Face, common building, glazed, paving, and thin wall brick, as well as glazed and unglazed structural tile, chemical resistant, and crushed brick for landscaping, were produced by Glen-Gery Corp. at its plant in Chillicothe, Livingston County.

Lime.—In 1992, the State ranked first among 32 lime-producing States. Production decreased about 2%, while value increased slightly in 1992. Two companies, Ash Grove Cement Co. in Springfield, Greene County, and Mississippi Lime Co. in Ste. Genevieve, Ste. Genevieve County, reported production of both quicklime and hydrated lime. Resco Products Inc. in Bonne Terre, St. Francois County, reported production of quicklime, dolomitic quicklime, and dead-burned dolomite. Lime sales were to the water-treatment industry, for oil refining, and for the manufacture of paper and steel. The steel industry is the largest consumer of lime.

Mississippi Lime Co. announced the formation of North American Management Co. to manage and service the Mississippi Lime plant in Ste. Genevieve and other plants the company owns. The Ste. Genevieve plant remained the top lime-producing plant in the country.

Mid-America Lime Co. was formed as a joint venture between Chemical Lime Co. of Fort Worth, TX, and Marblehead Lime Co. of Chicago, IL. The new company will produce lime at a facility to be constructed near Ste. Genevieve, in Ste. Genevieve County. The facility, scheduled to be operational in 1994, will supply the large emerging flue gas desulfurization lime markets along the Mississippi, Missouri, and Ohio Rivers.

A.P. Green Industries Inc. produced refractory products, used in producing steel and aluminum from its plant in Mexico, Audrain County.

Growth in the lime and limestone industry was expected to increase as a result of the Clean Air Act Amendments of 1990 and other environmental legislation that required installation of stack scrubbers at coal-fired powerplants. Scrubbers utilize lime and pulverized limestone to remove sulfur oxides from stack gases. Other areas of continued growth in usage included water treatment, to achieve proper pH balances, and treatment of sewage sludge and hazardous wastes. Increased demand for lime in an expanding economy is anticipated for the manufacture of steel and automobiles, construction, industrial and chemical uses, and increased mining, smelting, and environmental controls in the gold and copper industry.

Lime is manufactured by heating or calcining limestone or dolomite in a kiln at high temperatures to drive off carbon dioxide. The resulting product is quicklime. Hydrated lime, the more stable form, is produced when water is added to the quicklime. In addition to the abovementioned uses, lime is used as a soil conditioner, as plant food, for soil stabilization, as a flux, and as a basic chemical.

Sand and Gravel.—Both construction sand and gravel and industrial sand were mined in Missouri during 1992.

Construction.—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

The value of construction sand and gravel ranked sixth among the industrial minerals produced in Missouri in 1992, constituting about 3% of the total nonfuel mineral value. Reported production of construction sand and gravel was 219,000 short tons (about 2%) below that reported in 1990, and 1.6 million short tons (almost 22%) above the 1991 estimate. Reported value increased nearly $1.3 million (about 5%) above that reported by industry in 1990 and almost $6.4 million (32%) above the estimated 1991 value. Missouri construction sand and gravel statistics are compiled by geographical districts, as depicted on the State map. Tables 2 and 3 present end-use data for this commodity in the State and in the eight Missouri districts. District 5, in the east-central part of the State, reported the highest production, followed by districts 4, 8, 3, 7, 1, 6, and 2.

The construction sand and gravel industry consisted of 75 companies operating 125 pits in 55 of the State's 114 counties. The five leading counties, in decreasing order of tonnage produced, were St. Louis, Stoddard, Clay, Callaway, and Howard. Almost 57% of the State's production was from these counties. Four companies, Capitol Sand Co. Inc., Holliday Sand and Gravel Co., St. Charles Sand Co., and Winter Brothers Materials Co., together produced nearly 48% of the State total. Major end uses reported by producers included concrete aggregate, asphaltic concrete, road base and coverings, fill, miscellaneous concrete products, and other uses. A majority of the material was transported by truck from pits to plants and construction sites. Some material also was transported by waterway.

TABLE 2
MISSOURI: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	5,122	$14,590	$2.85
Plaster and gunite sands	153	631	4.12
Concrete products (blocks, brick, pipe, decorative, etc.)	202	904	4.48
Asphaltic concrete aggregates and other bituminous mixtures	715	2,415	3.38
Road base and coverings[1]	500	1,624	3.25
Fill	276	747	2.71
Snow and ice control	88	284	3.23
Railroad ballast	W	W	3.83
Other miscellaneous uses[2]	122	369	3.02
Unspecified:[3]			
Actual	42	121	2.88
Estimated	1,804	4,772	2.65
Total	9,024	26,457	2.93
Total[4 5]	8,186	26,457	3.23

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

Industrial.—Missouri ranked 14th among 38 States with industrial sand and gravel production. Industrial sand production was reported by All Purpose Sand Co., UNIMIN Corp., U.S. Silica Co., and Winter Brothers Material Co. operating four mines in Jefferson and St. Louis Counties. Production and value increased almost 11.5% and almost 9%, respectively, above totals reported in 1991. The material was transported by truck and rail from pits to plants.

Industrial sand was produced along the Meramec, Mississippi, and Missouri Rivers in the eastern part of the State and from the Ordovician St. Peter Sandstone. The principal use was as glass sand. Minor uses included abrasives, chemical uses, filter media, flux, roofing granules, and other special industrial purposes.

Stone.—Both crushed and dimension stone were produced in Missouri during 1992. Stone was the third leading industrial mineral produced, accounting for nearly 21% of the State's total nonfuel mineral value. Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Limestone and dolomite overlie more than 60% of the State. Igneous rocks, primarily felsite and granite, are exposed in the St. Francois Mountains of southeastern Missouri. Sandstone is widely distributed, but most deposits are thin and of low quality.

The utilization of a stone deposit is determined by the quality of the stone, demand, available transportation, and availability of the deposit. For some aggregate uses and for dimension stone, physical characteristics are significant. For some chemical and other specialized uses, chemical composition is important. If specific physical or chemical characteristics are not important, haulage distances, local demand, and availability are the determining factors.

Crushed.—The value of crushed stone production, estimated at $187.4 million, was nearly $20.2 million above that reported by industry in 1991. The State ranked sixth nationally in crushed stone production. Estimated production increased from 47.9 million short tons in 1991 to 52.2 million short tons in 1992.

Tower Rock Stone Co.'s Tower quarry, in Ste. Genevieve, was ranked the ninth largest crushed stone plant in the United States in 1992.[13] In 1991, the most recent year with a full-year industry canvass, principal producers included Ash Grove Cement, City Asphalt Co., Inc., Conco Quarries, and Fred Weber Inc. Crushed stone production in 1991 was reported by 117 companies operating 184 quarries in 67 of the State's 114 counties. Limestone, dolomite, granite, and traprock were produced. Three counties, Jefferson, Ste. Genevieve, and St. Louis, accounted for almost 30% of the total 1991 production. The State was fifth nationally in production of crushed limestone. Major crushed stone uses were for graded roadbase, concrete aggregate, railroad ballast, and riprap-jetty stone. Other uses included unpaved road surface, cement manufacture, bituminous aggregate, agricultural liming, and treatment of coal-fired plant stack gases to reduce sulfur dioxide emission.

Development continued in the use of mined out portions of underground limestone mines for office, storage, and manufacturing use. A number of mines already host secondary development, and several continued to be mined. Other companies were in various stages of evaluation, obtaining permits, and bringing their space into use. Abandoned quarries have been used for waste disposal, a lake development, an athletic field, and home sites.

A zoning request for a limestone quarry 2 miles northeast of Garden City, submitted by Limpus Quarries, Inc., was unanimously approved by Cass County in December. The company had been operating the quarry near its crusher and scale/office when it was discovered that

TABLE 3

MISSOURI: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[1]	169	683	(2)	(2)	—	—	986	3,146
Asphaltic concrete aggregates and road base materials[3]	84	287	(2)	(2)	(2)	(2)	333	1,159
Snow and ice control	12	40	5	21	(2)	(2)	51	155
Railroad ballast	—	—	—	—	—	—	—	—
Other miscellaneous uses[4]	—	—	—	—	—	—	—	—
Unspecified:[5]								
Actual	—	—	29	84	—	—	—	—
Estimated	250	636	13	40	700	1,846	62	255
Total[6]	514	1,645	230	783	732	1,927	1,432	4,715
Total[7 8]	466	1,645	209	783	664	1,927	1,299	4,715
	District 5		District 6		District 7		District 8	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[1]	3,524	9,813	(2)	(2)	269	824	386	1,117
Asphaltic concrete aggregates and road base materials[3]	439	1,518	79	186	219	684	262	725
Snow and ice control	W	W	(2)	(2)	(2)	(2)	W	W
Railroad ballast	W	W	—	—	(2)	(2)	—	—
Other miscellaneous uses[4]	15	116	—	—	—	—	106	279
Unspecified:[5]								
Actual	—	—	—	—	—	—	13	38
Estimated	188	334	225	692	83	182	284	788
Total[6]	4,167	11,781	311	942	587	1,717	1,052	2,947
Total[7 8]	3,780	11,781	282	942	533	1,717	954	2,947

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes plaster and gunite sands.
[2]Withheld to avoid disclosing company proprietary data; included with "Total."
[3]Includes fill and road and other stabilization (cement).
[4]Includes filtration.
[5]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[6]Data may not add to totals shown because of independent rounding.
[7]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[8]Total quantity and total value in thousand metric tons and thousand dollars.

the land was not properly zoned. The company will mine the 120-acre parcel in four phases, with each phase estimated to last 10 to 15 years.

West Lake Companies continued to divest its holdings, and in late 1992 sold the Grays Point crushed stone quarry, in Scott County, to Tower Rock Stone Co. Southeast Missouri Stone Co., Cape Girardeau, was sold to COLAF, a French company. The sale included properties in four States.

Controversy continued throughout the year over a permit request by Medusa Aggregates Co. to locate an asphalt and/or concrete plant at the limestone quarry it operates in Columbia, Boone County. Zoning conflicts and interpretation, along with objections raised by residents, were intertwined with a complicated mixture of land ownership and mineral rights on the property in question. Litigation was expected to continue in 1993.

Martin Marietta Aggregates Inc. acquired a 50% interest in Kaser Corp., of Des Moines, IA. Both companies produce limestone, agricultural lime, and sand and gravel.

Conco Quarries Inc. completed the construction of a new asphalt plant, in cooperation with Masters-Jackson, near its limestone quarry at Willard, Greene County. The plant was the largest in the State.

ISP Mineral Products quarried rhyolite, which it crushed for use as roofing granules, from its operation near Annapolis, Iron County.

Dimension.—Estimated production and value of dimension stone increased

nearly 10% in 1992. In 1991, two companies reported dimension stone production. Missouri Red Granite Quarries Inc., Iron County, mined granite, and Beavers Natural Stone Co., Camden County, mined sandstone. Both companies produced both rough and monument stone.

Missouri Red Granite Quarries Inc. operated a quarry on approximately 1,060 acres, about 4 miles north of Ironton, Iron County. Most of the granite was used for markers and monuments; some was used for buildings both in and out of State. Granite blocks were trucked from the quarry to Elberton, GA, and Mount Airy, NC. The blocks were fabricated, cut and polished, and made into monument stone, panels, small blocks, and other shapes. Finished pieces were trucked from North Carolina to St. Louis, MO, and other markets; more blocks were picked up from the quarry and trucked to North Carolina. The company attempted to interest the building industry in again using more "Missouri Red."

Stone, primarily granite and marble, was shipped into the State and fabricated into monuments and used for architectural applications.

Other Industrial Minerals.—Several industrial mineral commodities, produced in Missouri as byproducts of other industries or shipped into the State, either were sold as recovered or processed into higher value products.

Precipitated calcium carbonate was produced by Mississippi Lime Co. at its plant at Ste. Genevieve, Ste. Genevieve County.

A variety of gemstones, minerals, and fossils were collected by amateur collectors and professionals, both for private collections and for commercial sales. The materials were sold as specimens and formed into a variety of decorative items. Rock and mineral specimens included crystals of amethyst, barite, calcite, chalcopyrite, dolomite, galena, specular hematite, manganese, pyrite, quartz, and sphalerite. Ore minerals collected included calcite, chalcopyrite, copper, galena, iron, marcasite, nickel, silver, sphalerite, and tungsten. Also collected were agate, freshwater pearls, and quartz and calcite lined geodes.

Agate was collected by Spring Valley Rock Shop in Drury, Douglas County. Geodes were collected by Missouri Geodes in Alexandria, Clark County. Shell and freshwater pearls were collected by American Shell Co. and Tennessee Shell Co. from rivers and lakes in the State.

Lee Fertilizer in Camden Point, Platte County, produced fertilizer and transported it by barges and trucks to a variety of markets.

Olivine, mined in Norway by A/S Olivine, was shipped to New Orleans, transferred to barges and moved up the Mississippi River to St. Louis, and trucked about 70 miles to the Pea Ridge Iron Ore Co. Inc.'s pelletizing plant in Washington County. The olivine was used as a binder in making iron ore pellets.

Perlite was expanded by Georgia-Pacific Corp., at two plants in Cuba, Crawford County. The material was used primarily in concrete aggregate.

Slag, a byproduct of steelmaking, was processed by Heckett Div. of Harsco Corp. at a plant in Kansas City, Jackson County. The material was sold for use as a concrete aggregate, for fill, railroad ballast, and road base.

The Doe Run Co. produces synthetic sodium sulfate from its battery recycling facility at Boss, Dent County. The plant has a capacity to produce 9,000 metric tons of sodium sulfate per year.

Tripoli, a microcrystalline form of high-purity silica, occurs in deposits up to 12 feet thick in the Mississippian Boone formation. American Tripoli Inc., a subsidiary of NYCO Mineral and the Canadian Pacific Railroad, mined and processed tripoli quarried near Peoria, in Ottawa County, on the Oklahoma side of the border. The tripoli was transported to drying sheds at the company's mill in Seneca, Newton County, MO, to be crushed and processed. The processed material was used in buffing and polishing compounds, in concrete, and as a paint filler. The company spent $200,000 on improvements, including a new drying shed, and plans to install a new crusher next year.

Metals

A variety of metals were produced or refined in the State. The metals sector of Missouri's mineral industry accounted for about 37% of the 1992 mineral value.

Copper, Lead, Silver, and Zinc.—Missouri ranked first of 11 States producing lead, fourth of 9 States producing zinc, sixth of 12 States producing copper, and eighth of 18 silver-producing states in 1992. Reported production and value of lead decreased 14.6% and 10.5%, respectively, from 1991 reported values. Zinc production and value increased, 3.6% and 14.6%, respectively, from 1991 totals. Reported silver production and value decreased slightly, while copper production and value decreased substantially. Total value of lead produced in the State in 1992 was 300,589 metric tons valued at more than $232.6 million. This was 75.5% of U.S. production.

Royalties paid from mineral leases on Federal lands totaled more than $2.8 million in 1992: copper $362,721, lead $1,508,671, and zinc $975,017.[14]

Three lead and zinc mining districts in Missouri are the Southeast Missouri Lead district, which includes the Viburnum Trend and the Old Lead Belt; the Central Missouri district; and the Southwest district, which includes the Tri-State zinc-lead district of Kansas, Oklahoma, and Missouri. Copper and silver occur in the ore, but values vary.

Three nonferrous metal producers, The Doe Run Co., ASARCO Incorporated, and Cominco American Inc.-Dresser Industries, were active in the Southeast Missouri lead district. Lead was the primary metal mined; copper, silver, and zinc were recovered as byproducts during lead recovery. Mineralization occurred along the flanks of the St. Francois Mountains in the Cambrian Bonneterre Formation.

The top 10 lead-producing mines in the United States in 1992 included Doe Run's Fletcher, Buick, Casteel, and

Viburnum No. 29 mines, Asarco's West Fork and Sweetwater mines, and Cominco's Magmont mine. The mines are in Iron, Reynolds, and Washington Counties. These lead-producing mines also were among the top 25 leading zinc-producing mines in 1992. Doe Run's Casteel Mine, Iron County, was among the top 20 mines in the United States producing copper in 1992. Reynolds County led in the production and value of lead and zinc, followed by Iron and Washington Counties. Iron County reported the largest production and value of copper and silver, followed by Reynolds and Washington Counties.

Lead was used mainly for batteries. Other uses included ammunition, collapsible tubes, cable covering, caulking, solder, foil, pigments, plumbing, radiation shielding, and electronic equipment. Most lead used in batteries is later recovered and reused.

Zinc ores mined in Missouri were used for alloys, galvanizing, zinc oxide, and other metallurgical applications. Some zinc is processed at the American Zinc Co. smelter at Monsanto, IL, and at the AMAX Lead and Zinc Div. smelter at Blackwell, OK.

Copper is used in coins, electrical applications, brass manufacture, copper tubing, alloys, and for various chemical uses.

Silver is used in the manufacture of photographic materials, sterling silver, solder and brazing alloys, jewelry, optical goods, novelties, chemicals, various medicinal uses, and for dental amalgams.

Corporate restructuring continued as Asarco further consolidated its copper and lead-zinc operations nationwide. Lead mines in Missouri are integrated with the Glover smelter-refinery under the Missouri Lead Div. Asarco produced lead from its Sweetwater and West Fork mine and mill complexes.

Cominco American Inc. reduced production to about 60% of capacity and laid off 35 employees from the lead-zinc-copper mine and mill near Bixby, in Iron County. The cutbacks resulted from the depletion of ore reserves. Lead, zinc, and copper ore reserves at the mine were expected to be depleted within the next several years. The mine has produced more than 25 million tons of ore during 25 years of operation. The company continued planning for shutdown of the mine. Production was expected to continue through 1994.

After nearly 10 years of controversy aimed at blocking mining in Mark Twain National Forest, The Doe Run Co. was given clearance by the U.S. Forest Service in October to drill 20 exploratory holes for lead near Winona in southeastern Missouri. Drilling began in late 1992. In addition to the drilling controversy, the Teamsters union went on strike at the Herculaneum smelter in Jefferson County on July 30; the strike continued at yearend. The Fluor Corp. of Irvine, CA, owner of Doe Run, announced on November 30 the decision to sell Doe Run rather than shutting down. Doe Run has mines in Boss, Brushy Creek, Casteel, Fletcher, and Viburnum. It operates two smelters in Viburnum and one in Herculaneum, and a lead recycling plant near Boss. Operations continued as usual at yearend. Doe Run is North America's largest and only fully integrated producer of refined lead metal.

Laclede Steel Co. recovered zinc from electric arc furnace dusts, a product of steelmaking, at its plant in St. Louis, St. Louis County. The plant has a capacity to recover 6,000 metric tons of zinc per year.

For conducting injury-free worker operations in 1992, Asarco's West Fork lead mine and Doe Run's Viburnum No. 29 lead mine were runners-up for the 1992 Sentinels of Safety Award. The purpose of the program is to promote greater interest in safety and the development of more effective accident prevention programs through national recognition of operations.

Iron Ore and Iron Oxide Pigments.— Iron ore and crude and finished iron oxide pigments were produced in Missouri in 1992. Missouri ranked sixth of eight States producing iron ore in 1992. Pea Ridge Iron Ore. Co. Inc. reported production of iron ore from Washington County. Reported iron ore production decreased nearly 92% in 1992, while value increased more than 25%. Nationally steel production remained low as a result of the economic recession, but gradually increased throughout the year.

In 1992, the State ranked second of 5 States producing crude iron oxide pigments and third of 11 States producing finished iron oxide pigments. Production was from St. Louis and Washington Counties. St. Louis County produced synthetic black, brown, red, and yellow iron oxides from out-of-State source materials. Magnetite was produced from Washington County. Reported crude and finished iron oxide pigment production increased slightly in 1992.

Three types of iron ore deposits have been mined in Missouri: filled-sink hematite deposits, brown iron ore (limonite) deposits, and Precambrian hematite and magnetite deposits. Sink and limonite deposits are smaller, lower grade, and less uniform than the Precambrian deposits and therefore not as good for pellets. Precambrian iron ore deposits have been mined and prospected primarily in the southeastern part of the State, in the core area of the Ozark uplift in Iron County.

Pea Ridge Iron Ore Co., owned by Big River Minerals Corp. of Clayton, St. Louis County, was the Nation's only underground iron producer. The company produced specialty iron oxide products for use in coal preparation, ferritic magnet production, and chemical manufacturing, as well as olivine-enriched iron ore pellets for the steel industry, at its mine and processing facilities near Sullivan, Washington County. The pellet plant, the smallest of the Nation's 10 active pelletizing plants, temporarily closed in 1991 but production was expected to resume in 1993.

Heavy-media magnetite was recovered as a coproduct at the Pea Ridge plant. The magnetite was sold to coal washing plants. Sales of a product containing 69.7% iron and 0.21% silica for ferrite permanent magnet manufacture continued.

Pea Ridge produced both crude and finished iron oxide pigments from the Sullivan plant. Columbia Chemical Co.

produced finished pigments from a plant in St. Louis, St. Louis County. Pigment sales were for use in the manufacture of brake linings, electronics, magnetic printing inks, ceramic magnets, paint and coatings, color pigments, plastics, polishing compounds, rubber, and as a source of iron in glassmaking.

Other Metals.—Missouri ranked seventh of 14 States producing aluminum in 1992. Noranda Aluminum Inc., a subsidiary of Noranda Mines Ltd. of Toronto, Canada, operated the State's only aluminum reduction plant in New Madrid, New Madrid County. Bauxite was transported by barges along the Mississippi River from the Port of New Orleans to the 204,000-metric-ton plant. Primary aluminum and electrical conductors were produced.

Cyprus Minerals Co. shut down its Warrenton refinery for 5 days to allow the supply of copper scrap to catch up with production demands. Aggressive buying by China created a strain on the copper scrap market. The Warren County plant operated about 2 million pounds below capacity because of a shortage of scrap.

Armco Inc. operated its Midwestern Steel Div. at Kansas City, Jackson County. The facility produced carbon wire rods and grinding media.

Strontium metal and compounds, such as strontium chloride, were produced from strontium carbonate by Mallinkrodt Inc., St. Louis, St. Louis County.

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[1]State Mineral Officer, U.S. Bureau of Mines, Denver, CO. She has 15 years of mineral-related industry and government experience.

[2]Geologist, Missouri Department of Natural Resources, Division of Geology and Land Survey, Rolla, MO.

[3]Missouri Area Labor Trends, Dec. 1992 and Jan. 1993.

[4]U.S. Department of Labor, Mine Safety and Health Administration. Mine Injuries and Worktime, Quarterly, Jan.-Dec. 1992.

[5]Pay Dirt, Sept. 1992; Technology News, May 1992; U.S. Bureau of Mines, Minerals Today, Oct. 1992; U.S. Bureau of Mines, Research 93.

[6]Energy Information Administration. Weekly Coal Production, May 8, 1993.

[7]———. Coal Production 1990, Sept. 1991, and Coal Production 1991, Oct. 1992.

[8]National Coal Association. Facts About Coal, 1993.

[9]Energy Information Administration. Petroleum Supply Annual 1992, v. 1, 1993.

[10]———. Natural Gas Annual, Oct. 1993.

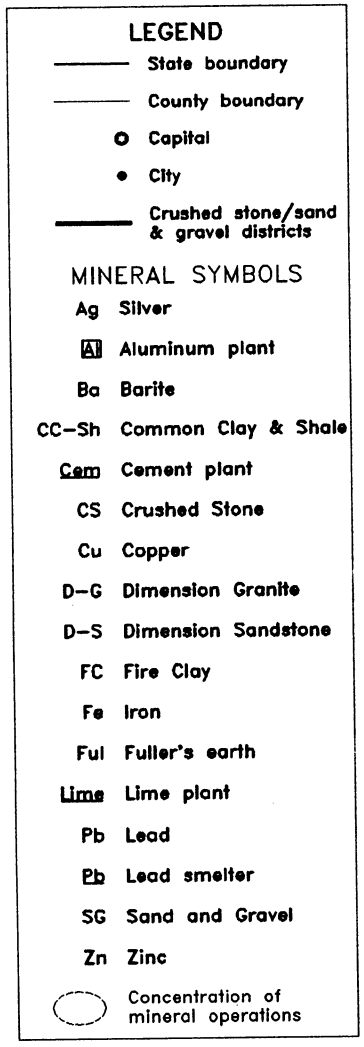
[11]Petroleum Information. Resume 1992.

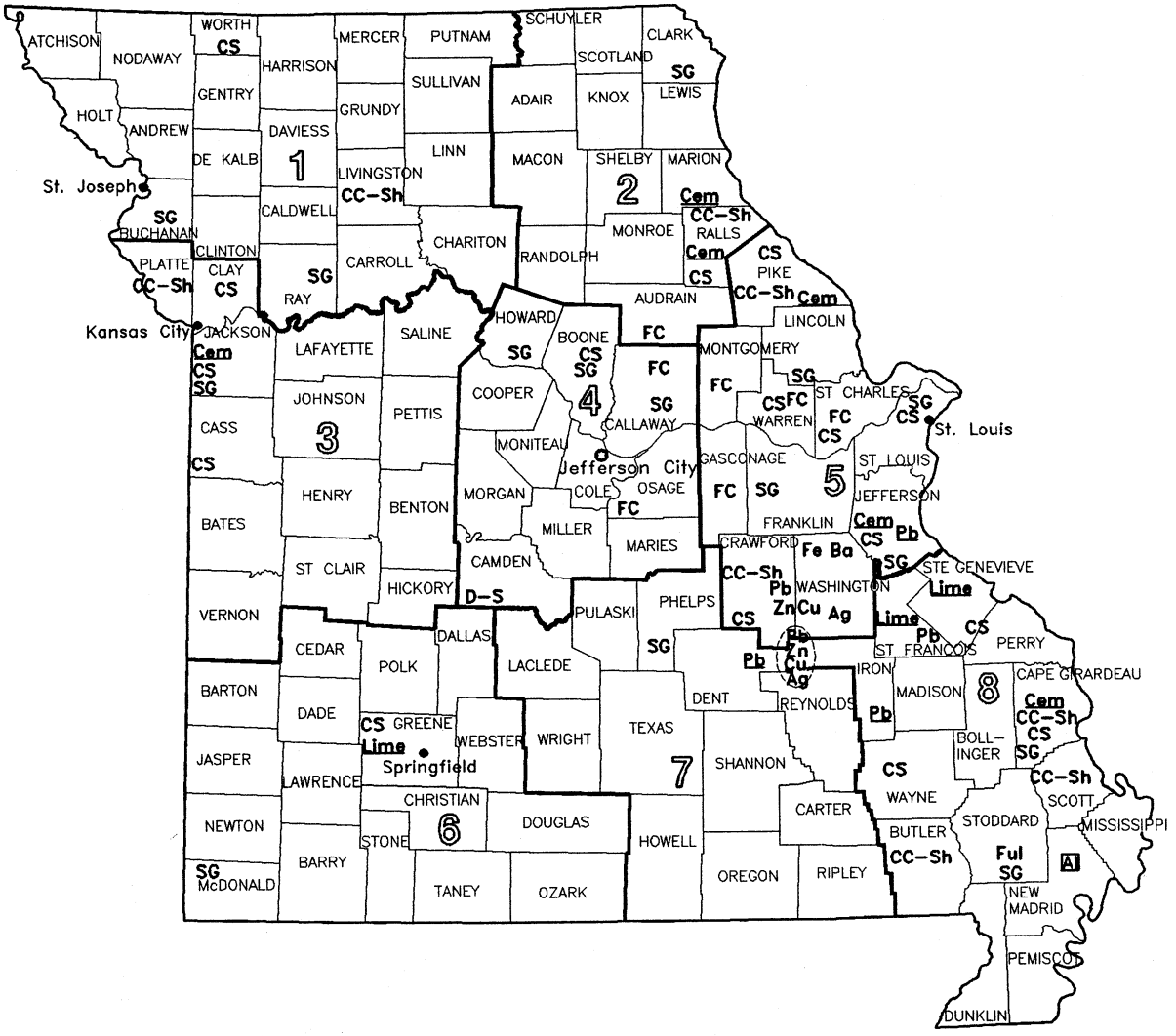
[12]U.S. Department of Commerce, Bureau of the Census. Permit Authorized Construction in Permit Issuing Places. Annual 1992.

[13]Rock Products, Oct. 1993.

[14]Minerals Management Service. Mineral Revenues 1992.

MISSOURI





Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Aluminum:			
Noranda Aluminum Inc., a subsidiary of Noranda Mines Ltd.	Box 70 New Madrid, MO 63869	Plant (smelter)	New Madrid.
Barite:			
Baroid Drilling Fluids Inc., NL Baroid Industries	Box 218 Potosi, MO 63664	Mine and plant	Washington.
Cement:			
Continental Cement Co.[1]	Box 71 Hannibal, MO 63401	Quarry, clay pit, plant	Marion and Ralls.
Holnam Inc., Dundee Cement Div., a subsidiary of Holderbank Financiere Glaris, Ltd.[2]	Box 67 Clarksville, MO 63336	Quarries and plants	Pike.
Lafarge Corp.[3]	Box 1017 Independence, MO 64051	Plant	Jackson.
Lone Star Industries Inc.[3]	Box 520, 25245 Spring St. Cape Girardeau, MO 63701	Quarry and plant	Cape Girardeau.
River Cement Co., a subsidiary of IFI International of Italy (Instituto Finanziario Industriale S.p.A.)[4]	Box 14545 St. Louis, MO 63178	do.	Jefferson.
Clays:			
Buildex Inc.	Route 1, Box 224 Dearborn, MO 64439	Pit and plant	Platte.
Golden Cat Corp.	Box 1086 Cape Girardeau, MO 63701	Pits and plants	Scott and Stoddard.
A. P. Green Industries Inc.	Green Blvd. Mexico, MO 65265	do.	Audrain, Gasconade, Osage.
Iron ore:			
Pea Ridge Iron Ore Co. Inc., a subsidiary of Fluor Corp.[5]	Route 4 Sullivan, MO 63080	Underground mine and plant	Washington.
Iron oxide pigments (finished):			
Columbian Chemicals Co.	Box 16309 Lemay, MO 63125	Plant	St. Louis.
Lead:			
Asarco Inc.:[6]	Route 1, Box 202C Bunker, MO 63629	Smelter, underground mine, plant	Iron and Reynolds.
Glover smelter	Box 7 Glover, MO 63646	Smelter	Iron.
Sweetwater Unit	Rural Branch Sweetwater, MO 63680	Underground mine and plant	Reynolds.
West Fork Unit	Route 1, Box 202C Bunker, MO 63629	do.	Do.
Cominco American Inc.-Dresser Industries:[6] Magmont Mine	Magmont Mine Rd. Bixby, MO 65439	do.	Iron.
The Doe Run Co.:[6]	11885 Lackland Rd. Suite 400 St. Louis, MO 63146	Underground mine, plant, smelter	Iron, Dent, Reynolds, Jefferson.
Brushy Creek	Box 158 Viburnum, MO 63629	Underground mine and plant	Iron.
Buick	Route KK Boss, MO 65440	Underground mine, plant, smelter	Dent.
Casteel (Viburnum #35)	Highway 32 Bixby, MO 65439	Underground mine	Iron.

See footnotes at end of the table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Lead—Continued:			
The Doe Run Co.—Continued:			
Fletcher	Box 257 Bunker, MO 63629	Underground mine and plant	Reynolds.
Herculaneum smelter	Main St. Herculaneum, MO 63048	Smelter	Jefferson.
Viburnum No. 28	Box 500, St. Joe Blvd. Viburnum, MO 65566	Underground mine and plant	Iron.
Viburnum No. 29	do.	do.	Do.
Lime:			
Ash Grove Cement Co.[3]	Route 3, Box 323 Springfield, MO 65804	Quarries and plant	Greene.
Mississippi Lime Co.	Drawer 31 Ste. Genevieve, MO 63670	Plant	Ste. Genevieve.
Resco Products Inc.	Box 440 Bonne Terre, MO 63628	Quarry and plant	St. Francois.
Perlite (expanded):			
Brouk Co.	1367 South Kingshighway Blvd. St. Louis, MO 63110	Plant	St. Louis.
Georgia-Pacific Corp.	Box N Cuba, MO 65453	do.	Crawford.
Sand and gravel:			
Construction:			
Holliday Sand & Gravel Co., a subsidiary of List & Clark Construction Co.	Box 12486 Kansas City, MO 64116	Dredges and plants	Clay.
Limited Leasing Co., a subsidiary of St. Charles Sand Co.	Route 1, Box 158 Hazelwood, MO 63042	do.	St. Louis.
Winter Bros. Material Co.	13098 Gravois Rd. St. Louis, MO 63127	Dredge and plant	Do.
Industrial:			
All Purpose Sand Co., a subsidiary of St. Charles Sand Co.[7]	Route 1, Box 158 Hazelwood, MO 63042	Pit and plant	Do.
UNIMIN Corp.[8]	1779 Horine Rd. Festus, MO 63028	do.	Do.
U.S. Silica Co.	Box 96 Pacific, MO 63069	Dredge and plant	Do.
Slag (iron and steel):			
Heckett Division of Harsco Corp.	Box 266309 Kansas City, MO 64126	Plant	Jackson.
Stone:			
Crushed:			
Granite:			
ISP Minerals Inc.[9]	Box 186 Annapolis, MD 63620	Quarry and plant	Iron.
Quality Aggregate Co.-Missouri Pacific Railroad	Box 307 Piedmont, MO 63957	do.	Wayne.
Limestone-Dolomite:			
Bussen Quarries Inc.[8]	5000 Bussen Rd. St. Louis, MO 63129	Quarries and plants	Jefferson and St. Louis.

See footnotes at end of the table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone—Continued:			
Crushed—Continued:			
Limestone-Dolomite—Continued:			
Hunt Midwest Mining Inc.	RR 13, 410 Randolph Rd. Randolph, MO 64161	Quarries	Clay and Platte.
Martin Marietta Aggregates	504 S. Hwy. 71, Box 269 Savannah, MO 64485	Quarries and plants	Andrew, Cass, Daviess, Gentry, Grundy, Harrison, Holt, Jackson, Mercer, Nodaway, Phelps, Worth.
Riverview Quarries Inc., J.H. Berra Construction Co.	Box 904 Florissant, MO 63032	Quarries	Jefferson, St. Francois, St. Louis.
Tower Rock Stone Co.	Box 111 Ste. Genevieve, MO 63670	Quarries and plant	Ste. Genevieve.
Fred Weber Inc.	Box 2501 Maryland Hts., MO 63043	Quarries and plants	Jefferson, St. Charles, St. Louis.
Traprock:			
Missouri Portable Stone Inc.	Box 449 Warrenton, MO 63383	Quarry	Franklin and Warren.
Dimension:			
Granite:			
Graniteville Stone Products Co.	301 South Main Ironton, MO 63650	do.	Iron.
Missouri Red Granite Quarries Inc.	HCR 63, Box 3371 Ironton, MO 63650	Quarry and plant	Do.
Sandstone:			
Beavers Natural Stone Co.	Box 322 Camdenton, MO 65020	do.	Camden.
Tripoli:			
American Tripoli Inc., a subsidiary of NYCO Mineral and Canadian Pacific Railroad[8]	Box 489 Seneca, MO 64865	Mill	Newton.
Vermiculite (exfoliated):			
Brouk Co.	1367 South Kingshighway Blvd. St. Louis, MO 63110	Plant	St. Louis.

[1]Also clay.
[2]Also clay and crushed limestone.
[3]Also crushed limestone.
[4]Also crushed limestone and crushed sandstone.
[5]Also crude iron oxide pigments.
[6]Also copper, silver, and zinc.
[7]Also construction sand and gravel.
[8]Also crushed sandstone.
[9]Also traprock.

THE MINERAL INDUSTRY OF MONTANA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Montana Bureau of Mines and Geology for collecting information on all nonfuel minerals.

By R. J. Minarik[1] and R. B. McCulloch[2]

Montana's 1992 nonfuel mineral production value was $539.2 million, a slight increase from that of 1991, according to the U.S. Bureau of Mines. Increases in the production value of lime, construction sand and gravel, and zinc more than offset the decrease in values of copper, gold, molybdenum, and silver.

Metallic minerals—copper, gold, iron ore, lead, molybdenum, platinum-group metals, silver, and zinc—accounted for 76% of Montana's total nonfuel mineral production value. The State ranked 20th nationally in value compared with 17th in 1991. Montana was the Nation's sole producer of platinum-group metals; it ranked first in talc production; third in barite, bentonite, and vermiculite; fourth in the output of copper, lead, and silver; and fifth in gold, phosphate rock, and zinc production.

TRENDS AND DEVELOPMENTS

Overall, metal mining activity remained relatively strong; the only significant drop in quantity produced was reported for molybdenum. On the other hand, prices for many of the metallic minerals produced in Montana remained depressed. In 1992, gold was the leading metal produced in terms of value, followed in order by copper, platinum-group metals, zinc, and silver.

A variety of industrial minerals was produced in the State. Their total production value increased more than 24% from that of 1991. In 1992, portland cement was the leading industrial mineral produced in terms of value, followed in order by construction sand and gravel, lime, and talc.

EMPLOYMENT

According to the Research and Analysis Bureau of the Montana

TABLE 1
NONFUEL MINERAL PRODUCTION IN MONTANA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	[2]29,741	[2]$193	362,635	$11,332	[2]35,368	[2]101
Gemstones		NA	3,692	NA	2,796	NA	674
Gold[3]	kilograms	13,012	161,861	r13,715	r160,197	13,994	155,210
Palladium metal	do.	5,930	21,735	6,050	16,923	6,470	18,097
Platinum metal	do.	1,810	27,176	1,730	20,635	1,840	21,060
Sand and gravel (construction)	thousand short tons	5,114	14,319	e4,800	e13,700	11,109	31,375
Silver[3]	metric tons	220	34,114	222	28,893	197	24,990
Stone (crushed)	thousand short tons	e4,000	e15,300	2,107	5,725	e2,200	e6,200
Talc and pyrophyllite	metric tons	430,125	18,883	W	W	407,657	16,162
Zinc[3]	do.	W	W	W	W	20,588	26,498
Combined value of barite, cement, clays [bentonite (1990, 1992)], copper, iron ore (usable), lead, lime, molybdenum, peat, phosphate rock, sand and gravel (industrial), stone (dimension), vermiculite, and values indicated by symbol W		XX	r276,021	XX	274,082	XX	238,787
Total		XX	r573,294	XX	r534,283	XX	539,154

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" figure.

[3]Recoverable content of ores, etc.

Department of Labor and Industry, overall mining employment, including petroleum and coal industry workers, dropped to 5,800, a decrease of 100 workers from that reported in 1991. Metal mining employment remained at 2,300 workers, unchanged from 1991. Average weekly earnings for Montana's mineral industry nonsupervisory personnel increased to $595 from the $594 figure recorded in 1991.

ENVIRONMENTAL ISSUES

Montana's two cement manufacturers applied for State and Federal permits to burn hazardous waste. Holnam Inc. proposed to burn hazardous waste at its cement plant at Trident, near Three Forks, and Ash Grove Cement West Inc. at its plant near Helena. A citizens group wants a moratorium on burning hazardous waste and laws passed to require a statewide vote before a company is allowed to import and burn such waste. Holnam said that cement plants cannot be compared with hazardous waste incinerators because the kilns would not burn the same chemicals as incinerators. Also, the higher temperatures of the cement kilns are more effective in destroying chemicals.

A number of mining companies have applied to the Montana Department of Health for exemption to the State's water nondegradation regulations. Included were the Stillwater Mining Co. at its Stillwater platinum-palladium properties and Noranda at its proposed Montanore project. State law forbids any water discharge that would lower the quality of a stream. An exemption would allow a mining company to discharge into State waters as long as the water retained or exceeded all Federal and State water quality standards.

Cleanup continued in the Anaconda and Silver Bow Creek/Butte areas of the Clark Fork Superfund site, Deer Lodge County. At the Anaconda smelter complex, two repositories were constructed on Smelter Hill. Process waste from the Arbiter refining facility was removed and taken to one of the repositories. The solids, sludge, and water had been stored in two ponds and four concrete bunkers east of the plant. Owing to the wet nature of the material, dry contaminated tailings from the Old Works tailings pond, adjacent to Warm Springs Creek, were mixed and hauled with the sludge. Beryllium wastes from the Opportunity Ponds and Weather Hill areas were removed. The contaminants were encased in specially designed hazardous material boxes, then sealed in the other repository. At the Old Works site, three retention basins were constructed to intercept storm flow and prevent erosion into the creek. Work continued on cleaning up the Warm Springs Ponds section of Silver Bow Creek. Contamination of the ponds was the result of decades of mining, milling, and smelting waste being dumped into Silver Bow Creek. The Anaconda Co. built a series of three tailings dams to prevent waste from entering the Clark Fork drainage. During periods of high water, the creek was allowed to flow around the ponds down the Mill-Willow bypass; this practice no longer is allowed. Work at Warm Springs included reconstruction of the upper third of the bypass, including its preparation as a fish habitat, construction of wet closure cells to increase water retention times, the building of a weather monitoring station, and a new computerized water-treatment facility.

EXPLORATION ACTIVITIES

According to the Montana Bureau of Mines and Geology (MBMG), there was a significant downturn in mineral exploration activity in 1992, by as much as 50%. Much of it was confined to later-stage projects and the reclamation of previous activities. The primary exploration targets continued to be gold and other precious metals; however, some interest was directed to massive sulfide deposits of copper, lead, and zinc. The U.S. Bureau of Land Management (BLM) reported the filing of 5,718 new mining claims in the State, compared with 5,745 in 1991, 6,692 in 1990, and 13,084 in 1989. The total number of active claims was estimated at 67,114. There were two land patents granted in 1992; they included seven claims and covered a total of 121.77 acres. According to the Montana Department of State Lands, there were 433 active exploration projects, compared with 845 in 1991 and 1,000 in 1989. Many were those in a reclaiming stage, and the majority consisted of private individuals expending time rather than money on properties.

In the northwest region, south of Libby, Bruce Switzer sunk a shaft in search of gold in the Flower Creek drainage. After entering into an option agreement with Orvana Resources Co., Pegasus Gold Inc. explored and drilled Orvana's Libby Gold (Lukens-Hazel) project between Flower and Granite Creeks. Reportedly, Pegasus may acquire up to 70% of the property through exploration expenditures prior to September 1995. The property is 4 miles from Libby and is considered ideally suited for heap leaching. Kennecott Exploration Inc. drilled for copper and silver near the Snowshoe Mine. Bulk sampling in search of gold was done by George Shaw on his Raven claim in the Snowshoe drainage, by Bill Ericksmoen on the Blacktail project in Bramlet Creek, and by Gwen Bakie on her Merril property in the West Fisher drainage. Hard Rock Mining Co. drove an adit near lower Houghton Creek. In the Trout Creek area, ASARCO Incorporated (Asarco) did assessment work in both the Trout Creek drainage and the Miners Gulch drainage on the Vermillion River. In search of base metals, Jon Sonju reopened adits on Glidden and Cherry Creeks, near Thompson Falls. Leroy Haun drilled and reopened an adit on the Riverside property. East of Missoula, Pegasus Gold continued its drilling program in the Garnet Range, identifying six small ore bodies. Mountain Minerals Co. drilled at its Coloma barite property. South of Bearmouth, FMC Gold drilled for gold in Brewster Creek on its Sliderock project, in Stony Creek, and on its Schively Ridge project in Juneau Gulch. Cyprus Metals drilled and trenched for gold in volcanic deposits on Basin Gulch. South of Darby, Pegasus Gold drilled in the Blue Joint Wilderness

Area. South of Philipsburg, Comeco U.S. Inc. drilled on its Londonderry project. In the Georgetown Lake area, Asarco drilled the Southern Cross property after optioning it from North Lilly Mining Co.; Pegasus Gold continued to drill its Hidden Lake, Northern Cross, and Robinson properties; Magellan Resources drilled the Golden Eagle property in the Red Lion district; and Cable Mountain Mines drilled on the Holiday claims on the north fork of Flint Creek. On upper Gold Creek, Blue Ribbon Resources drilled and trenched for gold. East of Deer Lodge, Hecla drilled in the Emery district. South of Elliston, Pegasus Gold drilled on its O'Keefe project in Telegraph Creek and its Clemmar Gulch project in Clemmar-Mary Ann Creek. North of Elliston, American Copper and Nickel drilled for copper and gold on the south side of Ophir Creek.

In the Helena region, the joint venture of Canyon Resources Corp. and Phelps Dodge Corp. began permitting work at its Seven-Up Pete project, which includes the Seven-Up Pete and McDonald prospects, a 44-square-mile land package east of Lincoln. Estimated reserves of the sizable McDonald deposit are 270 million metric tons at 0.73 kilogram gold per ton; Seven-Up Pete is the smaller of the two. Elsewhere in the region, Asarco continued assessment of its Heddleston property; Leigh Freeman drilled on the Black Butte project in the Little Whitetail drainage; and Golden Sunlight Exploration drilled in the Bull Mountains. In the Elkhorn Mountains west of Townsend, Pegasus Gold sampled the Diamond Hill Mine, Virgil Sells drove an adit on the Indian Creek property, United Minerals drilled at the Graphite Mine in the Indian Creek drainage, and Goldfields maintained a drilling program on the Elkhorn and East Fork Sourdough Creeks. Northeast of White Sulfur Springs, Cominco American Resources Ltd. continued exploration of the Sheep Creek property and Kennecott/BHP Utah International did geologic and geophysical work in the Checkerboard area, both massive sulfide deposits. Pegasus constructed drill pads on its Jack Creek Ridge project on Basin Creek, conducted exploration at Miller Mountain between Greenhorn Creek and Vermont Gulch, and in a joint effort with Earthworks Inc. drilled the Silver State project on Cataract Creek north of Basin.

In the Butte region, Magellan Resources drilled and trenched its Southern Cross property west of Anaconda, Deer Lodge County. The property later was optioned by Asarco. In the Tobacco Root Mountains of Madison County, underground exploration was done by Pathfinder Gold and Teck Resources at the Boss Tweed, Clipper, and Mammoth properties; by Golden Chalice Mines near Sheridan; FMC drilled its Arbeide project on Bevins Creek; and Kennecott explored and did underground drifting at the Kearsarge and other Alder Gulch properties near Virginia City.

In the southwest region, exploration and permitting continued at the New World property by the joint venture of Noranda Exploration Inc. and Crown Butte Resources Inc. Activity included drilling, geotechnical evaluation, and reclamation research. The venture finished the "completeness" review and was expected to submit a draft Environmental Impact Statement (EIS) in July 1993. The property, in the Beartooth Mountains near Cooke City, Park County, includes an underground reserve and two smaller open-pitable deposits of gold, with associated copper and silver. Reportedly, 88% of the project's gold and 76% of the tonnage are classified as underground. At this time, the joint venture plans only to mine underground and has eliminated the use of cyanide in its mill. It expects a 97% recovery rate, using gravity and flotation methods only. Reclamation of environmental damage from previous mining activity continued. Crown Butte Mines received the U.S. Forest Service (USFS) Northern Regional Forester's Excellence Award for outstanding environmental protection for its recent exploration practices at the proposed mine site.

Also in the southwest, Fisher-Watt Gold optioned its Emigrant property, a gold-silver-copper prospect, to Pegasus Gold, which proceeded to explore the gold-bearing breccia pipe; Harrison Western Corp. maintained a placer drilling program south of Pegasus's property on Emigrant Creek; and C.R. Conn Exploration drilled for chrome and base metals in the Stillwater Complex. In the north-central region, CR Kendall Corp. and Coeur d'Alene Mines Inc. explored in the Judith Mountains. The Giltedge properties, as well as the New Year Mine, were drilled. Manhattan Minerals (U.S.) Ltd. was seeking permission to explore for gold and silver in the Tootsie Creek drainage on East Butte, in the Sweet Grass Hills, Liberty County. An environmental assessment was completed in mid-1992 and an EIS was being prepared.

LEGISLATION AND GOVERNMENT PROGRAMS

The Montana College of Mineral Science & Technology, Butte, received an allotment of $16,000 from the U.S. Bureau of Mines in 1992. The school has received a total of $3.14 million since inception of the Mineral Institute Program in 1978.

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Aluminum.—The quantity and value of aluminum produced in Montana remained essentially unchanged from that of 1991. Columbia Falls Aluminum Co., the State's sole aluminum producer, reportedly operated its Flathead County reduction plant near its annual rated capacity of 168,000 metric tons.[3]

Antimony.—United States Antimony Corp. produced antimony oxide and sodium antimonate for use in the glass industry at its refinery on Prospect Creek, about 29 kilometers southwest of Thompson Falls, Sanders County. Antimony metal and sulfide concentrates were purchased on contract from China.

Copper.—Copper production decreased 4% in quantity and almost 6% in value from that of 1991. The Continental Pit in Butte, Silver Bow County, was the State's leading copper producer and ranked 13th in the Nation. The joint venture of Montana Resources Inc. (MRI) and Asarco, with MRI the operator, also produced molybdenum and silver. According to MBMG, production remained at 43,500 metric tons per day with a stripping ratio of 0.7:1. The operation pushed back the north wall, and because the pit has bottomed out on the south end, backfilling of that portion was done. The bulk of the copper concentrates was shipped to Asarco's facilities in Arizona and Texas.

In Lincoln County, Asarco operated its Troy Unit, the second largest copper producer in the State and the 16th largest in the Nation. A room-and-pillar mining method was used to extract ore from the 7,700-metric-ton-per-day copper-silver mine. In an effort to increase productivity, the mine was operated on 12-hour shifts for 3 1/2 days, with 3 1/2 days off. Exploration in the Ross Creek drainage area basically ceased when the U.S Fish and Wildlife Service (USFWS) determined that the company's surface drilling and portal excavations exceeded acceptable levels of activity for Grizzly bear habitat and denied a request for permits.

Gold.—Gold production in Montana increased 2% in quantity but dropped 3% in value from that of 1991. Production was reported from nine lode mines in six counties.

The Zortman-Landusky Mine, owned by Pegasus, was the State's largest gold producer and ranked 24th in the Nation; silver was produced as a byproduct. The Zortman and Landusky deposits are approximately 3 miles apart on either side of Antoine Butte in the Little Rocky Mountains, just south of the southern border of the Fort Belknap Indian Reservation, Phillips County. The mine is a conventional open pit, heap-leach operation, except that the ore does not require additional milling after blasting and can be processed as run-of-mine material. After ceasing the use of a contract mining company, 1992 was the first full year all mining activities on the property were handled by Pegasus employees. In 1992, mining was done principally on the Landusky side, with the continued loading of the Sullivan Park pad. Although the oxide ore on the Zortman side was nearly exhausted, production from leaching continued. Pegasus did preliminary engineering work and sought regulatory approval to mine the sulfide portion of the Zortman ore body. The project includes construction of a crushing circuit, a new leach pad, and a conveyer system that will allow the company to process harder non-oxide ore on the flats.

Placer Dome operated the Golden Sunlight Mine, Montana's 2d ranked gold producer and the 25th largest in the Nation. Sited near Whitehall, Jefferson County, the open pit mine also produced byproduct silver. Processing included agitated vat leach with carbon-in-pulp recovery. Golden Sunlight had a decline in production owing to the mining of a lower grade transitional zone and the complex metallurgy of the ore. The earth work and liner for a new tailings facility were finished. Two years after a permit was approved allowing the mine's continued operation—a permit that was reviewed for 28 months and includes a reclamation bond of $25 million that will eventually reach $38 million—five environmental groups sued Placer Dome and the Montana Department of State Lands, claiming unlawful granting of the permit.

Pegasus produced gold at its Montana Tunnels polymetallic mine 25 miles south of Helena, Jefferson County. The large-tonnage, low-grade deposit produced significant quantities of base metals employing a conventional milling circuit. Pegasus discontinued the use of contract miners at Montana Tunnels, with 1992 being the first full year that all mining activities were done in-house. A new gravity circuit was installed to recover free gold. Because this gold was previously lost to the tailings pond, overall gold recovery was significantly increased and operating costs lowered. Lead concentrate, with the bulk of the precious metals, was trucked to Asarco's smelter at East Helena; the zinc concentrate was sent by rail to the Cominco smelter at Trail, British Columbia, Canada.

Gold and silver were produced by Canyon Resources from its C.R. Kendall Mine in the North Moccasin mountains of Fergus County. The company continued construction of a new "life of mine" leach pad, expanded its processing facilities, added a new storm drainage pond, and was seeking permission to mine its final ore body. Reclamation was done on waste slopes, roads, and in the pit areas. Exploration for additional ore bodies was done both near the mine and in the nearby Judith Mountains.

Pegasus operated the Beal Mountain Mine in German Gulch near Anaconda, Silver Bow County. The open pit, heap-leach operation produced silver as a byproduct. Construction of a new leach pad area was completed, and the company doubled the capacity of its treatment plant. A new permanent crushing system was installed, replacing the portable crushing plant that was insufficient in treating the increasing amounts of harder ore found at depth. Pegasus was in the process of permitting an expansion to encompass newly discovered ore from two small pits on the south side of German Gulch. Work included the preparation of an EIS. The proposed pits would be mined in one operating season and backfilled with waste from the main Beal pit. The company wants to amend its operating permit to extend a haul road from the pits to the heap-leach pads, all within the company's current mine permit area. Pegasus received permission to explore the east slope of Beal Hill, east of the main Beal pit and south of the proposed South Beal pit.

The Mineral Hill underground mine, operated by TVX Gold Inc., a joint venture of American Copper & Nickel Co. and Homestake Mining Co., produced gold near Jardine, Park County. In an effort to maintain the zero discharge design of the surface milling and recovery

facilities, the mine deposited dry tailings, the only one in the State to do so. Processing included vat leaching, followed by Merrill-Crowe zinc precipitation. After completion of a tailings liner expansion, reclamation of the first tailings cell was initiated. Also, a land exchange with the USFS was completed in which 5 acres of its tailings facility was traded for undisturbed acreage on the property. Exploration of the surrounding area continued. After a successful drill program, TVX Gold applied for a permit to mine a new ore body in the Crevise District about 3 kilometers south of the Mineral Hill Mine. The ore would be trucked to the existing mill at the mine site.

At Basin Creek, Pegasus conducted tests on possible heap-leach production on a seasonal basis, using run-of-mine ore. According to MBMG, the company mined between 13,600 to 18,100 metric tons of ore and placed it on a pad for bulk testing. Sited about 18 miles southwest of Helena, Pegasus bought the property from Pangea Resources Ltd. in 1989, built a leach pad, and enlarged the operation. Although the company suspended mining in 1990 owing to lower than anticipated ore grades and low prices, Pegasus continued leaching operations.

Additional lode gold production was reported by Asarco from its Troy Unit, a copper-silver mine near Troy, and from MRI's Continental copper mine.

According to MBMG, placer gold production occurred at several localities. Some of the larger known placer operations were on the Vermillion River in Sanders County; Mattie V, McCormick, and Quartz Creeks in Mineral County; on Hughs Creek southwest of Darby in Ravalli County; on Elk Creek east of Missoula; in Granite County, in Day Gulch and on Deep Creek; in Beaverhead County, between the Nugget and Pioneer drainages southwest of Wisdom, and east of Bannack; in Lincoln Gulch and on Sauerkraut Creek near Lincoln, Lewis and Clark County; on Avalanche Creek and Vermont Gulch east of Helena; and on Indian Creek, Broadwater County.

Iron Ore.—Iron ore was produced by Hallet Minerals Co. at its Black Butte Mine near White Sulfur Springs, Meagher County. The product was used in Montana in the manufacture of cement.

Lead.—Lead production decreased more than 3% in quantity, but rose slightly in value from that of 1991. The Montana Tunnels Mine, Pegasus Gold's polymetallic operation near Helena, accounted for the bulk of the production. The mine ranked 11th in the Nation for lead production. Asarco's Troy Unit, Montana's 2d largest lead-producing mine, ranked 15th nationally.

Molybdenum.—The quantity of molybdenum produced decreased both in quantity and value from that of 1991. Molybdenum was recovered as a byproduct of copper production at MRI's Continental Pit in Butte. The Silver Bow County mine was the State's sole molybdenum producer. Concentrates were shipped to both domestic and foreign facilities for processing.

Platinum-Group Metals.—Platinum-group metal production increased almost 7% in quantity and more than 4% in value from that of 1991. The Stillwater Mining Co. operated the Nation's only platinum-group metals mine in the Stillwater Complex, near Nye, Stillwater County. The mill concentrate was processed at the company's smelter, about 40 miles away in Columbus. The palladium-platinum matte, which also contained copper, gold, nickel, and rhodium, was shipped to Belgium for additional processing. The company continued with preparation of an EIS that would allow it to essentially double its current mine production and petitioned the State Board of Health to grant an exemption under a law that prevents degradation of State water. If granted, the company still would not be allowed to exceed State water-quality standards. Also, the company completed a final EIS to build a new mine, its East Boulder project, south of Big Timber, Sweet Grass County; the mine would provide additional concentrates for the Columbus facility. Stillwater Mining is a joint venture of Manville Corp. and Chevron Resources Co. Late in 1992, Manville exercised an option and took over management of the company; Chevron's portion was for sale.

Silver.—Silver production decreased more than 11% in quantity and almost 14% in value from that of 1991. Output was reported from nine mines in six counties.

Asarco's Troy Unit was the State's largest silver producer and the fifth ranked silver-producing mine in the Nation. The 7,700-metric-ton-per-day underground copper-silver mine is in Lincoln County near Libby. Pegasus's Montana Tunnels Mine was the State's 2d largest silver-producing mine and was ranked 12th in the Nation. Ranking 3d in the State, MRI's Continental copper mine in Butte was the Nation's 16th largest silver-producing mine. Pegasus's Zortman-Landusky gold mine in the Little Rockies, Phillips County, ranked 4th in the State and 19th in the Nation for silver production.

The Black Pine Mine northwest of Philipsburg, Granite County, continued producing flux for Asarco's East Helena lead smelter. Production commenced in the Tim Smith vein at 900 metric tons per month. According to MBMG, the mixed sulfide and oxide copper ore averaged 340 to 480 grams of silver per metric ton. The ore was crushed at the Contact mill south of Philipsburg and trucked to East Helena.

At the Montanore project, a massive silver-copper prospect in the Cabinet Mountains southeast of Libby, Lincoln County, Noranda completed both its draft and final EIS's. The mine received an air quality permit, a water-quality variance, and an operating permit from the State. Final operating permits from the USFS are expected in July 1993. The USFWS continued its request that Noranda purchase a large block of land for Grizzly bear habitat. Work was voluntarily halted at the Montanore project in 1991, the result of a perceived violation of Montana's water

nondegradation policy. At the time of the work stoppage, a 4,900-meter development decline was nearing completion. The property is owned by the joint venture of Noranda, 55%, and Montana Reserves Co., 45%. Montana Reserves reportedly was having cash-flow problems and was attempting to sell its share.

Zinc.—Zinc production increased in both quantity and value from that of 1991. Pegasus's Montana Tunnels polymetallic mine near Helena, Jefferson County, accounted for the bulk of the State's zinc production. The zinc concentrates were sent to Cominco's smelter at Trail, British Columbia, and also to Dowa Mining Corp. in Japan; the lead concentrates, which contain most of the precious metals, were processed at the Asarco smelter in East Helena.

Industrial Minerals

Barite.—Rocky Mountain Minerals Co. (Dillon Exploration Inc.) mined barite at its Elk Creek underground mine east of Missoula in the Garnet Range, Missoula County. Mined concentrate and previously stockpiled material were shipped for further processing to the company's mill at Lethbridge, Alberta, Canada. The company was in the process of acquiring the necessary permits to reopen the nearby Coloma underground property.

Cement.—The quantity of cement produced in Montana decreased almost 10% in quantity, but rose more than 7% in value from that estimated in 1991. Portland cement was produced by Holnam Inc. at Trident, Gallatin County, and by Ash Grove Cement West Inc. at Montana City, Jefferson County; both companies also sold small amounts of masonry cement.

The bulk of the cement sold was general use, moderate heat Types I and II gray portland cement. Lesser amounts of oil well, Type III high early strength, and Type V high sulfate resistant also were sold. Users of portland cement produced in the State included building material dealers, concrete product manufacturers, government agencies, highway contractors, and ready-mixed concrete companies. Raw materials consumed in cement manufacture were locally mined clay, iron ore, limestone, sandstone, silica, and Wyoming gypsum. Both of the one-kiln wet-process plants used natural gas and coal for fuel and purchased electricity for energy.

Chlorite.—High-purity chlorite was mined by Luzenac America Inc. at its Golden Antler open pit mine near Silver Star, Madison County. The company developed a stripping program and expanded its reserve base through exploration in Cottonwood Canyon. The chlorite was sold for many of the same industrial applications in which talc was used.

Clays.—Clay production decreased in both quantity and value from that of 1991. The bulk of the State's clay production was bentonite. Two companies in Carter County produced swelling-type bentonite; a small amount of nonswelling bentonite also was produced in Carbon County. Uses for bentonite included animal feed supplement, drilling mud, foundry sand, and waterproof sealant. Four companies reported common clay production in Gallatin and Jefferson Counties. Common clay was used in the manufacture of cement, concrete block, and pottery.

Gemstones.—The value of gemstone production decreased from that of 1991. Several sapphire mines continued both commercial and hobbyist production, with some production targeted for international sales.

Near Skalkaho Pass, west of Philipsburg in Granite County, the Gem Mountain Sapphire Mine operated on the West Fork of Rock Creek. The mine produced bulk concentrate, as well as cut stones, for over-the-counter sales. Recreational activities included prescreened buckets of dirt ready for sorting by customers. Adjacent to Gem Mountain, a new floating wash plant remained idle at the Skalkaho Grazing Association Sapphire Mine.

East of Helena in Lewis and Clark County, sapphires were produced at French Bar and Spokane Bar. Both facilities sold washed concentrates, but did not allow fee digging. Nearby, Lovestone Mining continued commercial production of concentrates on a contract basis. Northeast of Helena, Eldorado Bar had two operations; one was strictly recreational and was the only mine in the State to allow fee digging, while the other included commercially processed gravel and the production of sapphire concentrates. At the famous Yogo Dike in Judith Basin County, Roncor Inc. and Vortex Mining Co. operated sapphire mines. Roncor processed sapphire-bearing material from the Yogo Dike and ran old tailings from the American Mine through its washing plant. Vortex continued to explore at depth a split off the main dike system of a sapphire-bearing breccia south of the American Mine.

Cominco American Resources received the necessary permits to begin mining for garnets in Alder Gulch dredge gravels between Virginia City and Alder in Madison County. Production was expected to start shortly after payment of a reclamation bond.

Lime.—Lime production increased 61% in quantity and more than 79% in value from that of 1991. After completing an expansion in 1991, which essentially doubled its capacity, Continental Lime Inc., a subsidiary of Graymount Inc., operated the Indian Creek quicklime facility near Townsend, Broadwater County, throughout 1992. Also, Great Western Sugar Co. operated a plant in Billings, Yellowstone County, and Holly Sugar Corp. produced quicklime at its plant in Richland County. The lime was mined by Montana Limestone Co. at the Warren quarry south of Billings in Carbon County.

Peat.—Montana peat production decreased both in quantity and value from

TABLE 2
MONTANA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	1,076	$5,494	$5.11
Plaster and gunite sands	2	3	1.50
Concrete products (blocks, brick, pipe, decorative, etc.)	(1)	1	5.00
Asphaltic concrete aggregates and other bituminous mixtures	1,940	7,376	3.80
Road base and coverings[2]	4,983	11,652	2.34
Fill	1,424	2,511	1.76
Snow and ice control	151	542	3.59
Railroad ballast	W	W	3.00
Other miscellaneous uses[3]	233	628	2.70
Unspecified:[4]			
Actual	312	835	2.68
Estimated	989	2,333	2.36
Total	[5]11,109	31,375	2.82
Total[6 7]	10,078	31,375	3.11

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses.
[1]Less than 1/2 unit.
[2]Includes road and other stabilization (cement).
[3]Includes filtration.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data do not add to total shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value in thousand metric tons and thousand dollars.

that of 1991. Bulk peat production was reported by Martin's Peat Inc. at Swan Lake, Lake County.

Phosphate Rock.—The production of phosphate rock increased both in quantity and value from that of 1991. Cominco produced phosphate rock at its Warm Springs Creek operation in Powell County, the last underground phosphate mine in the Nation. The phosphate was shipped by rail to Cominco's fertilizer plant at Warfield, British Columbia, Canada. There, the phosphate was mixed with sulfuric acid from the company's zinc smelter at nearby Trail and was used to make phosphoric acid and other phosphate-base products. Owing to production problems at the company's Trail facility, the mine was closed for 2 weeks in June and 3 weeks in September.

Rhône-Poulenc Chemical Co.'s Silver Bow elemental phosphorous plant, west of Butte, operated at capacity. The plant processed phosphate rock from the company's Rasmussen Ridge Mine in southeastern Idaho.

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991. The quantity and value of sand and gravel produced more than doubled from that estimated in 1991 and from that surveyed in 1990.

Montana construction sand and gravel statistics are compiled by geographical districts as depicted on the State map. Table 3 presents end-use data for the State's two districts. Major producing counties included Cascade, Flathead, Gallatin, Missoula, and Yellowstone. Major uses included road base and coverings, including stabilization (45%); asphaltic concrete aggregates and other bituminous mixtures (17%); fill (13%); and concrete aggregates, including concrete sand (10%).

Industrial.—Production of industrial sand and gravel increased by about one-third in quantity and value from that of 1991. Output was reported by Rhône-Poulenc Chemical from the Maiden Rock Quarry, Beaverhead County. The product was used for flux at the company's Silver Bow elemental phosphorous plant.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains actual data for 1991 and estimates for 1990 and 1992.

Crushed.—The estimated production of crushed stone in 1992 increased more than 4% in quantity and more than 8% in value from that surveyed in 1991. Some of the larger producing counties included Gallatin, Jefferson, and Yellowstone. The bulk of the crushed stone produced was limestone. A major use was in the manufacture of cement.

Dimension.—The Livingston Marble & Granite Works mined travertine building stone from a quarry north of Gardiner, Park County. The company marketed the product as ashlar, cut stone, and rubble from its plant at Livingston.

Sulfur.—Montana Sulphur & Chemical Co. and the Farmers Union Central Exchange recovered sulfur as a byproduct from petroleum refining near Laurel, Yellowstone County. Montana Sulphur & Chemical completed construction of a new ammonium thiosulfate unit, a small hydrogen plant, and other changes at its chemical and fertilizer complex in Lockwood, outside Billings.

Talc.—Talc production increased both in quantity and value from that of 1991. Three companies produced talc from four

TABLE 3

MONTANA:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2	
	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	747	4,044	329	1,450
Plaster and gunite sands	2	3	—	—
Concrete products (blocks, brick, etc.)	(2)	1	—	—
Asphaltic concrete aggregates and other bituminous mixtures	812	4,319	823	2,345
Road base and coverings[3]	2,391	6,057	2,379	5,168
Fill	768	1,447	652	1,056
Snow and ice control	W	W	W	W
Railroad ballast	(2)	(2)	—	—
Other miscellaneous uses[4]	313	838	4	20
Unspecified:[5]				
Actual	312	835	—	—
Estimated	376	1,099	613	1,233
Total[6]	5,721	18,645	4,801	11,272
Total[7 8]	5,190	18,645	4,355	11,272

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses.

[1]Excludes 587,462 short tons valued at $1,459,261, not reported by county.

[2]Less than 1/2 unit.

[3]Includes road and other stabilization (cement).

[4]Includes filtration.

[5]Includes production reported without a breakdown by end use and estimates for nonrespondents.

[6]Data may not add to totals shown because of independent rounding.

[7]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.

[8]Total quantity and total value in thousand metric tons and thousand dollars.

mines in Madison County.

Cyprus Industrial Minerals was sold to Rio Tinto Zinc, who then assigned and reorganized its American operations into Luzenac America Inc. Luzenac produced talc at its Beaverhead and Yellowstone Mines. At the Yellowstone Mine south of Ennis, the company continued to increase its reserve base, including development of a new ore body. Production at the Beaverhead underground mine, east of Dillon, included cosmetic talc. Luzenac utilized an underhand mining method with cement backfill of borrow material. At the Treasure Chest Mine south of Dillon, Barretts Minerals Inc. operated a fully automated talc beneficiation plant that utilized wet grinding and flotation technology. Barretts Minerals, a subsidiary of Mineral Technologies Inc., is 40% owned by Pfizer Inc. The company was preparing to expand production to the nearby Regal property. Sharing a common high wall with Luzenac's Yellowstone open pit south of Ennis, Montana Talc Co., a division of Costain Minerals Inc., operated its Johnny Gulch Mine. Production from the mine was processed at the company's Sappington plant near Three Forks, where improvements were made in product storage as well as dry ore storage. According to MBMG, Montana Talc undertook an exploration program that increased its estimated reserves to approximately 20 years.

Vermiculite.—W.R. Grace & Co. essentially finished reclamation of the mine and plant facilities at its Rainy Creek Mine near Libby, Lincoln County. The mine was closed in 1990 owing to a decline in demand for vermiculite, which contains asbestiform minerals. The property's buildings were sold, all outcrops were covered with soil, and about 40,000 trees were planted. W.R. Grace continued to ship processed vermiculite from its stockpiles through November.

The Monolite Mine east of Dillon, owned and operated by Mineral Products Inc., suspended operations, and the property was offered for sale. Stansbury Mining Corp. continued to work on an EIS for its new vermiculite mine near Hamilton, Ravalli County.

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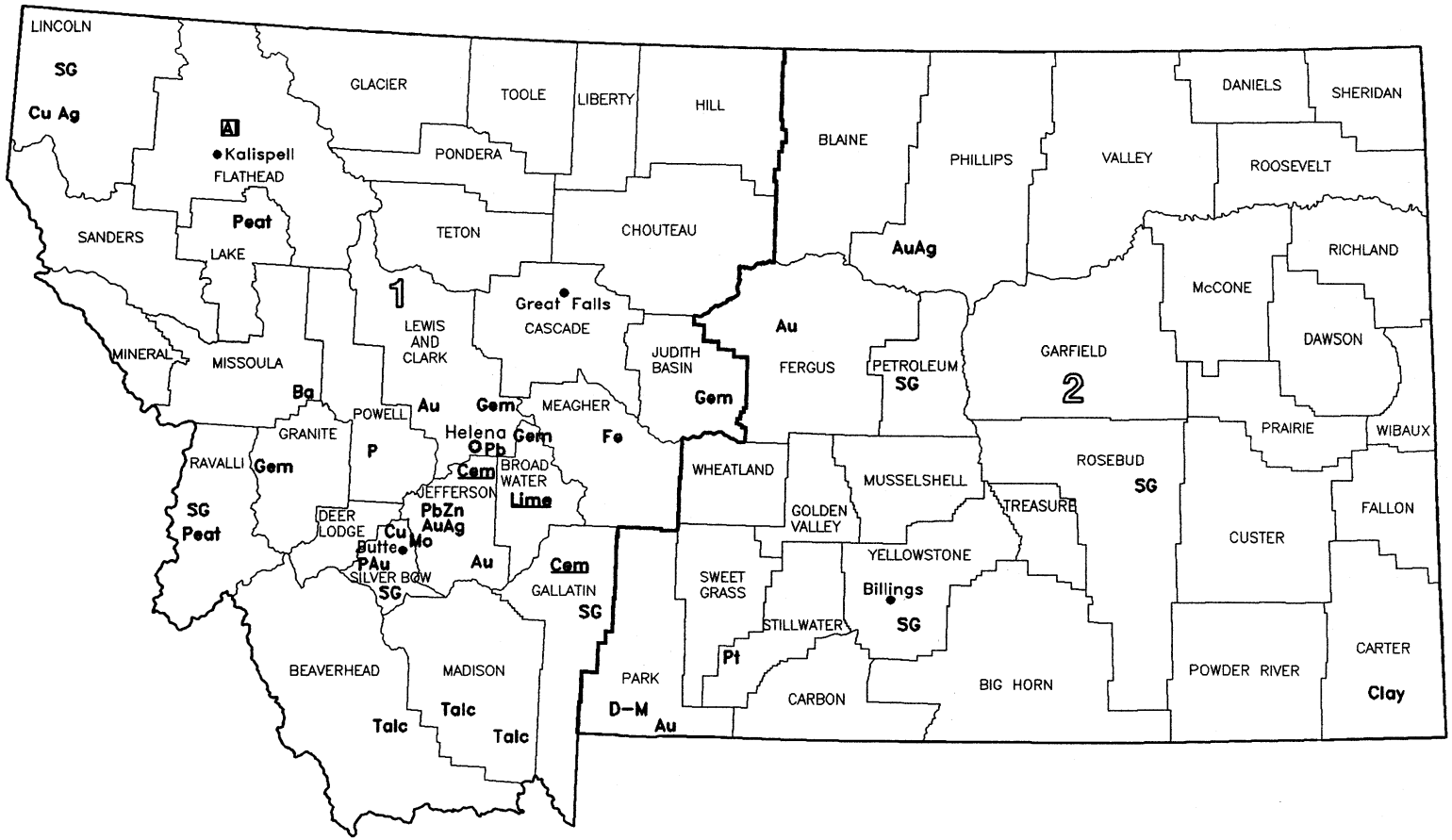
[1]State Mineral Officer, U.S. Bureau of Mines, Spokane, WA. He has 18 years of mineral-related experience in industry and government and has covered the mineral activities in Montana since 1989. Assistance in preparation of the chapter was given by W. A. Lyons, editorial assistant.

[2]Staff mining engineer, Montana Bureau of Mines and Geology, Butte, MT.

[3]American Metal Market. V. 100, No. 251, Dec. 30, 1992.

MONTANA



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Ag	Silver
Al	Aluminum plant
Au	Gold
Ba	Barite
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
Cu	Copper
D–M	Dimension Marble
Fe	Iron
Gem	Gemstones
Gyp	Gypsum
Lime	Lime plant
Mo	Molybdenum
P	Phosphate rock plant
Peat	Peat
Pb	Lead Smelter
Pt	Platinum group metals
SG	Stone and Gravel
Talc	Talc minerals
Zn	Zinc

Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Aluminum:			
Columbia Falls Aluminum Co.	Box 10 Columbia Falls, MT 59912	Reduction plant	Flathead.
Cement:			
Ash Grove Cement West Inc.	6720 SW Macadam Ave. Suite 300 Portland, OR 97219	Plant and quarry	Jefferson.
Holnam Inc.	Box 8789 Denver, CO 80201	do.	Gallatin.
Copper:			
ASARCO Incorporated	Box 868 Troy, MT 59935	Underground mine and plant	Lincoln.
Montana Resources Inc.	600 Shields Ave. Butte, MT 59701	Surface mine and plant	Silver Bow.
Gold:			
Canyon Resources Corp.	Box 799 Hilger, MT 59451	do.	Fergus.
Pegasus Gold Inc.	North 9 Post Suite 400 Spokane, WA 99201	Surface mines and leach plants	Jefferson, Phillips, Silver Bow.
Placer Dome Inc.	Box 678 Whitehall, MT 59759	Surface mine and plant	Jefferson.
TVX Gold Inc.	Box 92 Gardiner, MT 59030	Underground mine and plant	Park.
Lead:			
Pegasus Gold Inc.	North 9 Post Suite 400 Spokane, WA 99201	Surface mine and plant	Jefferson.
Lime:			
Continental Lime Co., a subsidiary of Graymont Inc.	Box 550 Townsend, MT 59644	Surface mine	Broadwater.
Great Western Sugar Co.	3020 State Ave. Box 30878 Billings, MT 59107	Plant	Yellowstone.
Holly Sugar Corp.	Box 1052 Colorado Springs, CO 80901	do.	Richland.
Molybdenum:			
Montana Resources Inc.	600 Shields Ave. Butte, MT 59701	Surface mine and plant	Silver Bow.
Phosphate rock:			
Cominco American Inc.	Box 638 Garrison, MT 59731	Underground mine and plant	Powell.
Platinum-group metals:			
Stillwater Mining Co.	Star Route 2 Box 365 Nye, MT 59061	do.	Stillwater.
Sand and gravel:			
Construction:			
Midland O'Leary Inc.	Box 80066 Billings, MT 59108	Pit	Yellowstone.
Empire Sand & Gravel Inc.	Box 1215 Billings, MT 59103	Pits	Do.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued:			
Construction—Continued:			
Treasure State Construction	2110 Reserve St. Missoula, MT 59801	Pits	Various.
Washington Construction Co.	Box 8989 Missoula, MT 59807	do.	Do.
Industrial:			
Rhône-Poulenc Basic Chemicals Co.	Box 3146 Butte, MT 59702	Pit	Beaverhead.
Silver:			
ASARCO Incorporated	Box 868 Troy, MT 59935	Underground mine and plant	Lincoln.
Montana Resources Inc.	600 Shields Ave. Butte, MT 59701	Surface mine and plant	Silver Bow.
Pegasus Gold Inc.	North 9 Post Suite 400 Spokane, WA 99201	Surface mines and plants	Jefferson and Phillips.
Sulfur (recovered):			
Montana Sulphur & Chemical Co.	Box 31118 Billings, MT 59107	Plant	Yellowstone.
Talc:			
Luzenac America Inc.	Box 99 Alder, MT 59710	Plant, surface, and underground mines	Gallatin and Madison.
Montana Talc Co.	28769 Sappington Rd. Three Forks, MT 59752	Plant and surface mine	Do.
Barretts Minerals Inc.	Box 1147 Dillon, MT 59725	do.	Beaverhead and Madison.
Zinc:			
Pegasus Gold Inc.	North 9 Post Suite 400 Spokane, WA 99201	do.	Jefferson.

THE MINERAL INDUSTRY OF NEBRASKA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the University of Nebraska-Lincoln, Nebraska Geological Survey, for collecting information on all nonfuel minerals.

By Jeanne E. Zelten[1] and Raymond R. Burchett[2]

The value of Nebraska nonfuel mineral production was $114.8 million in 1992, an increase of about 28% from that reported to the U.S. Bureau of Mines (USBM) by State mineral producers in 1991. Six of the eight principal mineral commodities produced in Nebraska increased in production and seven increased in value from 1991 totals. Nebraska ranked 42d nationally in the production of all nonfuel minerals, accounting for less than 1% of the national total. The State ranked 42d in industrial mineral production nationally. Most nonfuel minerals produced in Nebraska were basic construction materials, and production reflected construction trends in the State. Industrial sand was used for glass production and other miscellaneous applications. Gas, oil, and uranium also were produced. Lime, talc, perlite, and vermiculite were processed at plants in Nebraska from imported raw materials.

TRENDS AND DEVELOPMENTS

As 1992 closed, the recession and anticipated slow recovery were expected to continue to influence the construction industry. Consolidation of operations and divestitures of extended company holdings were expected to increase as company strategies shifted to adapt to changing economic conditions. Compliance with Federal, State, and local regulations undoubtedly will occupy a larger percentage of operators' time and resources.

Investigation into the use of waste products as fuel in cement kilns increased as companies attempted to decrease their fuel costs, thus decreasing a major part of operating expenses. Industrial wastes and old tires were among the alternate fuels considered.

The increase in nonfuel mineral production and value was attributed to increased production of sand and gravel and crushed stone, reflecting an increase in construction activities. The number of new private and public residential units authorized for construction during the year rose about 9.8% from 1991 figures to 7,134 units. The value of new nonresidential construction and alterations or additions to existing buildings rose to almost $314 million from $288 million in 1991. Nonbuilding construction, including highways, increased about 16.5%, from $9.3 million in 1991 to $10.9 million in 1992.[3]

EMPLOYMENT

Persons employed in the mineral industries in 1992 numbered about 1,435, approximately 5% fewer than in 1991. Employment in the mineral-dependent construction industry increased by 512 workers, from 27,600 to 28,112. Workers in the stone, clay, and glass products sector of the manufacturing industry increased about 5.8% to 2,756 in 1992. An increase of 2 employees occurred in the primary metals sector of manufacturing, bringing the yearend total

TABLE 1
NONFUEL MINERAL PRODUCTION IN NEBRASKA[1]

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
Clays	metric tons	227,292	$1,685	198,319	$909	182,873	$879
Gemstones		NA	7	NA	1	NA	645
Lime	thousand short tons	W	W	W	W	29	1,741
Sand and gravel (construction)	do.	11,453	30,056	e10,100	e27,300	13,206	38,108
Stone (crushed)	do.	e4,000	e21,200	4,861	23,328	e5,900	e29,100
Combined value of cement, sand and gravel (industrial), and values indicated by symbol W		XX	37,381	XX	37,854	XX	44,317
Total		XX	90,329	XX	89,392	XX	114,790

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

to 1,904. The average unemployment rate for Nebraska was 2.9%, up slightly from the 1991 figure of 2.7%.[4]

The average annual salary in mining remained at about $24,000, while the average wage in all industrial jobs in Nebraska increased from $18,400 to about $22,200.[5]

According to the U.S. Department of Labor, accidents in Nebraska nonfuel surface and underground mines resulted in 28 injuries with lost workdays and 31 injuries with no lost workdays during more than 1.2 million hours worked. Workers at mills and preparation plants sustained 9 injuries resulting in lost workdays and 15 injuries with no days lost in a period of nearly 536,000 hours.[6]

ENVIRONMENTAL ISSUES

The Occupational Safety and Health Administration ruled that six nonasbestiform minerals, including actinolite, tremolite, and anthophyllite, would no longer be treated as forms of asbestos in health and safety regulations. These minerals, commonly found in aggregates, will be regulated as particulates. The ruling could save operators $7 million annually in control measures to deal with the minerals. The rule became effective May 29, 1992, after 6 years of debate.

The U.S. Environmental Protection Agency (EPA) issued two regulations to implement air pollution controls required by the Clean Air Act Amendments of 1990. These included regulation of a number of mineral-products industries for toxic air pollutants and the implementation of permitting requirements for all major sources of air pollution. Also, new standards were set for particulate matter that apply to calciners and dryers at plants processing or producing construction products, including lightweight aggregate. EPA anticipated product price increases resulting from the new standards probably would be less than 0.5%, but could be as much as 1.75% for the lightweight aggregate industry.

EPA studied both the process and effects of using waste products as fuel in cement kilns. The studies were in response to public opposition and in an effort to reduce regulatory burdens on industry and to redefine a waste. EPA determined that there was no threat to human health or to the environment from the emissions created by burning certain hazardous wastes in cement kilns. Studies also indicated that cement products did not contain measurable increases in toxic metals. New regulation, expected in late 1994, would eliminate excessive regulations prohibiting the use of hazardous waste in the production of cement and other building materials.

Several industries saw increased competition from alternative products, especially waste products, which often were sold at prices undercutting the prices of mined materials. Because of increasing need to dispose of large quantities of waste material, the trend was expected to increase in coming years. Bottom ash, the residue produced at coal-burning powerplants, was sold for use as a lightweight aggregate in masonry applications. Byproduct lime and gypsum from water-treatment facilities and flue gas desulfurization were used for soil conditioning, gypsum-board manufacture, and portland cement. Alkaline fly ash was used for stack gas cleaning. Concrete and road asphalt also were recycled.

In response to the Clean Air Act Amendments of 1990, research was carried out by Federal and State agencies in an attempt to substitute various materials for traditional mined materials to produce usable byproducts. For example, phosphate was used to replace limestone in flue gas desulfurization, resulting in a salable fertilizer byproduct. Innovative use and handling of waste products, along with demand for a number of industrial minerals and a variety of chemicals, was expected to increase as operators modify their facilities to comply with the new regulations.

Ferret Exploration Co., operator of Nebraska's first commercial uranium mine, agreed to pay $3,500 to settle a case involving the discharge of radioactive water at the in situ Crow Butte Mine near Crawford, Dawes County. The discharge, resulting from a computer malfunction, did not pose a health threat because the pollutants were sufficiently diluted. Computer software was altered and alarms added to the system to prevent future occurrences.

A controversial $50 million incinerator planned near Kimball remained on hold. Waste-Tech Services Inc. of Colorado began construction in 1988 on a facility that would burn 29,930 metric tons (33,000 short tons) of waste per year. Under proposed tighter State control, the plant might be able to burn 40,815 metric tons (45,000 short tons) per year. A State hearing on permits for the facility was held during the year, but two private lawsuits opposing the project were awaiting hearings by the Nebraska Supreme Court.

EXPLORATION ACTIVITIES

Interest in what may be one of the world's largest carbonatite bodies was revitalized in 1992 when Molycorp Inc., a subsidiary of Unocal Inc., turned over 1,200 boxes of drill core samples to a Nebraska landowner when the company terminated exploration leases. A clause in one of the drilling leases held by Molycorp required that the company give core samples to the surface owners if the company decided not to mine. The landowners turned the core samples over to the Nebraska Conservation and Survey Division in Lincoln. In 1970, geologists with the Nebraska Conservation and Survey Division noted an unusually high gravitational anomaly over a 9.6-kilometer (6-mile)-diameter area. This led to the discovery of the Elk Creek carbonatite, in Johnson and Pawnee Counties, southeastern Nebraska. The Nebraska survey, aided financially by the USBM, drilled the deposit to a depth of 290 meters (952 feet) without reaching the base of the formation. Analysis of core samples revealed the presence of rare-earth elements including niobium (the primary ore mineral) and minor amounts of cesium, cerium, europium, lanthanum, and yttrium.

Cominco-America and Molycorp explored the carbonatite over a period of 20 years, drilling 115 test holes and reaching a depth of 762 meters (2,500 feet). Company representatives indicated the carbonatite body is 3.23 kilometers (2 miles) in diameter, is covered by about 183 meters (600 feet) of Paleozoic sediments, contains abundant apatite, and may be the largest resource of niobium in the United States (1.0% to 1.5% Nb_2O_5). Staff members of the State survey planned to study the core and issue a report on their findings.

LEGISLATION AND GOVERNMENT PROGRAMS

As of July 15, the Department of Environmental Control changed its name to the Department of Environmental Quality.

Progress toward the establishment of a five-State low-level radioactive waste disposal facility in northeastern Nebraska was slow. Nebraska was chosen in 1991 as the host State for the facility by the Central Interstate Low-Level Radioactive Waste Compact. Members of the five-State compact are Arkansas, Kansas, Louisiana, Nebraska, and Oklahoma. The Nebraska Department of Environmental Quality evaluated the proposed site west of Butte, in Boyd County. Opposition to establishment of the waste facility continued at yearend. Funding for the project, provided by the Nebraska Department of Environmental Quality, was $189,110 the first year and $103,245 the second.

Research continued into potential uses of the 336,000 metric tons (370,000 short tons) of fly ash produced in Nebraska each year as a byproduct of burning coal to generate electricity. The $165,000 joint-research project included the State, the University of Nebraska-Lincoln, two public power districts, and a private company. Funding was provided by the State.

The City of Fremont sought approval from the Nebraska Department of Environmental Quality and the U.S. Army Corps of Engineers to use fly ash blocks as bank stabilization along the Platte River. The city powerplant generates about 10,911 metric tons (12,000 short tons) per year of fly ash that is now being shipped to a landfill.

The U.S. Army Corps of Engineers stated that artificially created lakes and ponds excavated from dry land, including those created by aggregate producers, are not included under the definition of jurisdictional wetlands. With less regulatory restriction, operators are allowed greater flexibility in quarry development and reclamation.

Projects completed by State and Federal agencies provided information beneficial to mineral producers in the State. The Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, published a series of updated test-hole logbooks on exploration drilling in the State. Additional publications were updated and completed on the mineral industry of Nebraska, mineral facts for Nebraska, and oil and gas fields and uranium deposits in the State. Maps of mineral resources and the geologic bedrock of the State were compiled and revised. All active mines and quarries in the State were inventoried and a directory prepared.

Scientists with the Nebraska Conservation and Survey Division continued to evaluate drill core and seismic data from the Midcontinent Rift in the eastern part of the State for base and precious-metal resource potential. The mineral resource potential of Permian red-bed deposits in the southwestern part of the State also was evaluated. The study is part of a cooperative program with the U.S. Geological Survey (USGS) to study the relationship between copper deposits in the red-beds and major evaporite sequences in Nebraska.

Work commenced on the Mapping of Bedrock Surface and Geology of West-Central Nebraska Cooperative Geologic Mapping Program (COGEOMAP). The USGS provided funding of $35,000 toward this project.

Passage in May of the National Geologic Mapping Act of 1992, Public Law 102-285, could result in improved mapping coverage for Nebraska; only about 34% of the State has been mapped in detail. The State map component of the act identifies State geological surveys as the lead agencies to establish mapping priorities in their respective States. States must compete for funding, and equal distribution among States is not guaranteed. States are required to match the awarded funds. Despite full authorization of $18 million to States, the program was funded at only $1.39 million for 1993.

FUELS

Oil, gas, and uranium were produced in Nebraska in 1992, primarily for use as fuels.

Nebraska produced almost 5.5 million barrels of oil and ranked 21st nationally in oil production. This was a decrease of 358,000 barrels, or about 6% from 1991.[7] Drilling decreased by about 22%. Two new fields were opened, the Beyer Field in Cheyenne County and the Hamlet Field in Hayes County.[8]

The Nebraska Oil and Gas Conservation Commission reported that 691 million cubic feet of casinghead gas was produced. About 486 million cubic feet of dry gas was produced from 22 wells. Of the 103 wells drilled in 1992, 57 were for exploration, 43 for development, and 3 were miscellaneous or stratigraphic tests. Well completions were down about 45% from 1991 levels. Counties in which the most exploration and development wells were drilled were Cheyenne, Kimball, Hayes, Hitchcock, and Banner. Two natural gas processing plants are in Nebraska, one in Kimball County and the other in Cheyenne County. The plants produced natural gasoline, liquid petroleum gases, ethane, and other products.[9]

Advantage Resources and Arco Oil and Gas Co. together drilled three test wells in western Nebraska. Two of the holes, in Kimball County, produced oil from the Permian Wolfcamp Formation.

Exploration and production in the Kleinholz Field were high in 1992. Exxon Corp., Advantage Resources Inc.,

and independent companies produced oil and gas from the Kimball County field.

Natural gas was produced for the first time from the Niobrara Formation by Snyder Oil Corp. in Cheyenne County. The formation underlies most of the western part of the State.

The Nebraska Conservation and Survey Division continued plans to explore for coalbed methane in the Forest City Basin in the southeastern corner of the State. Nine coalbeds between 1,000 and 1,500 feet deep underlie about 815 square miles of Nemaha, Otoe, and Richardson Counties. The majority of the basin underlies parts of Iowa, Kansas, and Missouri. Together with the USGS, the four States have applied to the U.S. Congress for $8 million, to be used during a 4-year study to determine the development potential of the coalbed methane. A 6-month pilot study was approved by Congress in October.

Ferret Exploration Co. continued in situ leaching of uranium on a 1,200-hectare (3,000-acre) tract southeast of Crawford in Dawes County. Production of about 400,000 pounds of yellowcake uranium, worth approximately $4 million, was an increase over the 334,000 pounds, worth about $2.9 million, produced in 1991, the first year in which the mine produced. Reported reserves exceeded 12.2 million kilograms (27 million pounds) of uranium oxide. Ferret held leases on another 85,000 hectares (210,000 acres) in the Nebraska Panhandle. Ore grades ranged from 0.05% to 0.5% uranium oxide along the 9.7-kilometer (6-mile)-long ore trend. Bicarbonate of soda, carbon dioxide, and oxygen were injected into the ore body to dissolve and free the uranium. Yellowcake was dewatered on site prior to shipment out of State for final processing. The company completed uranium recovery in Unit 1 and began recovery in Unit 2 during the year. Permits were submitted for several new mining units.[10] Ferret held a 3-year, 68,000-kilogram (150,000 pound)-per-year contract for uranium with a domestic utility.

In September, Imperial Metals Corp., Vancouver, British Columbia, increased its interest in the Crow Butte Mine from 35.3% to 52.8%. The additional interest was acquired from Sedimex Mineralexplorations GmbH.

REVIEW BY NONFUEL MINERAL COMMODITIES

A variety of industrial minerals and metals were mined, manufactured, or recovered as byproducts in 1992. Nebraska's industrial minerals sector accounted for the majority of the State's nonfuel mineral value produced.

Industrial Minerals

Production of industrial minerals in 1992 was influenced by slight increases in the construction industry as the economy slowly began to recover. Increased highway construction in 1992 provided a boost to the industry. At yearend, residential construction was improving slowly, but commercial building remained stagnant, consisting primarily of remodeling existing facilities.

Aggregate and cement production increased in 1992, largely reflecting increased funding for highway construction provided by the $151 billion Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). Good weather also was a factor. ISTEA funds enabled Nebraska to increase transportation-related construction and anticipate further increases in 1993. The funds are allocated over 6 years for improvements to highways and bridges, but also could be used for mass transit and other nonhighway purposes.

Based on anticipated increases in public works projects, residential building, environmental work, and road construction, the demand for aggregate and portland cement in the United States was expected to increase by up to 6% in 1993. Aggregate production in Nebraska was expected to increase in 1993 because of anticipated increases in construction on highways, bridges, airports, and schools, as well as some commercial building. A flood control project sponsored by the Lower South Platte Natural Resources District includes plans to construct 19 dams in the 262-square-mile watershed.

Environmental and zoning regulations were cited as the primary reasons for making it increasingly difficult for the construction aggregates industry to expand existing quarries and to develop new quarry operations. As operations are forced to move farther from market areas, transportation costs increase, ultimately affecting aggregate prices and competition.

Nonfuel mineral production in Nebraska consisted entirely of industrial minerals. In 1992, the Nebraska Geological Survey, Conservation and Survey Division, noted there were 700 mining operations active in the State, including 24 limestone quarries, 644 sand and gravel pits, 8 clay or shale pits, 23 sandstone pits, and 1 uranium mine.[11] These 700 operations represent a decrease of 37 from that of 1991. Total land disturbance during 1992 was estimated at 188 hectares (464 acres); 65.6 hectares (162 acres) was restored.

Cement.—Cement was again the leading nonfuel mineral produced in Nebraska in terms of total value. The Ash Grove Cement Co. remained Nebraska's only producer of portland and masonry cement, operating a plant near Louisville in Cass County. Production of both portland and masonry cement increased substantially. Nebraska ranked 25th of 37 States in which portland cement was produced and 24th of 36 masonry cement-producing States. Limestone, clay or shale, and gypsum are the chief raw materials used in manufacturing cement. Cement plant locations are determined by the availability of raw materials, preferably near river or rail transportation, which provide access to markets.

Anticipated increases in residential construction, highways, and public works projects in 1993 could increase sales up to 5%. Residential construction was beginning to rebound at yearend and was expected to increase in 1993.

University of Nebraska-Lincoln researchers began a 2-year study to determine ways to use fly ash from

Nebraska's two major power producers. The two utilities produce more than 272,100 metric tons (300,000 short tons) of fly ash each year. Expanded shale and recycled fly ash were used to produce lightweight concrete blocks. The blocks weigh 18 pounds, 20 pounds less than traditional concrete blocks, and are 70% stronger. Researchers hoped the new product would improve productivity, reduce injuries, and encourage people to enter the masonry profession.

Cement plant operators throughout the region continued to explore the use of waste products as fuel in cement kilns. Faced with low cement prices and a recovering economy, the industry investigated ways to cut fuel costs, which constituted approximately 25% of operating expenses. The high temperatures needed in cement kilns were used to burn waste materials, such as waste fuels, industrial wastes, spent organic solvents, and used tires. Canned wastes and tires were placed directly into the cement kilns along with the other raw materials; the high temperature completely decomposed the organic material. Because portland cement clinker requires a certain amount of iron, the metal containers and the steel radial belts from the tires are simply incorporated into the clinker. Hazardous wastes have been burned in cement kilns for years, and in 1992, waste fuels accounted for about 6.6% of the energy used for making cement in the United States. It appeared to be an environmentally safe and efficient way to dispose of hazardous waste and other materials that have long been a problem, thereby eliminating the need to mine other resources to satisfy fuel requirements.

Ash Grove operated its Louisville plant at a rate of about 635,040 metric tons (700,000 short tons) in 1992. The plant has an operating capacity of 907,200 metric tons (1 million short tons). Ash Grove fuels two 49-meter (160-foot) kilns with coal, natural gas, fuel oil, and waste-derived fuels. Ash Grove and Cadence Chemical Resources completed a fuel-testing laboratory in April. Cadence developed the quality-control standards at the facility to ensure that the operation was safe and satisfied all environmental regulations. Waste-derived fuels are tested at least twice prior to use in the kilns.

Clays.—Reported clay production decreased almost 8% and value decreased about 3% from 1991 totals. Most of the production came from Cass and Jefferson Counties. Clay was used in the manufacture of common and face bricks and cement. Three brick companies operated in the State: Endicott Clay Products Co. near Fairbury in Jefferson County, Yankee Hill Brick Manufacturing Co. near Lincoln in Lancaster County, and Omaha Brick Works near Ralston in Douglas County and in Sarpy County. The State ranked 28th out of 43 States producing common clay.

Lime.—Reported production and value of lime increased in 1992. Lime was produced by Western Sugar Co. primarily for use in refining sugar from sugar beets. Lime kilns at Scottsbluff and Mitchell in Scotts Bluff County and at Bayard in Morrill County produced quicklime from limestone imported from Wyoming.

Growth in the lime and limestone industry was enhanced by the Clean Air Act Amendments of 1990 and other environmental legislation that required installation of stack scrubbers at coal-fired powerplants. Scrubbers utilize lime and pulverized limestone to remove sulfur oxides from stack gases. As the required scrubbers are installed and plants are brought into compliance with new regulations, the demand for lime and limestone is expected to increase over the next several years. Other areas of continued growth in usage included water treatment, to achieve proper pH balances, and treatment of sewage sludge and hazardous wastes. Increased demand for lime in an expanding economy is anticipated for the manufacture of steel and automobiles, construction, industrial and chemical uses, and increased mining, smelting, and environmental controls in the gold and copper industry.

Lime is manufactured by heating or calcining limestone or dolomite in a kiln at high temperatures to drive off carbon dioxide. The resulting product is quicklime. Hydrated lime, the more stable form, is produced when water is added to the quicklime. In addition to the abovementioned uses, lime is used as a soil conditioner, as plant food, for soil stabilization, as a flux, and as a basic chemical.

Sand and Gravel.—Both construction sand and gravel and industrial sand were mined in Nebraska during 1992. Sand and gravel was produced in most counties and constituted more than 25% of the total nonfuel mineral value produced in the State in 1992.

Construction.—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Reported production and value increased 15% and almost 27%, respectively, over totals reported in 1990, and nearly 31% and 40%, respectively, over 1991 estimates. Construction sand and gravel was the second most important nonfuel mineral commodity produced in Nebraska in terms of value and the largest in terms of distribution of activity, number of companies, and employees. Nebraska ranked 22d of 49 States producing construction sand and gravel.

Nebraska construction sand and gravel statistics are compiled by geographical districts, as depicted on the State map. Tables 2 and 3 present end-use data for this commodity in the State and in the five Nebraska districts. District 3, in the southeastern part of the State, reported the highest production, followed by districts 2 and 1.

Production was reported by 106 companies at 197 pits in 60 of the State's 93 counties. Five companies, All Spec Sand and Gravel Co., City Wide Rock and Excavation, Lyman-Richey Sand & Gravel Corp., Martin-Marietta Aggregates, and Western Sand & Gravel

TABLE 2

NEBRASKA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,154	$9,114	$2.89
Plaster and gunite sands	179	508	2.84
Concrete products (blocks, brick, pipe, decorative, etc.)	141	427	3.03
Asphaltic concrete aggregates and other bituminous mixtures	939	3,352	3.57
Road base and coverings[1]	3,871	11,313	2.92
Fill	705	1,279	1.81
Snow and ice control	103	275	2.67
Railroad ballast	W	W	3.67
Other miscellaneous uses[2]	43	266	6.19
Unspecified:[3]			
Actual	546	1,554	2.85
Estimated	3,524	10,020	2.84
Total	[4]13,206	38,108	2.89
Total[5 6]	11,980	38,108	3.18

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

Co., produced almost 44% of the State total. Deposits in four counties, Cass, Douglas, Sarpy, and Saunders, yielded 34.5% of the total. Major end uses reported by producers included road base and covering, concrete aggregate, asphaltic concrete, and fill. A majority of the material was transported by truck, although a small percentage was transported by rail, from pits to plants and construction sites.

Controversy arose over production of sand and gravel along the Platte River at Lincoln, and the case was brought before the State legislature. Two Lincoln companies, Concrete Industries Inc. and NEBCO Inc., donated two 65-hectare (160-acre) tracts of land along the Platte River in Saunders County to the Nebraska Game and Parks Commission the day before a condemnation hearing was filed by the Omaha Metropolitan Utilities District (MUD) against the two companies. MUD wanted the land for a water well field, but the two companies purchased the land for sand and gravel mining before MUD could complete the purchase. Under the donation agreement, the companies could extract about 10.89 million metric tons (12 million short tons) of high-quality sand and gravel from the land. The State legislature adjourned without voting to accept the land.

Industrial.—Reported production of industrial sand in the State was low, remaining nearly constant for 4 years. Western Sand & Gravel Co. produced industrial sand from its operation in Saunders County.

Stone (Crushed).—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed stone was the third most significant nonfuel mineral produced in Nebraska in terms of production. Estimated production and value of crushed stone in 1992 were 21% and almost 25% higher, respectively, than totals reported in 1991. The State ranked 33d out of 49 States producing crushed stone in 1992. Limestone was the principal stone produced.

The utilization of a stone deposit is determined by the quality of the stone, demand, available transportation, and availability of the deposit. For some aggregate uses and for dimension stone, physical characteristics are significant. For some chemical and other specialized uses, chemical composition is important. If specific physical or chemical characteristics are not important, haulage distances, local demand, and availability are the determining factors.

In 1991, the most recent year with a full-year industry canvass, limestone was produced from 13 plants in eastern Nebraska, 5 near Weeping Water in Cass County. Cass County was the leader in limestone production followed by Washington County. Principal producers of crushed limestone are Fort Calhoun Stone Co., Kerford Limestone Co., and Martin Marietta Aggregates, with operations in Cass, Pawnee, and Washington Counties. Nebraska's limestone is used primarily for aggregate in concrete, cement manufacture, road base, riprap, agricultural lime, wallstone, and mineral fillers.

In 1991, limestone processing in Nebraska included three firms that produce agricultural lime exclusively near Garland in Seward County, near Nelson in Nuckolls County, and near Ponca in Dixon County. Most crushed limestone plants in southeastern Nebraska also produced some agricultural lime. Three firms produced finely ground limestone (calcium carbonate) for feed supplements and fillers for cement, paint, and rubber. Producers were Kerford Limestone Co. and Iowa Limestone Co. west of Weeping Water in Cass County and Texasgulf southeast of Weeping Water. One plant on a reclaimed quarry site west of Weeping Water in Cass County produced limestone pellets for agricultural, lawn,

TABLE 3

NEBRASKA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	687	1,832	558	1,514	1,909	5,767
Plaster and gunite sands	22	55	24	48	134	405
Concrete products (blocks, brick, etc.)	W	W	12	32	W	W
Asphaltic concrete aggregates and other bituminous mixtures	297	976	334	1,126	308	1,251
Road base and coverings[1]	1,026	2,369	1,787	4,871	1,058	4,073
Fill	149	276	245	443	311	560
Snow and ice control	40	102	20	45	44	128
Railroad ballast	—	—	W	W	—	—
Other miscellaneous uses[2]	8	32	3	9	162	621
Unspecified:[3]						
Actual	—	—	439	1,108	107	446
Estimated	418	962	1,149	3,649	1,956	5,410
Total[4]	2,648	6,603	4,571	12,845	5,988	18,660
Total[5 6]	2,402	6,603	4,147	12,845	5,432	18,660

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

and garden use. Thirteen Nebraska firms, seven near Omaha, cut stone imported from other States.

Kerford Limestone Co. started production at Nebraska's fourth underground limestone mine near Weeping Water. Annual production of 1.18 million metric tons (1.3 million short tons) of limestone from mines in the Weeping Water area was used in asphalt and concrete. Although most of the State is underlain by limestone, it is mined only in the eastern counties because of the higher quality material and shallower depth of deposits.

Other Industrial Minerals.—Several other industrial mineral commodities, produced in Nebraska as byproducts of other industries or shipped into the State, either were sold as recovered or processed into higher value commodities.

Anhydrous ammonia, urea, and ammonium nitrate were produced by fertilizer plants in Nebraska. Major producers were Arcadian Corp. at La Platte in Sarpy County, Farmland Industries Inc. at Hastings in Dodge County and near Beatrice in Gage County, and Cominco-American, also operating near Beatrice in Gage County.

A variety of gemstones, minerals, and fossils were collected by amateur collectors and professionals, both for private collections and for commercial sales. The materials were sold as specimens and formed into a variety of decorative items. Rock and mineral specimens included agate, calcite, chalcedony rosettes, chert, jasper, marcasite, onyx, fire opal, pyrite, and a variety of other quartz minerals. Both massive and crystalline varieties of many of these minerals were collected. Fossils included bison teeth, brachiopods, crinoids, fish, horn coral, mammals, mastodon ivory, sharks' teeth, and petrified wood. A visitor center and museum were completed at Agate Fossil Beds National Monument in Sioux County. The facility will house mammal fossils recovered in the State, American Indian artifacts, and a variety of displays. A prehistoric flint quarry was discovered near Lyman, Scotts Bluff County.

Perlite was manufactured by the Zonolite Division of W. R. Grace & Co. near Omaha in Douglas County. Crude perlite was imported from other states and expanded at the Omaha plant. The expanded perlite was sold as filler material, aggregate for plaster and concrete, and a horticultural product.

One plant, previously owned by Cyprus Mines Corp., United Sierra Division, near Grand Island in Hall County, produced ground talc from raw material obtained outside the State. The talc was used for ceramics, cosmetics, paper, and plastics. Cyprus, the Nation's largest talc producer, sold its talc mines and processing facilities in the United States to the RTZ Corp. PLC, of the United Kingdom. The operations will be run by Talc de Luzenac, a French wholly owned subsidiary of RTZ, and will operate under the name Luzenac America Inc.

Construction Products Division of W. R. Grace & Co. produced vermiculite in Nebraska. The plant, near Omaha, processes crude vermiculite imported from Montana. The expanded vermiculite was used principally for insulation, concrete aggregate, and fire-proofing.

Metals

ASARCO Incorporated continued to operate a lead-zinc-antimony and precious-metals refinery at Omaha in Douglas County. The refinery has been in existence since 1870 and processes bullion brought in from other States. Most of the lead produced was used in the manufacture of storage batteries.

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[1]State Mineral Officer, U.S. Bureau of Mines, Denver, CO. She has 15 years of mineral-related industry and government experience.

[2]Research geologist, Conservation and Survey Division of the University of Nebraska-Lincoln (Nebraska Geological Survey), Lincoln, NE.

[3]U.S. Department of Commerce, Bureau of the Census. Permit Authorized Construction in Permit Issuing Places. Annual 1992.

[4]Nebraska Labor Market Information. Annual Summary Report, 1992.

[5]Work cited in footnote 4.

[6]U.S. Department of Labor, Mine Safety and Health Administration. Mine Injuries and Worktime, Quarterly. Jan. to Dec. 1992.

[7]Energy Information Administration. Petroleum Supply Annual, 1992, v. 1, May 1993.

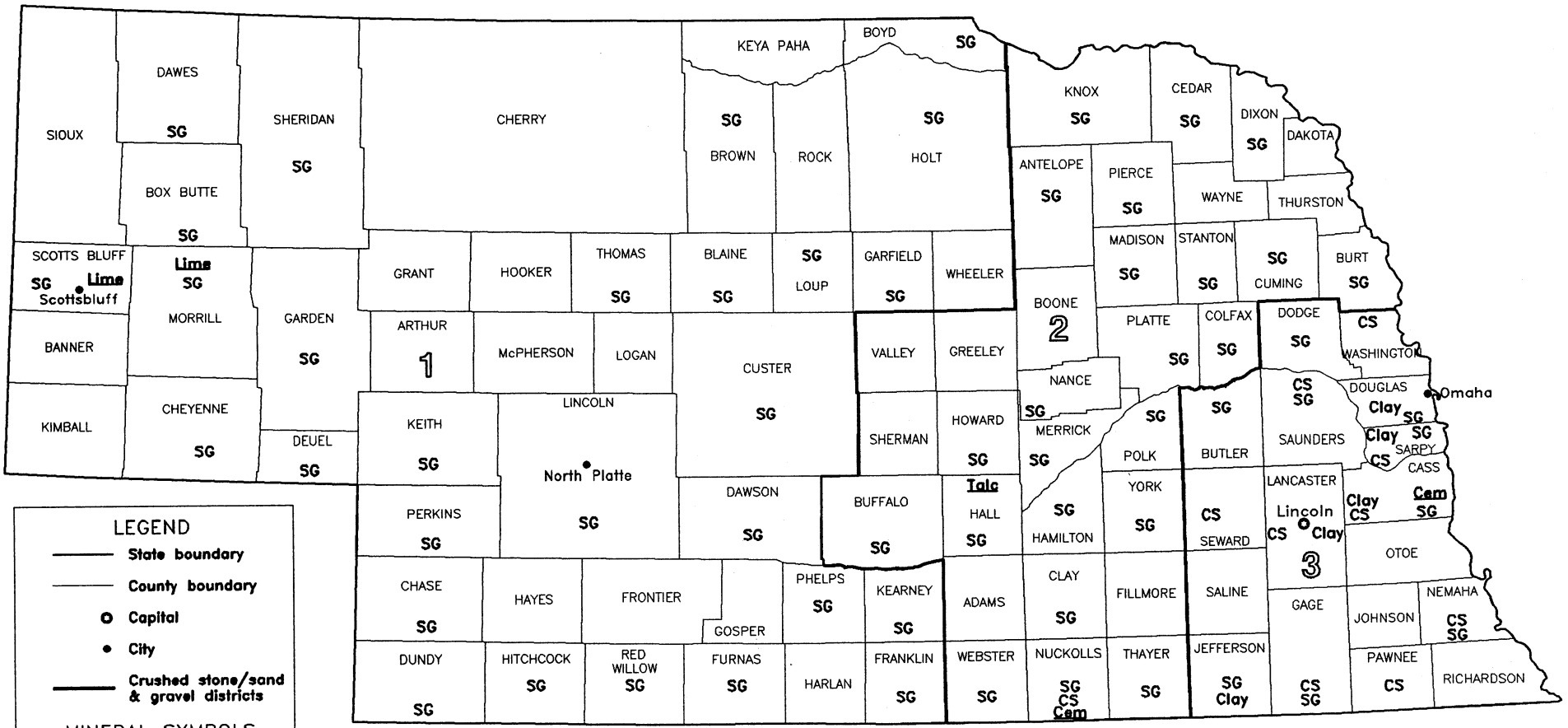
[8]Petroleum Information. Resume 1992.

[9]Energy Information Administration. Natural Gas Annual, Oct. 1993.

[10]Mining Business Digest, Oct. 1992.

[11]Burchett, R. R., and D. A. Eversoll. Nebraska Mineral Operations Review, 1992. NE. Geol. Surv., Apr. 1993.

NEBRASKA



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

- Cem — Cement plant
- Clay — Clay
- CS — Crushed Stone
- Lime — Lime plant
- SG — Sand and Gravel
- Talc — Talc plant

Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Ash Grove Cement Co.[1]	Box 25900 Overland Park, KS 66225	Quarry, clay pit, plant	Cass.
Clays:			
Endicott Clay Products Co.	Box 17 Fairbury, NE 68352	Pit and plant	Jefferson.
Omaha Brick Works	Box 27073 Ralston, NE 68127	do.	Douglas.
Yankee Hill Brick Manufacturing Co.	Route 1 Lincoln, NE 68502	do.	Lancaster.
Lime:			
Western Sugar Co.	Anaconda Towers Suite 1400 555 17th St. Denver, CO 80202	Plants	Morrill and Scotts Bluff.
Sand and gravel (construction):			
Central Sand & Gravel Co. Inc.	Box 626 Columbus, NE 68601	Pits and plants	Butler, Madison, Nance, Platte.
Hartford Sand & Gravel Co.	Box Z Valley, NE 68064	Dredges and pits	Dodge and Douglas.
Lyman-Richey Sand & Gravel Corp.	4315 Cuming St. Omaha, NE 68131	Pits and plants	Cass, Douglas, Platte, Saunders.
Western Sand & Gravel Co.[2]	Box 28 Ashland, NE 68003	Dredges and pits	Cass, Dodge, Saunders.
Stone (crushed):			
Limestone-dolomite:			
Fort Calhoun Stone Co.	1255 South St. Blair, NE 68008	Quarries and plants	Washington.
Kerford Limestone Co.	Box 449 Weeping Water, NE 68463	Quarry and plant	Cass.
Martin-Marietta Aggregates, Central Div.	Box 30013 Raleigh, NC 27622	Quarries and plants	Cass, Nemaha, Nuckolls, Pawnee, Saunders.

[1]Also clays in Cass County.
[2]Also industrial sand in Saunders County.

THE MINERAL INDUSTRY OF NEVADA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Nevada Bureau of Mines and Geology for collecting information on all nonfuel minerals.

By Fred V. Carrillo,[1] Harold F. Bonham, Jr.,[2] Stephen B. Castor,[3] and Marguerite Roberto[4]

Nevada's 1992 nonfuel mineral production was valued to be 10% higher than that of 1991 at $2,588,251. Nevada ranked second nationally in the value of its nonfuel mineral production, accounting for 8.09% of the U.S. total. Nevada continued to be the leading State in the production of barite, gold, mercury, and silver and was the sole producer of mined magnesite and brucite.

Mined gold production accounted for 87% of the total nonfuel mineral production value reported in the State during 1992. Silver, almost all as a byproduct from gold production, accounted for an additional 3% of Nevada's nonfuel mineral production and ranked Nevada number one among the Nation's silver-producing States. Principal nonfuel minerals produced in Nevada, in order of value, were gold, construction sand and gravel, and silver. Additional important industrial minerals in Nevada included barite, portland cement, clays, diatomite, gypsum, lime, lithium, magnesite, and industrial sand and gravel.

The data presented in table 1 are based on 1992 production figures that were reported by industry to the U.S. Bureau of Mines (USBM). The Nevada Bureau of Mines and Geology (NBMG) collected and reported similar information, partly obtained from the Nevada Department of Minerals, in a 52-page NBMG special publication (MI-1992), "The Nevada Mineral Industry, 1992." In addition to production statistics, this publication contains sections on metals, precious metals, industrial minerals, oil and gas, geothermal energy, and a directory of active mining operations.

TABLE 1
NONFUEL MINERAL PRODUCTION IN NEVADA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thoudsands)
Barite	metric tons	337,000	$5,884	374,000	$11,933	W	W
Clays[2]	do.	34,625	4,098	15,553	3,204	50,517	$7,722
Gemstones		NA	407	NA	958	NA	661
Gold[3]	kilograms	179,078	2,216,233	r180,382	r2,106,866	203,165	2,253,305
Lead[3]	metric tons	830	842	W	W	—	—
Mercury	do.	W	W	57	202	64	373
Sand and gravel:							
Construction	thousand short tons	18,377	59,008	e20,300	e69,000	24,273	93,585
Industrial	do.	607	W	546	W	531	W
Silver[3]	metric tons	r583	r75,783	578	75,050	614	77,724
Stone (crushed)	thousand short tons	e1,600	e5,000	1,199	6,527	e1,200	e6,700
Zinc[3]	metric tons	7,889	12,973	W	W	—	—
Combined value of brucite, cement (portland), clays [fuller's earth (1990-91), kaolin], copper, diatomite, fluorspar (1990), gypsum (crude), lime, lithium minerals, magnesite, molybdenum (1990-91), perlite, salt, and values indicated by symbol W		XX	216,820	XX	155,018	XX	148,181
Total		XX	r2,597,048	XX	r2,428,758	XX	2,588,251

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" figure.

[3]Recoverable content from ores, etc.

TRENDS AND DEVELOPMENTS

As has been the case for several years, gold continued to be Nevada's most valuable mineral commodity with a continued increase in gold production from 177,312 kilograms or 5,700,705 troy ounces in 1991 to 187,109 kilograms or 6,015,685 troy ounces in 1992. Nevada continued to be the leading gold-producing State in the Nation, yielding more than 60% of all gold produced in the United States and approximately 9% of all gold produced in the world. Relatively low gold prices, uncertainties regarding the access to Federal lands, and increasingly more restrictive State and Federal regulations caused a substantial decrease in exploration activity since the peak in 1988.

Arimetco Inc. produced copper at the Yerington mine in 1992, and Magma Copper Co. proceeded with plans to resume copper mining in the Robinson district in 1994.

EMPLOYMENT

According to the Nevada Employment Security Department, 12,900 workers were employed in the Nevada mining industry in December 1992, a 0.8% decrease from that of the previous year and an 8% drop from the peak employment of 15,000 workers reported in July 1990. Metal mining employment averaged 11,739 workers during the year. Precious-metals operations employed the largest number of workers, followed by the sand and gravel industry. Other mining employment averaged 1,199 workers during 1992 for a total yearly average of 12,938 workers in the mining industry.

ENVIRONMENTAL ISSUES

In an appropriations bill passed by both houses, the bill, The Interior Department and Related Agencies Appropriations Act of 1993 (Public Law 102-381), was approved on October 5, 1992, and established a mandatory annual rental fee of $100 for fiscal years 1993 and 1994 for each mining claim and site located and held under the General Mining Law of 1872. Mining claimants must pay $100 per claim for each of the two assessment years established in the Appropriations Act (September 1, 1992, through September 1, 1993, and September 1, 1993, through September 1, 1994). The Congress made an exception to the rental requirement for "small miners" who have 10 or fewer claims and who meet certain criteria with respect to levels of production or exploration activity and unreclaimed surface disturbance. The new fee requirement is temporary unless renewed by Congress.

EXPLORATION ACTIVITIES

Grassroots exploration for gold in Nevada, and in the western United States, continued the decline that started in 1989, although exploration for concealed deposits as well as for deep mineralization in sediment-hosted gold districts increased during the year. Contributory factors include relatively low gold prices, increasingly restrictive Federal and State regulations affecting mining, increased uncertainty concerning long-term access to Federal lands, and more favorable exploration and investment climates in many foreign countries, particularly in Latin America.

Atlas Corp. completed drilling of the Gold Canyon deposit near Eureka in May. In Lander County, Royal Gold continued drilling in the Crescent Valley, Santa Fe Pacific Inc. drilled in Mill Canyon adjacent to the Cortez mine, and Central Gold Corp. explored the Battle Mountain Trend near Cortez. Western Mining Corp. explored the Cloverdale area of the Toiyabe Mountain Range in Nye County. Rio Algom Exploration Inc. also explored in Nye County in the Toquima mountain range. Several mining companies explored south and southwest of Hawthorne in Nye County near the old Aurora mining camp. U.S.M.X. Inc. explored its White Pine County Yankee Project at Alligator Ridge.

LEGISLATION AND GOVERNMENT PROGRAMS

The Nevada Legislature did not meet during 1992. The USBM, Reno Research Center, was recipient of Research and Development Magazine's "R & D 100" award for 1992. The award was received for the development of a process to recover flake graphite from kish (a steelmaking waste mixture of iron, slag, and graphite).

A major effort at the USBM, Reno Research Center, during 1992 was to develop advanced technology for the processing of ores, scrap, and waste into useful products. Two cooperative research efforts with private industry and USBM under two CRADA's were completed and resulted in the development of technologies that have been commercialized. One technology is on the recovery of platinum-group metals from spent catalytic converters, and the other is on the recovery of flake graphite from a steelmaking waste. Other promising advanced technologies that the USBM is currently investigating and also negotiating with private industry to participate on a cooperative effort include an improved method for electrowinning copper, purification of all scrap for recycling, and an improved method for extracting gold from refractory ores.

Research on environmental technology at the Reno Research Center continued to focus on fundamental studies to delineate the origin, source, and significant factors leading to acid formation and metal and nonmetal contamination. Among the methods studied were control strategies to minimize acid formation and metal and nonmetal contamination by inhibiting the reactions and migration of contaminated waters, and treatment technology to neutralize acid waters while recovering or removing toxic metals and nonmetals.

Another area of research at the center in 1992 was the USBM Advanced Mining Systems program, which addressed new mining methods to recover minerals more efficiently and curtail the harmful impact of mining on the environment. Among these were studies to determine if micro-

organisms could be used to extract metals from ores under conditions of in situ leaching and whether bacteria could be used to decompose sulfide minerals in situ.

The USBM continued research on biotechnology for metallurgical applications using bacterial heap leaching of domestic manganese, precious metals, and cobalt and nickel ores. Additional environmental research explored the use of micro-organisms to convert toxic metals; that is, arsenic to nontoxic stable compounds.

FUELS

Nevada's 1992 oil production increased about 9% from that of 1991. Total net production of 3,724,720 barrels (1 barrel equals 42 gallons) was reported from 10 fields, according to the Nevada Department of Minerals. The Grant Canyon field, in Nye County, Nevada's largest, reported total production of nearly 19 million barrels of crude since the first production in September 1983 (almost 50% of Nevada's total oil production). Of the 72 wells in the State reported by the Nevada Department of Minerals to be capable of producing, 14 were shut-in for 6 months or more during 1992. Several operators continued to suspend production on their wells in various fields in Railroad Valley in Nye County.

A total of 29,543 thousand cubic feet of gas was produced in 1992 and used to operate production and related equipment at the lease sites of Apache Corp. and Western General, Inc.

Forty geothermal well permits were issued by the Nevada Department of Minerals during 1992, and 36 geothermal wells with a total footage of 59,000 feet were reported to have been drilled. Total geothermal electrical energy net production in the State in 1992 was estimated by the Nevada Department of Minerals to be 1,219,700 MW·h with a sales value of about $85,000,000. Production capacity from the 10 existing geothermal powerplants in Nevada was 191.7 megawatts.

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Copper.—Copper production in Nevada during 1992 jumped 81% from the previous year. Nearly all of the copper produced was from Arimetco International Inc.'s Yerington mine in Lyon County. The Yerington mine was scheduled to reach design capacity of 65,000 pounds per day of cathode copper by the end of 1992. Arimetco International Inc. acquired a 50% interest in the MacArthur property in Lyon County, from Holcorp Mines Ltd. Ore would be mined and leached to produce about 4,500 tons of copper per year; the property is estimated to contain reserves of 40,000 tons of copper.

The Yerington mine is currently producing 37,000 pounds of cathode copper per day and is scheduled to reach design capacity of 65,000 pounds per day by the end of 1992.

Magma Copper Co. began the permitting and design phase of its Robinson copper-gold project at the old copper mining camp of Ruth, west of Ely in White Pine County. The new phase of copper mining at Ruth is projected to yield approximately 2.5 billion pounds of copper over a projected 16-year mining life.

Gold.—Nevada remained the Nation's principal gold-producing State, reporting production of 203,165 kilograms (6.5 million troy ounces) valued at $2,253,305. Lower gold prices resulted in only a 6.9% rise in value from that of 1991, despite a 12.6% increase in production. Production was reported to the USBM from 60 lode and 1 placer mines in 12 counties. Eureka County was the largest gold-producing county, followed in descending order by Humboldt, Nye, Lander, Elko, and Mineral Counties, all of which produced more than 200,000 ounces of gold.

Newmont Gold Co., Nevada's largest gold producer, reported in its company annual report that gold production in 1992 was 1,587,900 ounces (49,389.1 kilograms), up 1% from the 1,576,900 ounces (49,047.1 kilograms) produced during 1991. The company produced gold from five Nevada mines in 1992: Gold Quarry, Rain, Genesis/Blue Star Post, and the company's original Carlin pit. Carlin was reopened in 1992 following several years of renewed evaluation of its nonreserve mineralization. Gold Quarry, the largest mine operated by the company, produced 927,800 ounces (28,858 kilograms) in 1992.

In December 1992 the company signed an agreement with Barrick Goldstrike Mines Inc. for the joint development of the Post ore body in Eureka and Elko Counties, which extends across their common border in the north region of the Carlin Trend.

Barrick Goldstrike Mines Inc., a subsidiary of American Barrick Resources Corp., was Nevada's second largest producer in 1992, reporting production of 16,987 kilograms of gold (546,144 troy ounces). American Barrick completed its mill expansion in April and finished work on its second and third autoclaves in June. Construction began in August on the sixth and final autoclave at the Barrick Goldstrike project.

In its 1992 annual report, Independence Mining Co., Inc., a subsidiary of Minorco (USA), reported that a record 38 million tons of material was moved and mill throughput was expanded to 8,171 tons per day, an increase of 3% above that of 1991. Exploration drilling near the mine site during 1992 nearly replaced 1992 production.

Atlas Corp.'s Gold Bar project in the Antelope district of Eureka County achieved new record production of 81,822 ounces (2,545 kilograms) according to its 1992 annual report. In addition to the Gold Bar production, ore was mined from satellite deposits at Goldstone, Gold Ridge, and Gold Pick. During the year mining was completed on the Gold Ridge South and Gold Pick West satellite deposits.

Production of gold and silver from heap leaching continued on a reduced

basis at Cominco America Resources' Buckhorn gold mine in Eureka County.

Battle Mountain Gold Co. concluded feasibility studies for new heap-leach and mill-grade gold mineralization at its Fortitude Mine in Lander County. The newly identified gold mineralization is expected to extend operations through the decade.

The first ore bullion from St. George Metals Inc.'s Dean mine in Lander County was poured on August 12, 1992. Underground production from Dean's Pittsburg and Morning Star veins through June averaged about 0.844 ounces of gold per ton. During the last week of October, the crushing system at the mine was completed and the entire plant became operational.

The Mineral County Aurora mine of Consolidated Nevada Goldfields Corp. produced 15,000 ounces of gold in 1992. A 36,000-foot drilling program defined additional reserves east of the Juniata pit. Mining of the principal deposit at Homestake Mining Co.'s open pit Santa Fe mine in Mineral County was completed during the year and operations were shifted to another area of the property.

The Sterling mine in Nye County, operated by Cathedral Gold Corp., produced its 100,000 troy ounce of gold in March. Heap-leach production at the Nye County Paradise Peak mine, owned by FMC Gold Co., contributed 96,000 gold equivalent ounces in 1992, about one-third of the mine's total gold equivalent production.

The Miramar Mining Corp. announced startup of production from the open pit Flowery mine near Virginia City in Storey County. Gold production at the Washoe County Hog Ranch mine of Western Mining Corp. (USA) increased nearly 24% as the nearby Bell Springs deposit was brought to full production and provided all of the plant feed for the second half of the year. Mining activity stopped at AMAX Gold Inc.'s Wind Mountain mine in Washoe County in January 1992, and reclamation was begun at the mine site.

On June 24, 1992, USMX Inc. poured the first gold bar at the Yankee Mine in White Pine County. The open pit, heap-leach, carbon absorption operation was 7 miles south of Alligator Ridge.

FMC Gold Co. conducted a $2 million exploration drilling project to evaluate the deep potential of its Humboldt property in Elko County, an 11-square-mile claim block located on the north end of the Carlin Trend.

Atlas Corp. drilled out a new deposit in Eureka County about 5,000 feet north of its Gold Ridge deposit. According to its annual report, the new deposit defined a resource of more than 130,000 ounces of gold.

Also in Eureka County, American Barrick Resources Corp. announced continuing exploration and development of the Purple Vein deposit at the proposed Meikle mine. Development continued with full production of 400,000 ounces per year targeted for 1996. According to its 1992 annual report, exploration drilling identified an area to the south of the main Meikle ore body with significant potential for increasing minable ore reserves in the upper levels of the mine.

In Humboldt County, Cameco Corp. began diamond drilling on Queenstake's Buckskin property. FirstMiss Gold Inc. identified four different new deposits with minable gold reserves on its Getchell property. Drilling at Santa Fe Pacific Mining Inc.'s Rabbit Creek mine resulted in an increase of reserves of 12% during 1992.

Drilling at Hanson Natural Resource Co.'s Mule Canyon gold deposit in Lander County identified six discrete ore bodies with gold reserves estimated at more than 1 million ounces of gold.

USMX Inc. reported significant deep and/or carbonaceous ore at its Alligator Ridge mine in the Vantage Basin area of White Pine County. At the Dee gold mine in Elko County, exploration drilling in 1992 added 2 years to the mine life.

USMX poured its first gold on June 24th at its open pit, heap-leach, carbon adsorption Yankee mine in the Alligator Ridge Trend of White Pine County.

The Santa Fe Pacific Gold Corp.'s Lone Tree mine near Stonehouse in Humboldt County was dedicated in May, after reaching a production rate of 120,000 ounces of gold per year. Atlas Corp. completed mining its Gold Ridge South and Gold Pick West deposits and began preproduction work on the Gold Pick East deposit in Eureka County.

Magma Nevada Mining Co. ceased gold mining operations at its Robinson project near Ely in August. Atlas Corp. reduced its personnel at the Gold Bar mine in Lander County by 46 employees or 24% of the work force.

Mercury.—Nevada was the principal mercury producer in the United States with production reported from nine operations in Elko, Eureka, Humboldt, Mineral, Nye, Washoe, and White Pine Counties. Total production of 64 metric tons of mercury, valued at more than $370,000, was 12.3% higher than the 57 metric tons reported in 1991. FMC's Paradise Peak mine in Nye County was the State's largest producer. All production in the State was derived as a byproduct recovered from gold operations.

Silver.—Nevada produced more silver than any other State in the Nation during 1992, although only one mine was operated primarily for silver. Most of the record silver production was recovered as byproducts from Nevada's record gold production. Nevada mines reported production of more than 20 million troy ounces, worth nearly $80 million in 1992.

Coeur-Rochester Inc. was Nevada's largest silver producer from its Rochester mine in Pershing County. Large amounts of silver (more than 1 million ounces) were also reported from FMC Corp.'s Paradise Peak mine in Nye County, Echo Bay Mines Ltd.'s McCoy-Cove mine in Lander County, and Nerco Metals Candelaria in Mineral County from byproduct gold production.

Other Metals.—No lead or zinc production was reported in Nevada during 1992. A decline in aerospace-related business caused the closure of Howmet Corp.'s Reno titanium plant in June. The

TABLE 2
NEVADA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	2,955	$14,545	$4.92
Plaster and gunite sands	260	1,452	5.58
Concrete products (blocks, brick, pipe, decorative, etc.)	80	646	8.08
Asphaltic concrete aggregates and other bituminous mixtures	2,597	12,995	5.00
Road base and coverings[1]	4,931	15,408	3.12
Fill	1,673	4,043	2.42
Snow and ice control	28	103	3.68
Other miscellaneous uses[2]	178	735	4.13
Unspecified:[3]			
Actual	8,787	35,795	4.07
Estimated	2,785	7,863	2.82
Total	[4]24,273	93,585	3.86
Total[5 6]	22,020	93,585	4.25

[1]Includes road and other stabilization (cement).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

plant had a capacity of 5 million to 6 million pounds per year of titanium and employed 34 people.

Industrial Minerals

Barite.—Nevada was the leading producer of barite among the States with more than 75% of the total, followed by Georgia and Missouri. It was used principally in drilling fluids with minor use in chemicals and as fillers in paper, plastics, and glass. Nevada's barite production in 1992 was reported to be 344,000 metric tons, which was a significant decrease from that of 1991. However, a larger share of barite shipped in 1992 was higher value ground barite, so the total value of barite produced in Nevada was up slightly from that of 1991 at about $12,427,000.

Three firms reported 1992 production in Nevada, with M.I. Drilling Fluids Co. again ranked the number one producer from its Battle Mountain operations in Lander County. Milpark Drilling Fluids Inc.'s Argenta Mine in Lander County and Circle A Construction Inc.'s Dry Creek operation in Elko County were additional producers.

Baroid Drilling Fluids mined barite from the Rossi Mine near Dunphy but did not report production to the USBM.

Cement.—Portland cement from the Centex Corp.'s Nevada cement plant near Fernley was Nevada's only reported cement production in 1992.

Clays.—Nevada's total clay production decreased 28.5% from that of 1991, according to the NBMG, and consisted of bentonite, fuller's earth, and kaolin varieties. Kaolin was the most valuable of the three types of clay produced, followed by fuller's earth and bentonite. Total bentonite production of 15,780 metric tons was valued at more than $3.4 million. Leading bentonite producers included Floridin Co.'s IMV Division and Vanderbilt Minerals Corp. Floridin also produced fuller's earth. Centex Corp. was the principal kaolin producer.

Diatomite.—Diatomite production in Nevada increased 0.2% from that of 1991 and value 4.6%. Nevada was second among the States following California in the 1992 production of diatomite. On the basis of total value, diatomite is the second most important industrial mineral mined in the State. According to the NBMG, total annual production nears 200,000 tons. Diatomite filter aids are shipped worldwide. Eagle-Picher Industries, Inc. produced the bulk of Nevada's diatomite. Filtration-grade diatomite was produced at the company's Colada operation in Pershing County. The company produced absorbent and filler-grade diatomite at its Clark operation in Storey County and shipped crude diatomite from a pit near Fernley in Lyon County.

Two other companies produced absorbent and filler-grade diatomite in the Fernley area in 1992: Moltan Co., which markets cat litter regionally, and CR Minerals, which sells diatomite for insulation and absorbent manufacture. Grefco. Inc. mined filler and absorbent-grade diatomite at Basalt in Mineral County.

Gypsum.—Despite a 4.5% increase in Nevada's 1992 gypsum production from that of 1991, the value of 1992's gypsum was 24% lower than that of the previous year, as continued weakness in the construction industry in California and Nevada resulted in lower prices. U.S. Gypsum Corp.'s Pershing County mine was the State's largest producer at about 400,000 short tons. James Hardie Gypsum at Blue Diamond near Las Vegas was the second largest producer in the State at about 380,000 short tons, followed by PABCO Gypsum and Georgia Pacific Corp., both in Clark County.

Homestead Minerals, a subsidiary of the Art Wilson Co., mined gypsum and anhydrite near Carson City that was sold to cement manufacturers and agricultural users.

TABLE 3

NEVADA:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2	
	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	883	3,914	2,072	10,631
Plaster and gunite sands	W	W	W	W
Concrete products (blocks, brick, etc.)	—	—	80	646
Asphaltic concrete aggregates and other bituminous mixtures	950	6,487	1,547	6,333
Road base and coverings[2]	1,030	3,564	3,861	11,784
Fill	576	1,660	1,097	2,383
Snow and ice control	11	46	17	57
Other miscellaneous uses[3]	147	738	291	1,449
Unspecified:[4]				
Actual	30	44	8,747	35,736
Estimated	1,118	2,477	1,667	5,386
Total[5]	4,744	18,929	19,379	74,406
Total[6 7]	4,304	18,929	17,580	74,406

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Excludes 150,000 short tons valued at $250,001, not reported by county.
[2]Includes road and other stabilization (cement).
[3]Includes filtration.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value in thousand metric tons and thousand dollars.

Lime.—In 1992, lime production in Nevada increased by about 9.4% over that of 1991. Chemstar, Inc. produced dolomitic lime in Henderson from dolomite mined at Sloan, south of Las Vegas, and high-calcium lime at Apex just northeast of Las Vegas, but shelved work on a high-calcium lime quarry and plant near Winnemucca following startup of a new operation in southern Idaho. In 1992 Chemstar, Inc. introduced "Leach-it," a gold ore processing product, and "Poz-o-cap," an environmental sealant. These new products contain lime and are manufactured at Henderson. Continental Lime produced high-calcium lime at its Pilot Peak operation near Wendover in Elko County, supplying gold recovery operations in northern Nevada.

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains estimates for 1991 and actual data for 1990 and 1992. Nevada sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 3 presents end-use statistics for Nevada's two districts.

Nevada's construction sand and gravel output increased about 20% to 24,273,265 short tons in 1992, from 1991's estimated production of 20,300,000 short tons despite the State's recent construction declines. The NBMG reported 1992 construction aggregate production of 24 million short tons, of which about 10% was crushed stone.

Large producers in the Las Vegas area in 1992 were Nevada Ready Mix Corp., Las Vegas Paving Corp., Bonanza Materials, Inc., WMK Transit Mix, Inc., Wells Cargo, Inc., and Frehner Construction, Inc. Although residential construction slowed considerably in 1992, aggregate consumption rose because the pace of commercial building increased with four major resort hotels under construction.

R. L. Helms Construction Co. was the largest producer in the Reno-Sparks-Carson City area in 1992. Granite Construction Co., Rocky Ridge, Inc., Paiute Pit Aggregates, Inc., and Sha-Neva, Inc. were also major producers.

Industrial.—Simplot Silica Products was the principal supplier of industrial sand in Nevada from its Overton pit near Las Vegas. Production of approximately 531,000 tons of silica sand (reported by the NBMG) was about 5% less than that of 1991.

Stone.—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991. Crushed stone in Nevada was derived principally from limestone, dolomite, lightweight granite rock, traprock, and volcanic cinders or scoria. Most of the crushed stone was used in construction aggregates, agricultural, chemical, and metallurgical applications. More specific uses included unpaved road surfacing, terrazzo aggregate, poultry grit, mineral food, and cement manufacture.

Other Industrial Minerals.—Basic Inc.'s mine in Nye County was the sole producer of brucite in the United States. Cyprus Foote Mineral Co. was the only producer of lithium carbonate from brines in the United States, which are refined at its adjacent Silver Peak plant in Esmeralda County. Plaster Aggregates, a subsidiary of U.S. Gypsum Co., produced a small amount of expanded perlite from its Empire plant in Washoe County. The Wilkin Mining and Trucking Co. shipped crude and expanded perlite from Lincoln County.

[1]State Mineral Officer, U.S. Bureau of Mines, Reno, NV. He has 27 years of mineral-related government

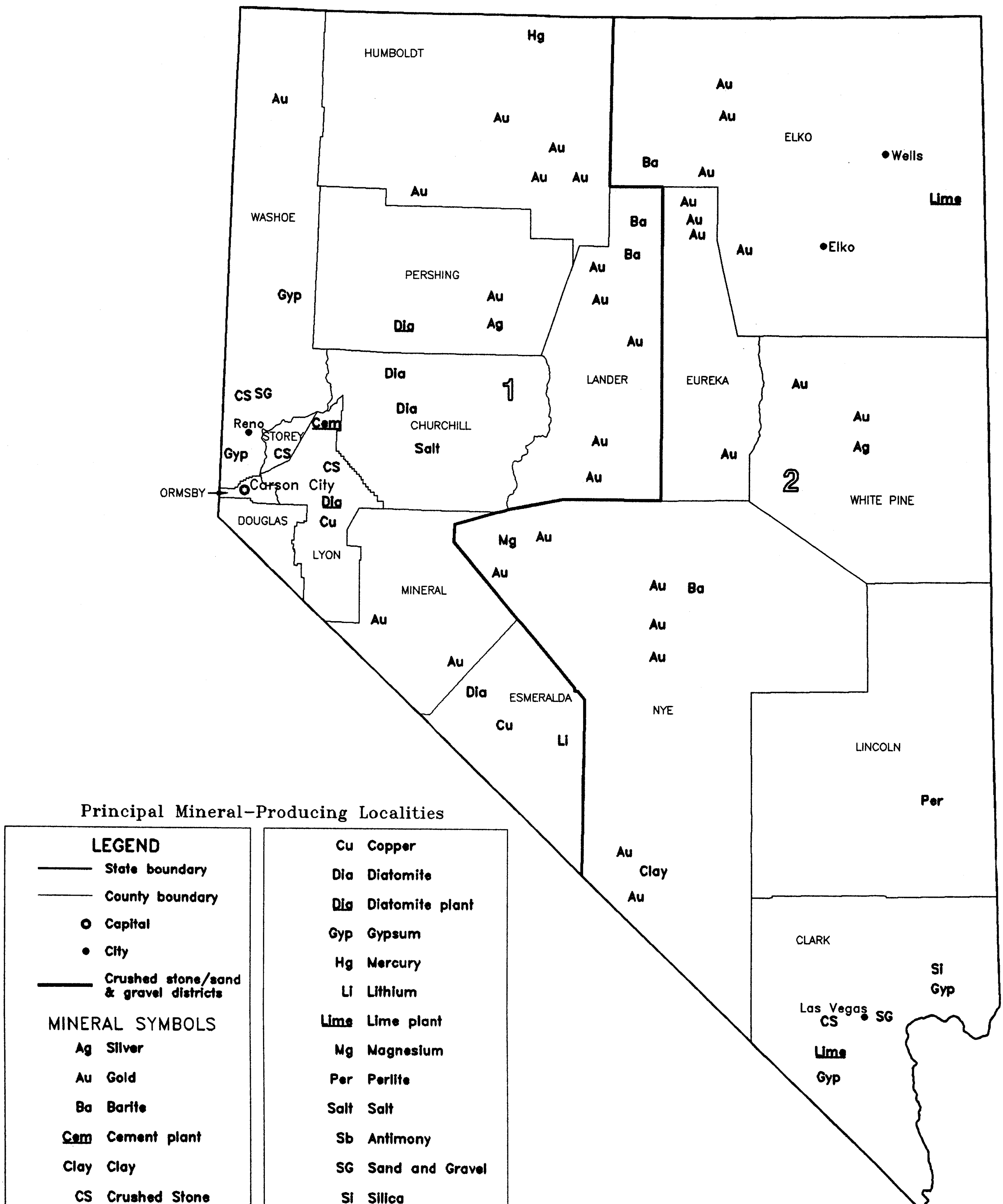
experience and has covered the mineral activities in Nevada for 11 years.

[2]Acting director/State geologist, Nevada Bureau of Mines and Geology, Reno, NV.

[3]Geologist, Nevada Bureau of Mines and Geology, Reno, NV.

[4]Program assistant, U.S. Bureau of Mines, Reno, NV.

NEVADA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Principal Mineral-Producing Localities
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State boundary
County boundary
Capital
City
Crushed stone/sand & gravel districts
MINERAL SYMBOLS
Ag Silver
Au Gold
Ba Barite
Cem Cement plant
Clay Clay
CS Crushed Stone
Cu Copper
Dia Diatomite
Dia Diatomite plant
Gyp Gypsum
Hg Mercury
Li Lithium
Lime Lime plant
Mg Magnesium
Per Perlite
Salt Salt
Sb Antimony
SG Sand and Gravel
Si Silica

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Barite:			
Milpark Drilling Fluids Inc.	Box 22111 Houston, TX 77242	Surface mine and mill	Lander.
M-I Drilling Fluids Inc.	Box 42842 Houston, TX 77242	do.	Nye.
Baroid Drilling Fluids Inc.	3000 Sam Houston Pkwy. Houston, TX 77251	Surface mine	Elko.
Cement:			
Centex Corp., Nevada Cement Co.	Box 895 Fernley, NV 89408	Plant	Lyon.
Clays:			
IMV Division of Floridin Co.	Route Box 549 Amargosa Valley, NV 89020	Surface mine and mill	Nye.
Copper:			
Airmetco Inc.	100 Burch Dr. Yerington, NV 89447	do.	Lyon.
Alta Gold Co.	Box 324 East Ely, NV 89315	do.	White Pine.
Cyprus Minerals Co.	Box 3299 9100 E. Mineral Circle Engelwood, CO 80155	do.	Esmeralda.
Diatomite:			
Eagle-Picher Industries Inc., Minerals Div.	Box 10480 Reno, NV 89510	Surface mine and plants	Lyon and Pershing.
Grefco Inc., Dicolite Div.	Box 288 Mina, NV 89422	Surface mine and plant	Esmeralda.
Moltan Co.	Box 860 Fernley, NV 89408	do.	Churchill.
Gold:[1]			
Newmont Gold Co., a subsidiary of Newmont Mining Corp.	Box 979 Carlin, NV 89822	Surface mine, mill, refinery	Eureka.
Round Mountain Gold Corp.	Box 480 Round Mountain, NV 89045	do.	Nye.
American Barrick Resources Corp.	Box 29 Elko, NV 89801	do.	Eureka.
Independence	Mountain City Star Route Elko, NV 89801	do.	Elko.
Battle Mountain Gold Co.	Box 1627 Battle Mountain, NV 89820	Surface mine and mill	Lander.
AMAX Gold Inc.	Box 1820 Winnemucca, NV 89445	do.	Humboldt.
Gypsum:			
Georgia Pacific Corp.	Box 30006 North Las Vegas, NV 89030	Surface mine and plant	Clark.
James Hardie Gypsum, Inc.	Box 2900 Las Vegas, NV 89124	do.	Clark.
Pacific Coast Building Products Inc.	Box 45 Newark, CA 94560	do.	Do.
USG Corp.	101 South Wacker Dr. Chicago, IL 60606	do.	Pershing.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Lime:			
Chemstar Inc.	901 Mariner's Island Blvd. Suite 425 San Mateo, CA 94404	Surface mine and plant	Clark.
Continental Lime, Inc.	Box 2520 Wendover, NV 89883	do.	Elko.
Lithium carbonate:			
Cyprus Foote Mineral Co.	301 Lindenwood Dr. Suite 301 Malvern, PA 19335-1740	Dry lake brines and plant	Esmeralda.
Magnesite:			
Premier Services Inc.	Box 177 Gabbs, NV 89409	Surface mine and mill	Nye.
Mercury:			
FMC Corp.	Box 1237 Hawthorne, NV 89415	Surface mine and plant	Do.
Perlite (expanded):			
USG Corp.	Empire, NV 89405	Plant	Washoe.
Wilkin Mining and Trucking Co.	Box 472 Panaca, NV 89042	Underground mine and plant	Lincoln.
Salt:			
Huck Salt Co.	895 Harrigan Rd. Fallon, NV 89406	Solar evaporation	Churchill.
Sand and gravel:			
Construction:[1]			
Nevada Ready Mix Co.	Box 530 Las Vegas, NV 89125	Pit	Clark.
Las Vegas Paving Corp.	1770 South Industrial Rd. Las Vegas, NV 89102	Pit	Do.
Robert L. Helms Construction Co.	Drawer 608 Sparks, NV 89432-0608	Pit	Lander and Washoe.
WMK Transit Mix, Inc. CSR Corp.	Box 14697 Las Vegas, NV 89114	Pits and mills	Clark.
Wells Cargo Inc.	Box 159 Wadsworth, NV 89442	Pit and mill	Washoe.
Granite Construction Co.	Box 2087 Sparks, NV 89432	Pits and mills	Do.
Bonanza Materials (Beazer USA)	565 Lalif Road Henderson, NV 89015	do.	Clark.
Frehner Construction Co.	124 W. Brooks Ave. North Las Vegas, NV 89030	do.	Do.
Southern Nevada Paving	3555 Polaris Ave. Las Vegas, NV 89102	Surface mine and plant	Do.
Sha-Neva	Drawer 669 Truckee, CA 95739	do.	Washoe.
Crushed stone:			
All-Lite Aggregate	Box 10865 Reno, NV 89510	do.	Storey.
Basalite	2600 Boeing Way Carson City, NV 89706	do.	Lyon.
Rilite Aggregate Co.	Box 11767 Reno, NV 89511	do.	Washoe.

See footnotes at end of table.

TABLE 4—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Crushed stone—Continued:			
Rocky Ridge, Inc.	Box 2669 Truckee, CA 95737	Surface mine and plant	Washoe.
Southern Nevada Lightweight	4675 Wynn Rd. Las Vegas, NV 89103	do.	Clark.
Industrial sand:			
Simplot Industries	Box 308 Overton, NV 89040	do.	Do.
Silver:			
Coeur-Rochester Inc.	Box 1057 Lovelock, NV 89419	do.	Pershing.
FMC Corp.	Box 1237 Hawthorne, NV 89415	do.	Nye.
NERCO Minerals Co.	Box 1246 Hawthorne, NV 89415	do.	Mineral.
Stone:			
Centex Corp., Nevada Cement Co.	Box 895 Fernley, NV 89408	Quarry	Lyon.
Chemstar Inc.	901 Mariner's Island Blvd. Suite 425 San Mateo, CA 94404	Quarries	Clark.
Southern Nevada Lightweight	4675 Wynn Rd. Las Vegas, NV 89103	Quarry	Do.

[1]Listed in descending order of production.

THE MINERAL INDUSTRY OF NEW HAMPSHIRE

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the New Hampshire Department of Environmental Services for collecting information on all nonfuel minerals.

By Donald K. Harrison[1]

The value of New Hampshire's nonfuel mineral production in 1992 was $42 million, an $11.6 million increase over that of 1991. The primary reason for the gain was an increase in production of construction sand and gravel over 1991 estimates. Estimated output of crushed stone, the State's second leading mineral commodity in terms of value, also increased in 1992. Dimension stone, common clay, and a small amount of gemstones accounted for the remainder of the State's mineral value. Gypsum, imported into the State, was calcined at two plants in Rockingham County.

TRENDS AND DEVELOPMENTS

After steadily declining for the past 4 years, overall construction activity in New Hampshire finally began to turn around. Although well below the peak building year of 1988, the overall value of construction projects in 1992 rose 25% over that of 1991. The largest gains were recorded in residential and nonresidential construction. The value of residential contracts experienced the largest gain, rising 45% above that of 1991; nonresidential construction contract values rose by 37%. The only category of construction that declined was nonbuilding contracts, which fell by 24%. This decline, however, was not enough to offset the large increases in the other categories. Because most of New Hampshire's mineral production is used by the construction industry, the turnaround resulted in higher output of all of the State's mineral commodities. Output of sand and gravel, the State's most valuable mineral commodity, rose 37%. Estimated crushed and dimension stone output increased by 10% and 8%, respectively, while clay production, used primarily to manufacture face brick, more than doubled. Although most of the face brick was marketed in Boston, MA, construction activity in Massachusetts also increased in 1992 after steadily declining since 1988.

EMPLOYMENT

In 1992, the average number of workers employed in the mineral extractive industries in New Hampshire was 396, slightly more than that of 1991.[2] This included 259 at sand and gravel operations, 123 at crushed and dimension stone operations, and 14 workers at mineral-related mills and preparation plants in the State.[3]

LEGISLATION AND GOVERNMENT PROGRAMS

Senate bill 332 was introduced into the 1992 legislative session to help in the cleanup of municipally owned toxic waste sites, at least one of which was a former sand and gravel pit. The bill was to provide $80 million over 7 years to help municipalities in the cleanup of at least six U.S. Environmental Protection Agency (EPA) designated Superfund waste sites identified in the State. The measure would set up a State bond to allow any community to receive up to $20 million for the investigation, design, and cleanup of dumps where the community was determined to be the primary "responsible party." However,

TABLE 1
NONFUEL MINERAL PRODUCTION IN NEW HAMPSHIRE[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$38	NA	$31	NA	$4
Sand and gravel (construction)	thousand short tons	7,901	26,599	e4,700	e16,200	6,436	25,570
Stone:							
Crushed	do.	e600	e2,500	1,542	9,148	e1,700	e11,000
Dimension	short tons	r e16,559	r e6,910	34,803	5,013	e37,647	e5,460
Total[2]		XX	r36,047	XX	30,392	XX	42,034

eEstimated. rRevised. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Partial total, excludes values which must be concealed to avoid disclosing company proprietary data.

the bill, as introduced, was killed by the Senate.

Chapter 37, signed into law in April, designated gold panning as a small motor activity not requiring a small motor mineral dredging permit. The bill had the support of both recreational prospectors and the New Hampshire Department of Environmental Services (DES).

In December 1991, the New Hampshire State Geologist was placed on furlough owing to reductions in State expenditures and the continuing weakened economy in the State. In July 1992, however, the position was reinstated and the New Hampshire Geological Survey (NHGS) was restored under a DES directive. The NHGS primarily supports the activities of the DES and other State agencies. NHGS is also committed to (1) geologic response to public inquiries; (2) expansion of the geologic data base of the State; (3) management of the preparation and distribution of State geologic publications, and (4) general liaison with other States, the Federal Government, other countries, and geologic professional associations.

Despite the 7-month hiatus in 1992, the NHGS continued to maintain a COGEOMAP research program with the U.S. Geological Survey (USGS) in progress since 1984. The purpose of the program is to map the surficial geological deposits in the State at a 1:24,000 scale, and ultimately, produce a new State map at a 1:100,000 scale and topical reports. Final revisions of a new bedrock map of New Hampshire (1:250,000 scale) were sent to the USGS for publication.

NHGS, together with the five other New England State Geologists, began a study financed by the Minerals Management Service, U.S. Department of the Interior, to assess the availability of onshore sand and gravel in the region. The supply study is the second phase of a total resource assessment; the first phase, which involved a demand projection, was published in January. In the supply assessment, a series of maps are being prepared for each State to show sand and gravel deposits and areas that are off limits to mining. The volumes of aggregate that are off limits will be subtracted to give a presently usable volume. The study is expected to be completed in late 1993. Following completion of the supply study, the demand and supply studies will be used to draw conclusions on the regional construction aggregate outlook and forecast whether offshore supplies of sand and gravel will be needed to meet future demand. A final report of the findings will be published with recommendations for future initiatives.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Clays.—Kane-Gonic Brick Corp., the State's only clay producer, mined common clay at a pit in Gonic, Strafford County. The clay was used to manufacture face brick and was marketed primarily in the Boston, MA, area.

Gypsum.—Two companies calcined imported gypsum in New Hampshire. In 1992, production rose 20% over that of 1991 primarily because of an overall pick up in construction activity in the State. Most of the calcined gypsum was made into wallboard.

National Gypsum Co. operated a wallboard manufacturing plant at Portsmouth, Rockingham County. Crude gypsum for the plant was imported from the company's subsidiary in Canada through the Port of Portsmouth.

Domtar Gypsum Inc. operated a gypsum wallboard manufacturing plant along the Piscataqua River in Newington, Rockingham County. Crude gypsum for the plant was shipped from a company-owned quarry in Newfoundland, Canada.

Domtar is underwriting the cost of a program in the towns of Dover and Lee to collect and recycle gypsum wallboard primarily from general contractors and private home builders who previously took it to a landfill. In the first 2 weeks of operation, more than 6 tons of wallboard was collected. The program, the only one of its kind in New Hampshire, is being run through the combined efforts of the towns of Dover and Lee, the University of New Hampshire, and Domtar. If the program proves to be a success, the organizers of the program hope to expand it to include the entire New Hampshire seacoast area.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Construction sand and gravel was the State's leading mineral commodity produced and accounted for almost two-thirds of the State's total mineral value. In 1992, output increased almost 37% over the 1991 estimated figure. The increase was largely attributable to an increase in construction activity in 1992. A total of 31 companies mined construction sand and gravel from 53 operations at 62 pits in 10 counties. Leading counties, in order of output, were Merrimack, Hillsborough, Carroll, Strafford, and Grafton. Major uses were for concrete aggregate, asphaltic concrete, and road base.

The State's new sand and gravel mining regulations (Chapter 310), which was signed into law in 1991, has caused some controversy and confusion for both operators and township planning boards in the State. Under the new State law, owners of existing sand and gravel operations should have submitted a report of the site's continued use to the local planning board by August 4, 1991. In the town of Wilton, for example, the planning board estimated that there were at least six grandfathered sand and gravel operations that may have lost their "grandfathered" status and may be classified as abandoned. The State law reads that an excavation becomes "abandoned" if the owner has neither secured a permit nor filed a report of existing excavation by the cutoff date. An abandoned pit, to restart operation, would need to obtain a permit and would lose its grandfathered status.

TABLE 2
NEW HAMPSHIRE: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	1,185	$6,479	$5.47
Plaster and gunite sands	W	W	6.65
Concrete products (blocks, brick, pipe, decorative, etc.)	4	28	7.00
Asphaltic concrete aggregates and other bituminous mixtures	597	3,552	5.95
Road base and coverings	912	3,342	3.66
Fill	928	2,013	2.17
Snow and ice control	157	492	3.13
Railroad ballast	64	146	2.28
Other miscellaneous uses[1]	1,359	5,032	3.70
Unspecified:[2]			
Actual	385	1,213	3.15
Estimated	844	3,274	3.88
Total[3]	6,436	25,570	3.97
Total[4 5]	5,839	25,570	4.38

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes filtration.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data may not add to totals shown because of independent rounding.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

Stone.—Crushed stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—Crushed stone was the State's second leading mineral commodity produced in terms of value. Estimated crushed production rose 10% over that reported in 1991. Crushed granite, traprock, and limestone were produced by an estimated 9 companies at 10 quarries in 5 counties. Leading counties, in order of output, were Hillsborough, Rockingham, Merrimack, Cheshire, and Grafton. Main uses were for roadbase, bituminous aggregate, road surfacing, macadam, and concrete aggregate.

Dimension.—New Hampshire ranked eighth of 34 States that produced dimension stone in 1992. Dimension granite was mined by three companies at three quarries, two in Hillsborough County and one in Merrimack County. Primary uses were for rough blocks, curbing, and monumental stone.

The Barretto Granite Corp., a family-run dimension stone operation for more than 40 years, was purchased by a Chelmsford, MA, company. In recent years, Barretto had cut its work force in half owing to financial problems and a decrease in business. Fletcher Granite Co., a subsidiary of the Australian building materials conglomerate, Pioneers International Limited, bought the company after a consulting firm negotiated with the Federal Deposit Insurance Corp. Under the new ownership, the company is now going by the name of Baretto-Fletcher Granite Corp.

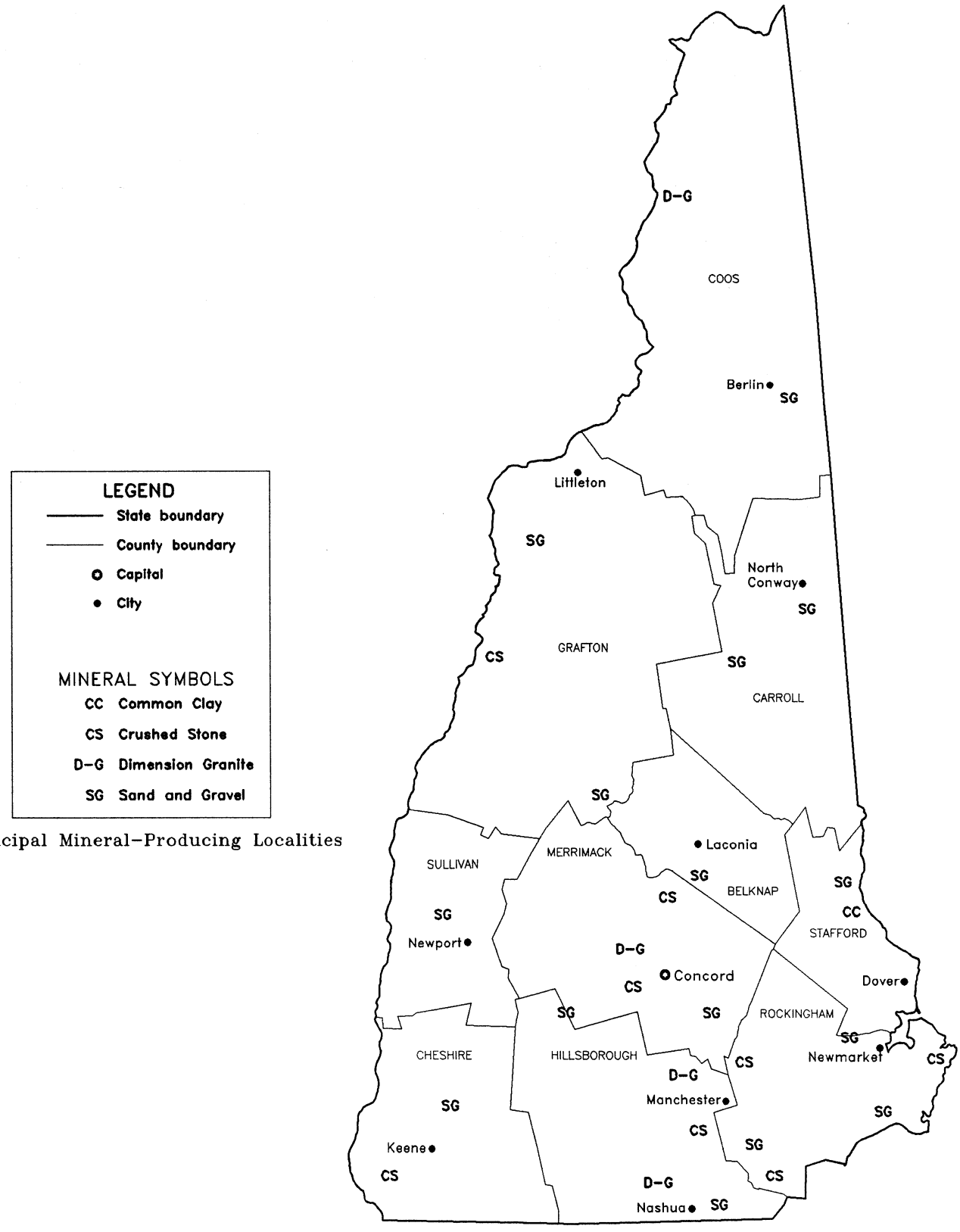
J. Swenson Granite Co. Inc., Concord, signed an agreement with Rock of Ages Asia Corp., a new corporation formed by Rock of Ages Corp., Barre, VT, and a Japanese firm. The new corporation will engage in the sale of granite supplied by J. Swenson Granite, Rock of Ages, Royalty Granite Corp. of Carleton, GA, and other granite suppliers to Japan, Taiwan, Republic of Korea, and other potential markets in Asia. Estimated sales for Rock of Ages Asia's first year of operation are in excess of $7.5 million.

[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related experience and has covered the mineral activities in New Hampshire for 8 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]"Average number of workers" is a summary of the average number of workers at individual mining establishments during periods (not necessarily continuous) of active operations.

[3]U.S. Department of Labor, Mine Safety and Health Administration. Mine Injuries and Worktime Quarterly, Jan.-Dec. 1992, 32 pp.

NEW HAMPSHIRE



Principal Mineral–Producing Localities

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Clays:			
Kane-Gonic Brick Corp.	Box 7400 Gonic, NH 03867	Pit	Strafford.
Gypsum (calcined):			
Domtar Gypsum Inc.	1222 Old Dover Rd. Newington, NH 03801	Plant	Rockingham.
National Gypsum Co.	4100 First International Bldg. Dallas, TX 75270	do.	Do.
Sand and gravel:			
Brox Industries	1471 Methuen St. Dracut, NH 01826	Pits	Carroll, Hillsborough, Merrimack, Strafford.
Coastal Material Corp.	Box 415, Dunbarton Rd. Manchester, NH 03105	do.	Hillsborough and Strafford.
Concord Sand & Gravel Inc.	Route 106, Box 1133 Concord, NH 03301	Pit	Merrimack.
Manchester Sand & Gravel	Box 16425 Hooksett, NH 03106	Pits	Do.
Plourde Sand & Gravel Co. Inc.[1]	21 Union St. Suncook, NH 03275	Pit	Do.
Twin States Sand & Gravel Co.	Box 5243 West Lebanon, NH 03784	Pit	Grafton.
A. Whitcomb Inc.[1]	Lancaster Rd. Gorham, NH 03581	Pits	Belknap, Cheshire, Coos, Grafton.
Stone (1990):			
Crushed:			
Continental Paving Inc.	1 Continental Dr. Londonderry, NH 03053	Quarry	Rockingham.
John Iafolla Co. Inc.	Peverly Hill Rd., Box 840 Portsmouth, NH 03801	do.	Do.
Lebanon Crushed Stone Co.	Plainfield Rd. West Lebanon, NH 03784	do.	Grafton.
Pike Industries	U.S. Rte. 3 RFD 2, Box 9 Tilton, NH 03276	Quarries	Merrimack.
F. W. Whitcomb Construction Corp.	Box 100 Walpole, NH 03608	Quarry	Cheshire.
Dimension:			
Fletcher Granite Co. Inc.	Groton Rd. W. Chelmsford, MA 01863	do.	Hillsborough.
Kitledge Granite Corp.	Armory Rd. Milford, NH 03055	do.	Do.
J. Swenson Granite Co.	North State St. Concord, NH 03301	do.	Merrimack.

[1]Also crushed stone.

THE MINERAL INDUSTRY OF NEW JERSEY

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the New Jersey Geological Survey, New Jersey Department of Environmental Protection & Energy, Division of Science and Research, for collecting information on all nonfuel minerals.

By Donald K. Harrison[1]

The value of nonfuel mineral production in 1992 was $240.4 million, a $35.5 million increase over that of 1991. This was the first increase in value since 1989 when the alltime high of $249 million was reported. The combined value of crushed stone and construction sand and gravel, the State's two leading mineral commodities, accounted for 85% of the mineral production value. Other mineral commodities produced included common and fire clays, industrial sand, greensand, peat, titanium, and zircon concentrates. Industrial minerals processed or recovered included gypsum, iodine, perlite, steel slag, sulfur, and vermiculite. New Jersey was the only State that produced greensand, which was used primarily for water filtration. It was one of only two States that produced zircon and rutile and one of only three States where ilmenite was recovered. The State ranked fourth of 38 States that mined industrial sand and fourth in exfoliated vermiculite output.

TRENDS AND DEVELOPMENTS

In contrast to a nationwide increase of 14% in the overall value of construction contracts in 1992, the total value of contract construction in New Jersey was down nearly 12% from that of 1991. The hardest hit sector was in nonresidential construction, which declined by almost 19%. Nonbuilding construction also declined by 15%. Residential construction saw a slight gain of 4% during the same period. However, near yearend there were signs of stabilization in the State's badly depressed construction industry, which has lost 70,000 jobs (or 41%) of its work force over the past 4 1/2 years. Because aggregate producers rely heavily on a healthy construction industry, the continuing slump in this industry was reflected in stagnant growth of the State's mineral industry.

However, the long-term construction outlook for the State looked favorable. During the year, the New Jersey Department of Transportation proposed a $1.5 billion transportation program for 1993, the largest in the State's history. The program should provide thousands of construction jobs, while improving mass transit and repairing many of the State's deteriorated roads. However, passage of the program depends on the New Jersey Legislature removing the statutory cap on the State's Transportation Trust Fund.

TABLE 1
NONFUEL MINERAL PRODUCTION IN NEW JERSEY[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$3	NA	$3	NA	$1
Peat	thousand short tons	W	527	W	541	W	W
Sand and gravel:							
Construction	do.	13,862	64,245	e10,300	e47,900	16,416	79,993
Industrial	do.	1,762	26,190	1,634	23,738	1,518	24,727
Stone (crushed)	do.	e21,200	e131,700	[2]16,680	[2]119,287	e[2]17,100	e[2]126,000
Combined value of clays (common, fire), greensand marl, stone [crushed sandstone and other (1991-92)], titanium concentrates [ilmenite and rutile (1991-92)], zircon concentrates, and values indicated by symbol W		XX	6,805	XX	13,519	XX	9,718
Total		XX	229,470	XX	204,988	XX	240,439

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain stones; value included with "Combined value" figure.

According to the New Jersey Concrete & Aggregate Association, the combination of the trust fund, Federal spending, and various bond issues was expected to provide $5 billion for public works projects during the next 3 to 5 years. The association also noted that residential and commercial markets were expected to stay stagnant in 1993.[2]

In a decision that could cost municipalities millions of dollars in revenue, the New Jersey State Tax Court changed the ways in which wetlands may be taxed. In a case involving an undeveloped 240-acre tract of wetlands in East Rutherford, a State tax court judge ruled that because Federal and State regulations restrict the development of wetlands, the tract must be taxed as undeveloped land, not on the basis of its potential commercial value. The assessment value of the 240-acre tract was reduced from $20 million to $1 million. The decision could have national impact because wetlands are controlled under the Federal Clean Water Act. New Jersey is one of several States whose wetlands protection laws are stricter than Federal requirements.[3]

EMPLOYMENT

In 1992, the average number of workers[4] employed in surface mining in New Jersey was 1,697. Most of these workers (1,284) were employed at sand and gravel operations. There were no underground mining operations in 1992. Mineral-related mills and preparation plants in the State employed 343 workers.[5]

ENVIRONMENTAL ISSUES

The Nuclear Regulatory Commission (NRC) announced that the owner of the Heritage Minerals Inc. tract in Lakehurst had until 1995 to remove radioactive minerals from a 7,000-acre parcel in the township. Between 1987 and 1991, Heritage Minerals had recovered zircon and lecontite from tailings piles at the former ASARCO Incorporated titanium plant operations. Radioactive minerals in the monazite-rich sands on the site are thorium and uranium.[6]

In October, the U.S. Environmental Protection Agency (EPA) and the Department of Justice asked a bankruptcy court to approve a $27 million settlement with CF&S Steel Corp. and its subsidiaries for cleanup costs associated with the Roebling Steel Superfund Site in Roebling. CF&S owned and operated the now defunct steel mill from 1954 to 1972. The facility ceased operations in 1982, and in 1988, the site was placed on EPA's national priorities list for hazardous waste cleanups. According to the EPA, total cleanup costs are expected to reach $100 million. The 250-acre site is contaminated with PCB's, baghouse dust, lead-contaminated soil, and slag piles.

LEGISLATION AND GOVERNMENT PROGRAMS

Several bills concerning environmental issues were signed into law in 1992. Chapters 27 and 97 concerned the siting of hazardous and radioactive waste, respectively. Chapter 85, dealing with research on hazardous substance treatment, was signed into law, as well as other bills concerning recycling (chapters 98, 167, and 168). Although many bills related to environmental issues were introduced in 1992, most of these remained in committee and were scheduled to be carried over into the 1993 legislative session.

The State Department of Transportation's proposed $1.5 billion transportation fund for 1993 depends on the New Jersey Legislature removing the statuary cap on the Transportation Trust Fund construction program. Senate bill 510, which would remove the restriction, remained in the transportation committee at yearend.

The New Jersey Geological Survey (NJGS), part of the Department of Environmental Protection and Energy, Division of Science and Research, continued to be the primary State agency responsible for investigating the State geology and mineral and water resources.

Research in 1992 included a study of aggregate and heavy-mineral resources from vibracore samples taken from offshore northern New Jersey and northern Coastal Plain sediments. The study is attempting to define the occurrence and sources of heavy minerals in northern Coastal Plain sediments. Results of the study are expected to be completed in 1993. A cooperative agreement between the NJGS and the U.S. Geological Survey (USGS) resulted in the completion of a surficial geologic map of northern New Jersey. In 1992, the map was in review. Work on a surficial geologic materials map (scale 1:48,000) and a map showing the karst features and abandoned mines of Warren County was also under way. The latter map will depict the locations of all operating and abandoned mines, pits, and quarries. There are more than 80 known abandoned iron mines in Warren County. The expected completion date of both of these maps is June 1993.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Clays.—Two companies reported clay production in the State. Glen-Gery Brick produced common clay and shale at an operation in Somerset County, and The Morie Co. Inc. mined fire clay in Cumberland County. Common clay was used primarily for manufacturing common brick; fire clay was used primarily in foundries.

In September, the DuPont Co. acquired an option to purchase a clay property in Alloway Township. DuPont had purchased clay from the 164-acre site for the past 12 years. The clay would be used for a landfill the company is planning to build at its Deepwater facilities. The company is building an incinerator at the Deepwater plant and needs a location to dispose of its waste ash. Previously, the clay was used in the closure of ditches at the site where chemical runoff formerly occurred.[7]

Greensand.—New Jersey was the only

TABLE 2
NEW JERSEY: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	8,114	$41,499	$5.11
Plaster and gunite sands	183	1,036	5.66
Concrete products (blocks, brick, pipe, decorative, etc.)	559	2,534	4.53
Asphaltic concrete aggregates and other bituminous mixtures	767	3,271	4.26
Road base and coverings[1]	1,134	6,091	5.37
Fill	1,089	3,953	3.63
Snow and ice control	76	326	4.29
Other miscellaneous uses[2]	400	2,238	5.60
Unspecified:[3]			
Actual	2,619	11,389	4.35
Estimated	1,475	7,656	5.19
Total	16,416	79,993	4.87
Total[4 5]	14,892	79,993	5.37

[1]Includes road and other stabilization (cement).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

State that produced greensand. The Inversand Co., a subsidiary of Hungerford and Terry Inc., Clayton, Gloucester County, was the only producer. In 1992, production decreased about 10% from that of 1991 although value remained essentially the same because of higher unit values. Greensand, also known as the mineral glauconite, is a hydrous iron potassium silicate containing various amounts of aluminum, magnesium, sodium, and trace elements. It was processed and sold mainly as a filtration medium to remove soluble iron and manganese from well water. A secondary use was as an organic conditioner for soils.

Peat.—New Jersey ranked sixth of 20 States that reported peat sales. Two companies mined peat in 1992, one in Sussex County and one in Warren County. Most of the peat was sold for general soil improvement and as an ingredient in potting soil.

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

New Jersey construction sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 3 presents these statistics for the three New Jersey districts.

Construction sand and gravel was the State's second leading mineral commodity produced, accounting for one-third of the State's mineral value. Construction sand and gravel was produced by 49 companies at 65 pits in 17 of the State's 21 counties. Leading counties, in order of output, were Middlesex, Ocean, Morris, Sussex, and Cumberland. Major uses were for concrete aggregates, fill, and roadbase and coverings.

In July, Egg Harbor Township Committee passed an ordinance that restricts sand and gravel mining in the township. In addition to barring any new operations, mining below the water table was prohibited. Ole Hansen & Sons Inc., one of two sand and gravel operators in the township, filed a lawsuit in Superior Court in September. The company, which has been mining sand and gravel at the site for 40 years, contends that the restriction to mine below the water table would essentially put it out of business.

Genstar Stone Products Co., MD, was appealing the Millville Planning Board's rejection in April of the company's sand and gravel mining proposal in the township. Genstar was proposing to mine 1,500 of 2,000 acres it leased from George Pettinos Inc. The company wanted to mine the tract over a 100-year period in 17 phases, with each phase lasting several years. In rejecting the proposal, members of the planning board cited their concern about the future land use plan and the vastness of the project that could last for 100 years. Other concerns included ground water conditions, questions of air quality, noise pollution, and increased traffic in the proximity of a new elementary school.[8]

Industrial.—Nationally, New Jersey ranked fourth of 38 States that produced industrial sand in 1992. The State also accounted for two-thirds of the northeast region's production, which included the six New England States, New York, Pennsylvania, and New Jersey. In 1992, 7 companies operated 12 pits in 6 counties and produced 1.5 million short tons valued at $24.7 million. The majority of the State's production was mined in Cumberland County. Other counties that produced industrial sand, in descending order of tonnage, were Ocean, Camden, Atlantic, Cape May, and Gloucester. Principal uses for the industrial sand were for glass products, molding and core, and sandblasting.

U.S. Silica Co.'s Millville plant in Newport won first place in the dredge group in the Sentinels of Safety awards program sponsored by the Mine Safety and Health Administration and the American Mining Congress. To qualify for the award, a company had to compile

TABLE 3

NEW JERSEY: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	1,833	9,244	3,443	20,613	2,838	11,642
Plaster and gunite sands	99	701	W	W	W	W
Concrete products (blocks, brick, etc.)	343	1,572	12	167	204	796
Asphaltic concrete aggregates and other bituminous mixtures	198	957	W	W	W	W
Road base and coverings[1]	874	4,815	38	212	222	1,064
Fill	635	2,995	59	149	395	810
Snow and ice control	59	263	16	W	1	W
Other miscellaneous uses[2]	317	1,858	265	1,068	471	2,024
Unspecified:[3]						
Actual	70	175	1,826	7,878	722	3,336
Estimated	211	915	602	2,564	663	4,177
Total[4]	4,638	23,495	6,263	32,650	5,515	23,849
Total[5 6]	4,208	23,495	5,682	32,650	5,003	23,849

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

at least 30,000 employee work-hours at an individual operation during the year without a lost-time injury or fatality. The Millville plant logged 85,755 hours without a lost-time injury or fatality in 1992.[9]

Stone (Crushed).—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed stone, the State's leading mineral commodity, accounted for slightly more than one-half of the State's total mineral value. Estimated crushed stone production in 1992 totaled 17.1 million short tons valued at $126 million. Traprock, granite, limestone, and sandstone, in descending order of production, were quarried for crushed stone. Leading counties, in order of output, were Somerset, Morris, Passaic, Mercer, Sussex, and Hunterdon. Main uses of crushed stone were for concrete aggregate, road base and coverings, and bituminous aggregate.

In late 1991, nearly 3,000 residents of Hopewell Township petitioned the township committee to reject Trap Rock Industries' proposal to expand its 166-acre quarry in the township into part of the 940 acres the company owns on nearby Kuser Mountain. In September 1992, members of the township committee declared that they will not give any more consideration to the company's proposal. Trap Rock owns 940 acres of the 2,000-acre mountain. Approximately 150 acres of Trap Rock's land is zoned for mining; the other 750-plus acres is zoned residential. The company is currently allowed to mine to 60 feet above sea level or roughly ground level. In exchange for the expansion, Trap Rock agreed to donate a major portion of the mountain to the township as an open-space preservation area. Trap Rock's current zoning permit will allow the company to mine the area for about another 20 years.

In April, a new rail facility was opened in Camden that will provide crushed limestone for ready-mix concrete and asphalt operators in southern New Jersey. The terminal, opened at an investment of $1 million by Wimpey Minerals Inc. has a 75,000-short-ton ground storage capacity. The company quarries crushed limestone in eastern Pennsylvania.

Other Industrial Minerals.—In addition to the mineral commodities mined and listed in table 1, the production and value of some processed or manufactured mineral commodities were also surveyed by the U.S. Bureau of Mines.

Gypsum imported from Nova Scotia, Canada, was calcined by the National Gypsum Co., Burlington County, and by Domtar Gypsum, Camden County. Most of the calcined gypsum was made into wallboard.

Crude iodine was shipped into New Jersey by four companies to manufacture various iodine-containing compounds. Most of the material was used as

inorganic compounds. One company produced organic pharmaceutical products.

Crude perlite from out-of-State was expanded by The Schundler Co., Middlesex County, and sold primarily for horticultural purposes, cavity-fill insulation, and other fillers.

Steel slag was produced by two companies, one in Burlington County and the other in Middlesex County.

Elemental sulfur was recovered as a nondiscretionary byproduct at two refineries in the State. The sulfur was used in the manufacture of sulfuric acid, fertilizers, plastics, and other products. During the year, DuPont closed its 200,000-metric-ton-per-year Grasselli sulfuric acid plant in Linden. The company cited a decrease in demand for the product.

Nord Ilmenite Corp., a wholly owned subsidiary of Nord Resources Corp., recovered titanium (ilmenite and rutile) and zircon concentrates from tailings at Jackson. Monazite also was recovered and reportedly sold for further upgrading.

Crude vermiculite, shipped from out-of-State, was exfoliated by three companies in 1992. Principal uses were for insulation, lightweight building aggregate, and horticultural agents.

Metals

AMAX Specialty Coppers Corp. produced oxygen-free copper (OFHC) and copper alloys at a plant in Carteret. The products were used in the electronics, plating, and construction industries.

Iron oxide pigments were produced by two companies in Camden and Middlesex Counties.

New Jersey Steel Corp. produced steel at an electric furnace minimill in Sayreville, Middlesex County. Almost all of the production was rebar. Raritan River Steel Co., a leading producer of wire rod, operated an electric arc furnace and continuous caster in Perth Amboy, Middlesex County.

[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related experience and has covered the mineral activities in New Jersey for 10 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Rock Products. ISTEA Should Heat Up 1993 Aggregate Market. V. 95, No. 12, p. 27.

[3]New York Times. Taxes Lowered on Wetlands Tract in New Jersey. May 1, 1992.

[4]"Average number of workers" is a summary of the average number of persons working at individual mining establishments during periods (not necessarily continuous) of active operations.

[5]U.S. Department of Labor, Mine Safety and Health Administration. Mine Injuries and Worktime Quarterly, Jan.-Dec. 1992, 32 pp.

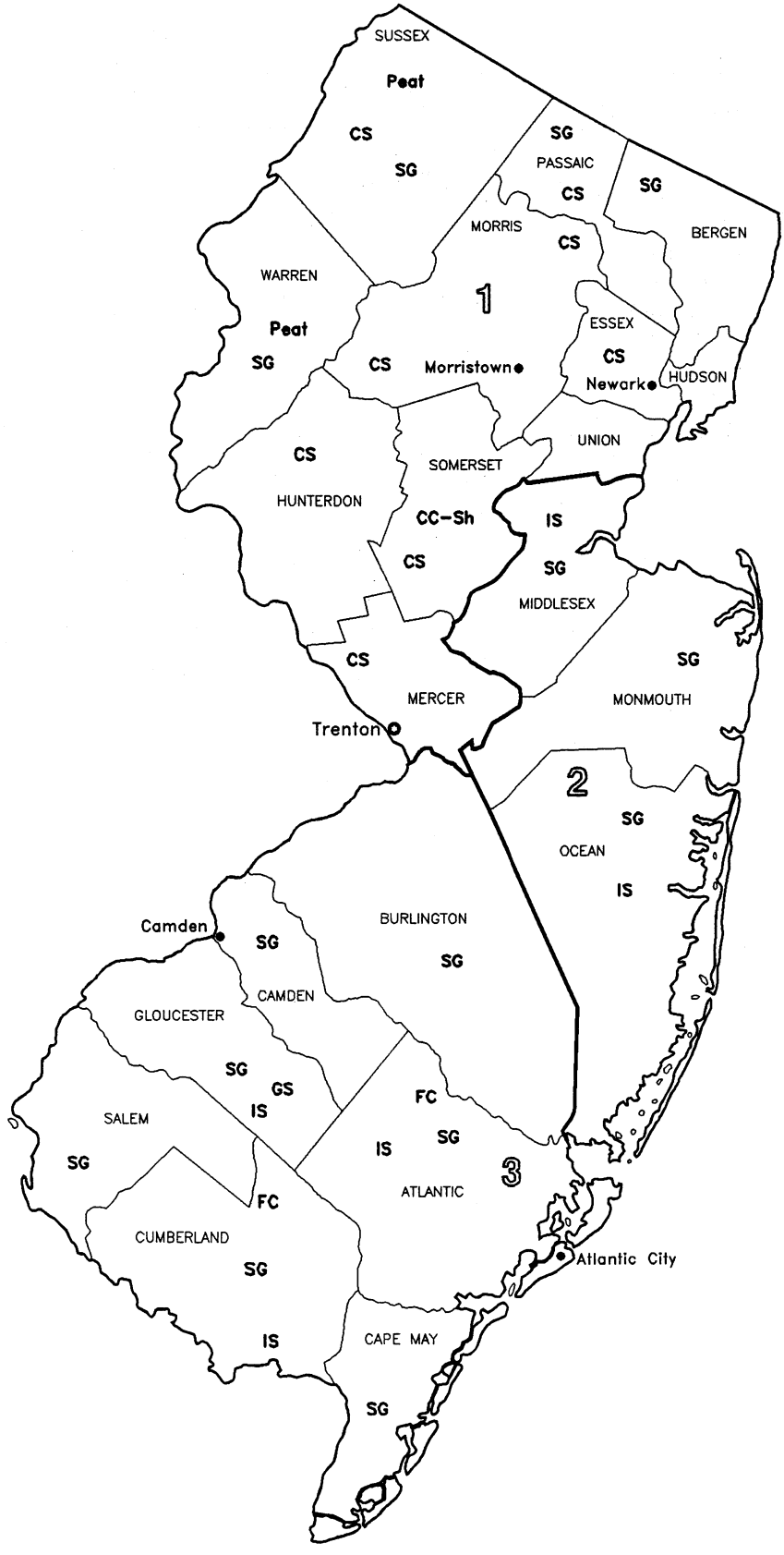
[6]Ocean County Times Observer. Old Mine To Get Radiation Cleanup. Apr. 23, 1992.

[7]Today's Sunbeam (Salem, NJ). DuPont Acquires Option in Clay Mine. Sept. 6, 1992.

[8]The Press (Atlantic City, NJ). Genstar Appeals Denial of Permit To Mine Sand. Aug. 25, 1992.

[9]Engineering and Mining Journal. Mining Operations Honored for Outstanding Safety Records. V. 193, No. 9, Sept. 1992, p. 16AA.

NEW JERSEY



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

CC-Sh	Common Clay & Shale
CS	Crushed Stone
FC	Fire Clay
GS	Greensand
IS	Industrial Sand
Peat	Peat
SG	Sand and Gravel

Principal Mineral-Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Clays:			
The Morie Co. Inc.[1]	1201 North High St. Millville, NJ 08322	Pit	Cumberland.
Glen-Gery Brick	75 Hamilton Rd. South Somerville, NJ 08876	Pit and plant	Somerset.
Greensand:			
Inversand Co., a subsidiary of Hungerford & Terry Inc.	Box 650 Clayton, NJ 08312	Pit	Gloucester.
Gypsum (calcined):			
Domtar Gypsum Inc.	1101 South Front St. Camden, NJ 08103	Plant	Camden.
National Gypsum Co.	2001 Rexford Rd. Charlotte, NC 28211	do.	Burlington.
Iron oxide pigments (finished):			
American Minerals Inc.[2]	Box 677 Camden, NJ 08101	do.	Camden.
Columbian Chemicals Co.	303 Hoffmeister Ave. St. Louis, MO 63125	do.	Middlesex.
Peat:			
Glacial Soils Lab	346 Grand Ave. Englewood, NJ 07631	Bog	Sussex.
Kelsey Humus Co.	Kelsey Park Great Meadows, NJ 07838	Bog	Warren.
Perlite (expanded):			
The Schundler Co.[3]	Box 251 Metuchen, NJ 08840	Plant	Middlesex.
Sand and gravel:			
Construction:			
Amboy Aggregates	Box 3220 South Amboy, NJ 08879	Dredge and plant	Middlesex.
Blue Circle American	Box 505 Hackensack, NJ 07602	Pit	Sussex.
Clayton Sand & Gravel Co.	Box 928 Lakewood, NJ 08701	Pits	Burlington and Ocean.
County Concrete Corp.	Box F, 50 Railroad Ave. Kenvil, NJ 07847	Pit	Morris.
Dallenbach Sand Co. Inc.	Box 407, Stonehouse Millington, NJ 07946	Pit	Middlesex.
Mays Landing Sand & Gravel Co.	Box 957 Marlton, NJ 08053	Pit	Cumberland.
The Morie Co. Inc.	1201 North High St. Millville, NJ 08332	Pits and plant	Atlantic, Cape May, Cumberland.
Tri County Asphalt Corp.[4]	R.D. 3, Box 561 Lake Hopatcong, NJ 07849	Pit	Morris.
Industrial:			
Unimin Corp., Dividing Creek Plant	258 Elm St. New Canaan, CT 06840	Pit	Cumberland.
U.S. Silica Co.	Box 458 Newport, NJ 08345	Pit	Do.
Ricci Bros. Sand Co. Inc.	Box 429, Dragston Rd. Port Norris, NJ 08349	Pit	Do.
Whitehead Bros. Co.	Box 259, River Rd. Leesburg, NJ 08327	Pits	Do.

See foonotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone (1991):			
Granite (crushed and broken):			
Mt. Hope Rock Products Inc.	625 Mt. Hope Rd. Wharton, NJ 07885	Quarry	Morris.
Passaic Crushed Stone Co. Inc.	Foot of Broad St. Pompton Lakes, NJ 07442	do.	Passaic.
Riverdale Quarry Co.	125 Hamburg Turnpike Riverdale, NJ 07457	do.	Morris.
Traprock (crushed and broken):			
Fanwood Crushed Stone Co.	141 Central Ave. Westfield, NJ 07090	do.	Union.
Millington Quarry Inc.	Box 407 Millington, NJ 07946	do.	Somerset.
Minnesota Mining & Manufacturing Co.	3M Center 224-6 SW St. Paul, MN 55101	do.	Do.
Stavola Construction Materials Inc.	810 Thompson Ave. Bound Brook, NJ 08805	do.	Do.
Trap Rock Industries Inc.	Box 419 Kingston, NJ 08528	Quarries	Hunterdon, Mercer, Somerset.
Sulfur (recovered):			
Exxon Co. U.S.A.	Box 2169 Houston, TX 77252	Refinery	Union.
Mobil Oil Corp.	Box 428 Paulsboro, NJ 08066	do.	Gloucester.
Vermiculite (exfoliated):			
W. R. Grace & Co.	62 Whittemore Ave. Cambridge, MA 02140	Plant	Mercer.
Zircon:			
Nord Ilmenite Corp.[5]	Box 118 Jackson, NJ 08527	do.	Ocean.

[1]Also industrial sand.
[2]Also milled zircon.
[3]Also exfoliated vermiculite.
[4]Also crushed stone.
[5]Also ilmenite and rutile.

THE MINERAL INDUSTRY OF NEW MEXICO

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the New Mexico Bureau of Mines and Mineral Resources for collecting information on all nonfuel minerals.

By Jean A. Dupree[1] and Robert W. Eveleth[2]

In national standing, the Land of Enchantment dropped in 1992 from 10th to 13th in total mineral value. Dropping 12% from 1991, New Mexico's 1992 nonfuel mineral production was valued at $871 million, 2.72% of U.S. total value. New Mexico continued to lead the Nation in potash and perlite output. It ranked second in the country in production of mica and pumice, third in U.S. copper production, and fourth in natural gas production. Values of copper and potash continued to lead other State mineral commodities by about a factor of 10. Relative to 1991 State performance, value of portland and masonry cement, common clay, crude gypsum, mica, perlite, potash, pumice, sand and gravel, crushed stone, and zeolites increased in 1992. Although its value inched up, potash production dropped slightly. Output of fire clay, gemstones, salt, and dimension stone declined. Partly because of several mine and mill closures, New Mexico's production of all metals dropped, and, during 1992, the State had no zinc output.

TRENDS AND DEVELOPMENTS

Depletion of mill-grade ore at Tyrone caused New Mexico's total 1992 copper production to drop about 16%, a decline offset somewhat by a production surge at both Tyrone and Chino solvent extraction-electrowinning (SX-EW) plants. State molybdenum output plummeted with the shutdown of Molycorp Inc.'s Questa Mine, and the Chino operation, a primary copper mine, assumed the role of being the State's largest (and only) molybdenum producer. Cyprus Minerals Co. continued development of a deep copper-rich ore body at its Pinos Altos Mine, and normal mine production resumed toward yearend. For the first time in several years, the company reported no zinc production. The November shutdown of Horizon Potash Inc.'s mine contributed to a decline in State potash output.

The State's construction industry

TABLE 1
NONFUEL MINERAL PRODUCTION IN NEW MEXICO[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2]	metric tons	27,994	$74	27,794	$74	32,645	$79
Copper[3]	do.	262,815	713,622	252,859	609,454	211,337	500,504
Gemstones		NA	225	NA	100	NA	34
Gold[3]	kilograms	888	11,041	W	W	W	W
Lead[3]	metric tons	W	W	193	142	W	W
Perlite	do.	454,500	13,181	W	W	W	W
Potash	thousand metric tons	1,451	245,571	1,469	250,900	1,436	256,620
Sand and gravel (construction)	thousand short tons	r10,311	r39,631	e9,200	e35,900	11,210	46,176
Silver[3]	metric tons	48	7,431	W	W	W	W
Stone (crushed)	thousand short tons	e2,400	e12,800	2,801	13,089	e3,000	e14,400
Combined value of cement (portland), clays (fire), gypsum (crude), helium Grade-A 1990-91), iron ore [includes byproduct material (1990), usable], mica (scrap), molybdenum, pumice, salt, stone (dimension), zinc, and values indicated by symbol W		XX	r9,445	XX	75,851	XX	53,466
Total		XX	r1,103,021	XX	985,510	XX	871,279

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; value included with "Combined value" figure.
[3]Recoverable content of ores, etc.

improved slightly during the year, fueled by strong growth in housing construction. According to an annual State economic review, single-family building permits rose a promising 22% compared to those in 1991.[3] In addition, the State Highway and Transportation Department's 1992-93 operating budget for highway construction, $375 million, was higher than its 1991-92 budget of $208 million. Beginning in 1992, monies from the new Intermodal Surface Transportation Efficiency Act began to enter the State highway construction budget.

During its final hours, the 102d U.S. Congress transferred authority over 10,000 acres of land at the Waste Isolation Pilot Project (WIPP) from the U.S. Department of the Interior to the Department of Energy (DOE). The 1992 land transfer ended the deadlock regarding progress at WIPP and enabled DOE to begin tests of its suitability as a transuranic waste storage facility.

EMPLOYMENT

Overall, New Mexico's economy improved during 1992. It was the second year that the State's growth rate in personal income outpaced the national average. New Mexico ranked 16th nationally in terms of unemployment in 1992 with 7.0% of its population out of work, compared with a U.S. average of 7.4% and the State's 1991 average unemployment of 6.9%.[4] Among the bright spots in the State's economy was a turnaround in the construction industry amounting to a 6% increase in jobs. Although 1992 nonagricultural employment increased from 585,400 jobs to 597,500, layoffs plagued the State's mining sector. Mining employed an average of 14,900 people in 1992, a loss of about 1,800 jobs from the previous year. The "mining" sector, as defined by the State Department of Labor, included those employed in metal mining, nonmetal mining, and oil and natural gas extraction. Metal mining employed an average of 1,500 people during 1992, a drop of almost one-third, or 600 employees, from the 1991 average. Employment at the State's coal, potash, and other nonmetal mines averaged 4,300, an improvement of 100 jobs. Average employment for 1992 in the oil and gas industry was 9,100, down 1,300 jobs from the 1991 average. Weakened interest in oil and gas exploration activity created much of the State oil industry loss.[5]

Three major 1992 layoffs affected New Mexico mining industry employees. In January, 180 people lost their jobs at Questa as Molycorp Inc. placed its mine on standby; only a skeleton staff remained to perform reclamation and maintenance in the event the molybdenum mine reopens. Although production from its SX-EW facility continued, Phelps Dodge Corp. released about 500 people in February when conventional mining and milling operations ended at Tyrone. Lastly, Horizon Resources Corp., citing bargain-basement prices for Russian potash, laid off 275 Carlsbad workers as the year ended. The U.S. Department of Labor provided $400,000 for workers laid off at Questa and Tyrone. Funds were allotted for reassessment, job development and placement, relocation assistance, on-the-job and classroom training, and support services for the unemployed.

ENVIRONMENTAL ISSUES

Heavy September rains brought another fish kill at Lisboa Springs Fish Hatchery near Pecos (San Miguel County) and, again, the culprit was alleged to be metal contamination washed down the Pecos River from the inactive Terrero Mine. The loss amounted to 15% of the hatchery's fish. The U.S. Environmental Protection Agency (EPA) agreed to work with State officials to try to keep Terrero from being included in the Superfund program. AMAX Inc. agreed to pay 80% and the State, 20% of the estimated $50 million in mine-site cleanup costs. Although the State acquired the surface rights to the property in 1950, 51% of the mineral rights were still held by AMAX Inc., corporate heir to American Metals Co., which operated Terrero during the 1920's and 1930's. Cleanup was expected to be finished by late 1995 or early 1996. Complicating the situation further, Terrero Mine tailings had been used years ago to surface roads and parking lots in Santa Fe National Forest. During 1992, the New Mexico Department of Game and Fish removed about 8,000 cubic yards of surfacing materials and trucked them back to the Terrero Mine.

The second phase of remedial investigation of the Cleveland Mill (Grant County) Superfund site, 5 miles north of Silver City, was conducted during late spring. The 5- to 10-acre site included an abandonned copper, lead, and zinc mill that stopped operating in 1947. The site was added to the National Priorities List in March 1989. On the site were two steep-sloped tailings piles described by EPA as unlined, uncovered, and unstabilized. Testing was conducted to determine whether contaminants from the tailings had entered ground water. Conducted by the New Mexico Environment Department under the auspices of EPA, the study involved aerial photography, geologic mapping, an ecological survey, and monitoring of four wells.

The town of Carrizozo (Lincoln County) and EPA signed an agreement in April to permit EPA to pump cyanide-contaminated water from the Cimarron Mill Superfund site into the municipal sewer system. During the 1980's, Southwest Minerals Corp. used the mill to extract gold but operated without a State permit for cyanide processing. Carrizozo officials asked EPA for permission to test water from the seven Cimarron site extraction wells before it was added to the sewer system. In addition, the town requested EPA to install automatic monitoring equipment that could shut off the flow if cyanide concentration surpassed the sewer system's ability to process it to safe drinking water standards. The town also asked EPA for $1,500 per month for use of its sewer system. At one point during the negotiations, EPA refused to meet with the town trustees and threatened financial penalties if the Agency was denied access to the sewage system. Well testing, as demanded by the town,

began in September.

EXPLORATION ACTIVITIES[6]

Effective October 30, Pegasus Gold Corp. canceled its joint-venture agreement with LAC Minerals Ltd. on the Ortiz Project. All rights, titles, and interests were transferred to LAC, thereby dissolving the exploration partnership that began in February 1989 and in which Pegasus had spent $19.2 million. Pegasus cited lack of success in renegotiating terms of the agreement with LAC as the reason for terminating the joint-venture partnership. LAC later declared it would continue its exploration effort in the area.

Vera Cruz Minerals Corp. announced that FMC Gold Co. encountered extensive gold-bearing breccia in two core holes drilled on the Vera Cruz project near Carrizozo. FMC, however, returned the property after drilling 10 holes.

Champion Resources Ltd., owner of the Jones Hill Precambrian massive-sulfide deposit near Pecos, failed to close a joint-venture deal with Western Mining Corp. of Australia to fund a deep drilling project. Champion continued to search for a partner to continue development of the property, purchased from Santa Fe Mining Co. and originally drilled by Conoco Inc.

According to the Society of Economic Geologists Newsletter, Biron Bay Resources Ltd. staked 8,000 feet of possible strike extensions of known epithermal base- and precious-metal mineralization in the Steeple Rock District. Echo Bay Mines Ltd. drilled at Victorio Peak near Deming for an unknown target. The Steins Pass-San Simon area of the Peloncillos Mountains attracted the attention of Americas Mining Corp. and local prospectors for precious metals. Cominco Ltd. acquired three prospects in the Lordsburg area. Royalstar Resources Ltd., a subsidiary of Noramco Mining, drilled the San Pedro copper-gold skarn near Albuquerque and reported encouraging results. Royalstar drilled the Spanish Pit, No. 1 West Stope, Home Tunnel, and Swan areas. Kennecott Corp. drilled a massive-sulfide target north of Taos. South of Picacho, Phelps Dodge Corp. drilled coincident aeromagnetic-gravity geophysical anomalies, presumably marking a deep, Precambrian layered mafic intrusion. The company lost the hole after drilling through 2,180 feet of unmineralized Permian limestone, recovering only 20 feet of Precambrian material. The Hecla Mining Co./Canyon Resources Corp. joint-venture partnership drilled alkalic "Great Plains margin" targets near Gallinas and intersected some low-grade gold mineraliztion. Goldfield Corp. was reportedly disappointed in results of drilling gold-copper targets at Oro Grande.

LEGISLATION AND GOVERNMENT PROGRAMS[7]

The second session of the legislature, 30-days long and held during even-numbered years, is traditionally devoted only to consideration of bills and resolutions related to the State budget and emergencies. During the short session, 977 bills, 35 joint resolutions, 23 joint memorials, and 246 memorials were introduced into the House and Senate. Of bills introduced, 118 were signed into law by the Governor. Several others would have significantly impacted the State's mining industry had they been enacted.

Members of the New Mexico 40th Legislature failed to pass House bill 312 (Minerals Equalization Tax Act). The bill would have required mining companies to pay a 2% severance tax, although it would have permitted a tax credit to offset amounts paid to the State in the form of royalties. According to the New Mexico Mining Association, the bill was a thinly veiled protest of the 1872 Mining Law because it was designed to sunset only if the U.S. Congress created a royalty provision. It also inadvertently created a tax penalty for fee owners of minerals because they pay no royalty. The bill was tabled by the House Taxation and Revenue Committee.

Also stalled was a mine reclamation bill, House bill 40 (the New Mexico Mining Act). In its second year of introduction, the bill was opposed by industry because of an attached moratorium on new mine starts until reclamation regulations were in place. The moratorium theme resurfaced separately as House memorial 97, which died the last day of the special session, and even after the session had concluded, the Governor was petitioned by environmental groups to institute a moratorium by executive order. The New Mexico Mining Act would have required bonded reclamation plans for all mines in the State except potash, sand and gravel, and caliche mining operations. It would have founded a nine-member commission to establish reclamation and permitting regulations and coordinate State agencies involved with mine monitoring. It also would have provided for a category of lands unsuitable for mining and instituted criminal penalties for violations of the act's provisions.

House bill 13 was enacted and broadens the scope of the State's abandoned mine land program beyond the traditional coal emphasis to abandoned hard-rock mine sites. The new law also removes the exemption for commercial coal extraction where surface mining operation affects 2 acres or less (Federal law no longer permits such an exemption).

New Mexico Environment Department bills, House bill 79 and Senate bill 104, were signed into law. They increase penalties and create new permitting requirements for entities regulated under the State Air Quality Control Act and Hazardous Waste Acts. Provisions of the two bills, however, are no more stringent than existing Federal provisions.

After years of delay, on October 30, the DOE finally obtained title to land near Carlsbad for the Waste Isolation Pilot Plant. The President signed the Waste Isolation Pilot Plant Land Withdrawal Act (S. 1671) withdrawing the 10,240-acre site from public use and clearing the way for a 5-year test of the site's suitability for storing low-level radioactively contaminated waste (transuranic waste).

By transferring jurisdiction of the site from the Department of the Interior, the act allows DOE to emplace a limited amount of transuranic waste at WIPP to test the site's suitability as a permanent storage location. New Mexico immediately received $43 million, and, for at least 15 years, the State will be paid $20 million annually for road improvements and citizen safety measures. The bill also requires EPA to adopt regulations governing permanent waste storage on the site no later than 6 months (i.e., April 30, 1993) from the date of enactment of the bill.

Washington lawmakers unsuccessfully attempted to push through legislation (S. 2178) that would have created a 57,000-acre Jemez National Recreation Area to prevent an Espanola pumice company from converting its unpatented claims to patented claims. Copar Pumice Co. had filed an application to patent its existing Las Conchas Mine and unpatented claims inside the proposed recreation area.

The U.S. Bureau of Land Management (BLM) implemented new rental fees for unpatented mining claims as mandated by the 1993 Interior Department and Related Agencies Appropriations Act (amendment 18 to HR 5503, signed October 5, 1992). The act requires holders of unpatented mining claims to pay the Federal Government a rental fee of $100 per year per claim. The new fee, which replaces the $100 annual assessment work per claim, was viewed as a method of reducing surface disturbance carried out solely to maintain a mining claim and to discourage filing of nuisance claims. Rental fees will be deposited into the general treasury, and a portion of the monies will be returned to BLM to fund its mining law administration program. The rental fee requirement was scheduled to expire September 30, 1994. Types of unpatented claims affected include lode claims, placer claims, mill sites, and tunnel sites.

The U.S. Bureau of Mines and the U.S. Geological Survey continued their joint mineral-deposit appraisal of the 6-million acre BLM Caballo Resource Area and the 14.5-million-acre Roswell Resource Area. Additionally, the U.S. Bureau of Mines completed a report on rare-earth resources of Tertiary alkalic complex deposits in the Gallinas Mountains, a study done in cooperation with the New Mexico Bureau of Mines and Mineral Resources and the U.S. Geological Survey. A similar rare-earth deposit inventory began in the Cornudas Mountains in April. Also completed during 1992 was a site-specific study of mineral deposits in the Valle Vidal Unit of the Carson National Forest in northern New Mexico.

The U.S. Bureau of Mines continued to fund the New Mexico Mining and Mineral Resources Research Institute, which is administered by the New Mexico Institute of Mining and Technology in Socorro. Total funding allocated to the institute during 1992 was $16,000.

The New Mexico Division of Mines and Mineral Resources released the following mineral-related publications during 1992: "Mines, Mills, and Quarries in New Mexico"; Bulletin 130, "Bibliography of New Mexico Geology and Mineral Technology 1986"; and OF-353 entitled "Uranium Mines and Deposits in the Grants District, Cibola and McKinley Counties, New Mexico."

FUELS

The U.S. Energy Information Administration (EIA), DOE, again ranked New Mexico seventh in crude oil production. As reported to EIA, total crude oil produced in the State was 70.0 million barrels, down slightly from the 1991 total of 70.4 million barrels.[8] According to the New Mexico Oil Conservation Division, 70.8 million barrels of oil valued at $1.29 billion was produced from 22,759 active wells in 1992. Lea and Eddy Counties, by far, led the State in crude oil production.[9]

According to EIA, New Mexico's natural gas output again shot past the trillion-cubic-feet mark, increasing to a record 1.24 trillion cubic feet (compared with 1.02 trillion cubic feet produced in 1991). According to the Agency, New Mexico continued to rank fourth in the United States in terms of production.[10] Net natural gas production (gross production less reinjected gas) reported to the New Mexico Oil Conservation Division was 1.25 trillion cubic feet valued at $2.02 billion. A total of 20,457 wells produced natural gas. Principal producing counties, listed in decreasing order of natural gas production, were San Juan, Rio Arriba, Lea, and Eddy. Coalbed methane accounted for about 29% of State gas production, or 365 billion cubic feet, an increase of 57% from 1991.[11]

As companies turned their attention toward domestic reserve acquisitions and opportunities abroad, U.S. drilling activity for oil and gas slumped during 1992. Low petroleum prices continued to dampen exploration interest. According to Petroleum Information Corp., New Mexico kept its sixth place rank in the Nation for total well completions with a total of 668 wells, down from 1,092 wells in 1991.[12] The State, however, recorded 721 new well completions.[13] In its annual summary of U.S. drilling activity, Petroleum Information Corp. listed Lea and Eddy Counties as fifth and ninth, respectively, in the country in terms of total footage drilled.

A $4 million cooperative research agreement was signed between Amoco Oil Co. and Los Alamos National Laboratories to design a computer system to improve the refining of heavy crude oils. The partnership married Amoco's experimental work on chemical processes with Los Alamos' computer expertise.

EPA began, and later shelved, an attempt to fine 38 oil- and gas-producing companies (9 of which were New Mexico-based) $4 million in penalties for allegedly releasing oilfield brine into a salt playa in Eddy County. Each firm was assessed a fine ranging between $30,000 and $125,000. The companies had contracted with B & E Inc., a Carlsbad trucking firm, to discharge "produced water" (oil-field brine) into Laguna Quatro, one of several salt playas near Hobbs. A representative of the New Mexico Oil and Gas Association declared that the companies believed that they were operating legally under BLM and State permits.

According to EIA, New Mexico placed

13th in the Nation in coal production. Total coal production for the State for the year was 24.7 million short tons of bituminous and subbituminous coal, up 15% from that of 1991.[14] New Mexico had two underground mines operated by Pittsburg and Midway Coal Mining Co.: the Cimarron Mine and York Canyon Underground (Colfax County). Six surface mines also operated during 1992, including BHP-Utah International Inc.'s Navajo Mine (San Juan County), Pittsburg and Midway's Westridge Mine (Colfax County) and McKinley Mine (McKinley County), San Juan Coal Co.'s La Plata Mine and San Juan Mine (San Juan County), and Santa Fe Pacific Coal Corp.'s Lee Ranch Mine (McKinley County). As ranked by the National Coal Association, the following New Mexico surface coal mines were among the top 40 in the country for 1992 coal production: Navajo (15th), McKinley (21st), Lee Ranch (37th), and San Juan (40th).

House bill 69, the Coal Surtax Exemption Act, relaxed the requirements for total or partial exemptions from the surtax imposed on coal sales. The tax reduction for the State coal industry improved its competitive position, enabling producers to capture new contracts for coal sales and expand production.

Pittsburg & Midway Coal Co. won a major 15-year contract from Wisconsin Electric Power Co. to supply about 2 million short tons of coal annually to the Oak Creek powerplant near Milwaukee. The first train load left the company's York Canyon complex (which includes the Cimarron underground mine and the Westridge surface mine) in early September. Pittsburg & Midway committed $60 million for improvements at York Canyon in Colfax County, improvements that were expected to involve the Cimarron underground mine and coal preparation facilities. After modernization is completed, the company anticipated that York Canyon capacity will increase to 3.9 million short tons per year of raw coal, equating to 3.0 million short tons per year of salable product.

New Mexico's only remaining producer, Quivira Mining Co. (a subsidiary of Rio Algom Corp.) placed on standby status its in situ Ambrosia Lake uranium mine and mill, 15 miles north of Grants in McKinley County. In its annual report, Rio Algom announced the Ambrosia Lake property had produced 111,000 pounds of U_3O_8, compared with 179,000 pounds produced in 1991. The production resulted from ground water pumping as a part of ongoing reclamation. RTZ Corp. indicated it would sell its 51% stake in Rio Algom Ltd. to Canadian institutional investors and the public. According to EIA, the average uranium price for deliveries from domestic supplies was $13.45.[15]

Uranium Resources, Inc. (URI), in the guise of Hydro Resources Inc., held the largest uranium reserves in the State and acquired an additional 1,440 acres of leases adjoining its 484-acre Crownpoint property in McKinley County. Leases for surface and mineral rights were signed with Native American allottees in the "checkerboard area" of northwestern New Mexico, and URI paid $367,000 to the Bureau of Indian Affairs to hold in trust pending the Agency's review and approval of the company's mining proposal. The company also continued permitting its 2,225-acre Churchrock property in McKinley County. URI anticipated production at the Churchrock in situ leach operation could occur in 1994. URI's permit applications were the first to be filed with the State in more than a decade. The company indicated that the 2 mines would eventually employ about 200 people. Navajo tribal officials expressed concerns regarding ground water contamination and announced they would attempt to halt further development at the two sites.

At yearend, a U.S. District Court judge ruled that United Nuclear Corp. must pay for cleaning up seepage from uranium tailings at the defunct Churchrock mill. The mill operated between 1977 and 1982 and was placed on the National Priorities List in 1983. Waste tailings from the acid-leach solvent-extration process were pumped to a 100-acre disposal area. The court ruled that seepage from the tailings had entered the ground water, including the Gallup aquifer.

The year brought the first competitive geothermal lease sales on Federal land since 1985; one tract in Dona Ana County was offered and leased. By October, New Mexico had five active Federal and four active State geothermal leases for a total leased acreage of 7,144 acres (all in Dona Ana and Hidalgo Counties). According to the New Mexico Division of Mines and Mineral Resources, the two largest geothermally heated greenhouses in the Nation were in Hidalgo and Dona Ana Counties.

During 1992, the State Mine Inspector and the New Mexico Mining Association conferred Operator of the Year Awards to Santa Fe Pacific Coal Corp.'s Lee Ranch Mine, Quivira Mining Co.'s Ambrosia Lake Operation, and Homestake Mining Co.'s Grants Operation for their safety records between July 1, 1991, and June 30, 1992.

REVIEW BY NONFUEL MINERAL COMMODITIES[16]

Metals

Copper.—Along with iron and aluminum, copper is a crucial metallic ingredient in modern technology. It finds use in building construction, electrical and telecommunications products, industrial machinery, transportation, household appliances, and in strategic military applications. During 1992, New Mexico dropped from second to third place (behind Arizona and Utah) of 12 States in terms of total copper production. Total production for the State was a little more than 211,300 metric tons (232,900 short tons), compared with slightly less than 252,900 metric tons (278,800 short tons) produced during 1991. Likewise, the value of the State's output fell 18% to slightly less than $501 million, which amounted to 57% of New Mexico's 1992 total nonfuel mineral value. For the second year in a row, the average COMEX 1992 spot copper price dropped, falling to $1.03 (as compared with the

average 1991 price of $1.05 and the 1990 average of $1.19).

Phelps Dodge Corp. operated the State's two largest copper mines: Chino and Tyrone. Cyprus Minerals Co. continued operating the Pinos Altos property, but as a primary copper and not a primary zinc producer. Goldfield Corp. reported production from the St. Cloud and Lordsburg operations, and Mount Royal Mining Corp. also produced copper as a byproduct of primary precious metal production at its Center Mine.

Phelps Dodge operated the Tyrone open pit mine, concentrator, and SX-EW plant; the Chino open pit, concentrator, SX-EW plant, and Hurley smelter; and the Hidalgo smelter. SX-EW accounted for about 55% of the combined 1992 copper production from Tyrone and Chino.

The Tyrone open pit and SX-EW plant near Silver City (Grant County) was fully owned by Phelps Dodge and operated by its subsidiary Burro Chief Copper Co. During 1992, the Tyrone operation fell from 5th to 10th place in U.S. copper production. The Tyrone concentrator was retired in February as mill-grade ore was exhausted. It produced only 7,700 metric tons (8,500 short tons) of concentrate in 1992 compared with 56,800 metric tons (62,600 short tons) during 1991, the last full year of mill operation. As the concentrator finished its task, Phelps Dodge laid off about 500 workers, although the company retained about 250 at the Tyrone leach operation and SX-EW facility. After the company completed the fourth expansion of its SX-EW facility, total 1992 SX-EW production at Tyrone vaulted to a record 63,700 metric tons (70,200 short tons) of electrolytic copper, up from 54,000 metric tons (59,500 short tons). Phelps Dodge expected production from the Burro Chief SX-EW plant to last about another 10 years. Borrowing an idea from the company's Cochise project at Bisbee, AZ, the Tyrone leach operation experimented with crushing to determine its effect on copper leachability and recovery. If results prove favorable, the company anticipated that the crushing plant (at the former Tyrone mill) could process 23,000 to 27,000 metric tons (25,000 to 30,000 short tons).

Phelps Dodge held a two-thirds interest in Chino Mines Co.; Heisei Minerals, a Mitsubishi Materials Corp. subsidiary, owned the other one-third. Chino Mines Co. operated a large open pit copper mine, concentrator, and SX-EW plant at Santa Rita in addition to a smelter at Hurley (Grant County). Chino Mines employed about 865 people at its mine and mill. The Chino operation produced 138,000 metric tons (152,200 short tons) of copper, a record 52,000 metric tons (57,300 short tons) of which was produced via SX-EW. In national standing for 1992, Chino dropped from fourth to fifth in copper production.

The Hurley (or Chino) smelter was shut down for a 28-day "turnaround," a period scheduled for major repairs and modifications, for which the company spent $12.5 million. Work on environmental controls, particularly at the acid plant, comprised a significant portion of smelter reconditioning. Among smelter improvements was installation of a new automated takeoff machine that could remove anodes and determine their weight and quality. Pioneered in Canada, the technology was first tested at the company's El Paso refinery, which refined anodes cast by the two New Mexico smelters. Even with the turnaround, the Hurley smelter set a 1992 production record of 134,000 metric tons (147,900 short tons) of copper anode.

After 8 years of continuous operation, the Hidalgo smelter also paused for a 60-day turnaround. About $7.5 million was spent for maintenance and another $5 million for equipment purchases. The 8-year period without shutdown was a record for Hidalgo's Outokumpu flash furnace, which originally came on-stream in 1976. Although originally built to accommodate concentrates from Tyrone, Hidalgo was the main outlet for Morenci concentrates. Despite the refurbishment, Hidalgo achieved its third highest year of production: 164,500 metric tons (181,300 short tons) of copper anode.

According to Cyprus Minerals Co.'s Form 10-K, 1992 production from Pinos Altos Mine (Grant County) was curtailed because of repairs and modifications to its Miami, AZ, smelter. Cyprus changed its emphasis from zinc to copper during 1992, and the company continued to drive a decline to open a deeper copper-zinc ore body, about 1,100 feet below the surface. Total copper recovered at the mine was 3,100 metric tons (3,400 short tons), an amount that gave Pinos Altos 22d place in 1992 U.S. copper production. Normal mine production resumed during the latter part of the year with an average output of about 180 metric tons (200 short tons) per day. Run of mine ore graded 6.5% copper, plus gold and silver smelter credits.[17]

Several other companies reported 1992 production to the U.S. Bureau of Mines from New Mexico properties. Goldfield Corp., as its subsidiary St. Cloud Mining Co., reported copper production from sales of siliceous smelter flux from the St. Cloud property (Sierra County). In addition, Lordsburg Mining Co. (the name of the Goldfield-Hidalgo and Federal Resources Corp. partnership) continued to supply siliceous smelter flux from its property near Lordsburg (Hidalgo County). Cyprus' Miami smelter in Arizona was the principal consumer of the flux from Lordsburg. According to Goldfield's annual report, St. Cloud produced 5.4 metric tons (5.9 short tons) of copper and Lordsburg produced 81 metric tons (90 short tons) of copper during 1992.

At yearend, Cobre Mining Co., a subsidiary of Metallic Ventures Inc., purchased part of Bayard Mining Corp.'s assets, including the Continental copper mine near Hanover. The company began rehabilitating the No. 2 mill and planned to begin mining in the Continental pit by spring 1993.

Champion Resources Ltd. of Vancouver and Western Mining Corp. of Australia submitted a plan to the U.S. Forest Service in June to drill 16 holes to explore for copper-bearing massive sulfide deposits near Pecos in Santa Fe National Forest. The New Mexico Department of Game and Fish and the New Mexico Environment Department protested the decision to allow drilling,

claiming that the Forest Service should study the effects of mining in the area, not merely of drilling. Work in the Jones Hill Mine area was to have begun in October; however, Western Mining pulled out of the joint-venture partnership, and drilling was postponed.

Gold Express Corp. continued its quest for financing for the $50 million Copper Flat project. The company indicated that construction and renovation of the Copper Flat Mine would begin in early 1993 and anticipated that production would begin in early 1994. During December, officials with BLM announced that the Environmental Assessment for the property was available for public comment.

Gold.—New Mexico ranked next to last of 13 States reporting gold production to the U.S. Bureau of Mines in 1992. State output and value were nearly the same as that reported for 1991. The average gold price was $344.97 per troy ounce. Companies reporting primary production included Mount Royal Mining and Exploration Co. at its Center Mine (Grants County); Goldfield Corp. at its St. Cloud operation; and Lordsburg Mining Co. at its Lordsburg property. Goldfield reported in its annual report that Lordsburg produced 92 kilograms (3,000 troy ounces) of gold during 1992 from siliceous convertor flux sales. Goldfield's St. Cloud subsidiary also produced 0.6 kilogram (20 troy ounces) of gold from silica flux sales. In addition, Phelps Dodge recovered byproduct gold from copper mining at Chino and a much smaller amount from Tyrone. Cyprus also recovered byproduct gold at Pinos Altos.

In October, Pegasus Gold Corp. called to a halt its joint-venture partnership with LAC to explore at Ortiz (Santa Fe County), citing difficulties in renegotiating the agreement. Earlier, Pegasus had won permission from the State Engineer to dewater the Carache Canyon Decline for 12 days. The engineer also allowed Pegasus to drill three wells to gauge underground water supply and the effect of water pumping on ground water availability. LAC reacted to Pegasus's exit by announcing that it would continue the permitting process and reclamation of contamination left by Gold Fields Mining Co. (a subsidiary of Hanson PLC) at the Cunningham Hill Mine site. In early December, the Santa Fe County Commission approved a 6-month moratorium on issuance of permits for exploration or development. The county delayed action on a permit regarding extension of the decline LAC had submitted just days before the announcement of the moratorium.

Molybdenum.—With the shutdown of its sole primary producer, New Mexico's molybdenum production sank precipitously in 1992, decreasing to only 15% of 1991 output. The State ranked sixth of seven States reporting such production for 1992, in contrast to 1991 when New Mexico was fifth of eight molybdenum-producing States. Only Phelps Dodge's Chino copper mine produced molybdenum (as a byproduct). Uses for the soft, silvery metal include as a high-temperature lubricant and as an alloy with steel to enhance the toughness of steel products.

During January, Molycorp Inc. laid off about 180 career miners and other staff as Questa shut down for an indefinite period. The company cited a saturated world molybdenum market and consequent low molybdenum prices. Although company representatives promised a continued presence in the area, workers removed electrical equipment and other material via the 1,000-foot main shaft, pumps were stopped, and 15 miles of tunnels were allowed to flood. About 25 employees remained to seal the tailings pond east of the village and begin reclamation of the open pit. During February, Molycorp indicated it would donate $3,000 per month to Questa for 2 years to help the village absorb the shock of the mine closure.

EPA levied a $20,000 fine against Molycorp for a May 1991 release of 25 gallons of tailings and slurry into the Red River. Although the company had notified EPA of the discharge, the Agency alleged that Molycorp had not indicated that the discharge contained silver levels 11 times the 500 parts per billion allowed under its permit. Although it acknowledged that the silver concentration was not hazardous, EPA still assessed the fine, asserting that if the mine were allowed to exceed permitted levels frequently, water quality would be impaired.

Silver.—New Mexico dropped from seventh of 16 States to ninth of 18 States in silver production. State silver production and value essentially halved in 1992 as a result of continued low silver prices (which averaged $3.94 per troy ounce). With the exception of Mt. Royal's Center Mine and Goldfield's St. Cloud and Lordsburg properties, silver production in the State continued to occur as a byproduct of copper mining. The largest silver producer in the State was Phelps Dodge's Chino property. Chino was the 24th largest silver producer in the country during 1992. Shutdown of its mill caused Tyrone to fall to second place in the State during 1992. Cyprus Minerals Co.'s Pinos Altos Mine also produced silver as a byproduct of primary copper mining.

In its annual report, Goldfield noted that St. Cloud has produced 0.5 metric ton (9,500 troy ounces) and that Lordsburg had produced 2.2 metric tons (71,300 troy ounces) from smelter flux sales.

Zinc.—New Mexico has produced zinc since 1989; however, low zinc prices caused Cyprus Minerals Co. to revamp its former zinc producer, the Pinos Altos Mine, as a copper mine. As a result, the State had no reported zinc output in 1992.

Other Metals.—New Mexico remained eighth of 11 States that reported lead output. Two New Mexico mines were important domestic lead producers during 1992. In the Steeple Rock District in Grant County, Mount Royal Mining and Exploration Co.'s Center Mine produced lead as a byproduct of precious-metal mining during 1992. The Center Mine

ranked 18th in the Nation in 1992 lead output. The Lordsburg property operated jointly by Goldfield-Hidalgo and Federal Resources ranked 19th in the United States during the year. State lead output and value dropped slightly from 1991 totals. Lead prices averaged $0.35 per pound, or $774 per metric ton.

Industrial Minerals

Cement.—New Mexico's 1992 output and value of portland cement appears to have increased substantially over 1991 estimates. Likewise, both production and value of masonry cement increased for the year.

Ideal Basic Industries Inc. (a subsidiary of Holnam Inc.) announced that renegotiations of a power tariff with a local utility had resulted in savings of $40,000 for each full production month at its Tijeras plant near Albuquerque.

Gypsum.—According to the New Mexico Division of Mines and Minerals, two gypsum mines operated in New Mexico: Centex American Gypsum Co.'s White Mesa Mine (Sandoval County) and the small Coogler Gypsum Pit (Otero County).[18] Output of crude gypsum and the amount calcined for making wallboard increased during 1992.

Centex announced it completed construction of a new wallboard plant near Bernalillo (Sandoval County). The new facility operated all year and made encouraging progress toward correcting design and related deficiencies and attaining stable production. The company's older Albuquerque plant (Bernalillo County) operated sporadically during the year and was expected to remain on standby until wallboard demand increased.

Mica.—New Mexico moved up to second place among five States reporting mica output. Of five producing States, New Mexico's production was exceeded only by North Carolina. Both production and value increased. During 1992, Franklin Limestone Co., a subsidiary of Franklin Industries Inc. (formerly Mineral Industrial Commodities of America) changed its name to Franklin Industrial Minerals. The Nashville-based company operated New Mexico's only mica mine and mill, in Taos and Rio Arriba Counties, respectively. Its M.I.C.A. mine was one of the few mines in the United States that produced mica as a primary product. Among its uses, Franklin's mica product was sold as a functional mineral filler in joint cement compound, paints, and plastics.

Perlite.—The State remained the leader in U.S. perlite production with, by far, the largest output and value of six States. New Mexico assumed the lead among U.S. perlite producers in 1957, only a decade after perlite deposits were recognized in the State. Compared to 1991 totals, State production and value increased. The building and construction industry, which accounted for roughly 65% of 1992 U.S. perlite sales, remained the largest customer for perlite. Perlite was also used in filter aids, as a mineral filler, and for horticulture. Perlite was in demand for horticulture for its porous structure, which aids soil aeration, and for its high moisture-retention capacity. Three companies operated in New Mexico (listed in order of decreasing output): Dicaperl Corp. (Socorro and Taos Counties), Harborlite Corp. (Taos County), and U.S. Gypsum Co. (Cibola County). A fourth company, Solico Co., Inc. operated an expansion facility in Bernalillo County.

Perlite operations of Grefco Inc. were transferred to another wholly owned company called Dicaperl Corp. Dicaperl operated the El Grande Mine and mill in Taos County and the Socorro Perlite Mine and Mill in Socorro County. The company's coarse product went into horticulture; midsize materials were used as a filler in acoustical ceiling tiles, and finer sizes were expanded to make "micro bubbles" for wallboard joint cement compound. Baghouse fines were used to neutralize hydrofluoric acid for the manufacture of phosphoric acid.

World Minerals, Inc. announced that it would merge the perlite operations of Harborlite Corp. and Cellite Corp. under its subsidiary Harborlite Corp. Although most material Harborlite mined at the No Agua Mine and Mill in Taos County was shipped east of the Mississippi for expansion, some also was expanded at the company's plant in Antonito, CO. The most important use for its product was in the manufacture of ceiling tiles. Some of its perlite also was used in horticulture, in foundry sand, and to make concrete block.

Solico Co., Inc. was the only company that expanded perlite in New Mexico; the company operated a plant in Bernalillo County.

Potash.—New Mexico has led U.S. potash production since 1933. The State's deposits were developed during a post-World War I bid by the U.S. Government to find its own potash reserves in the event of another war. The State supplied 81% of 1992 U.S. production with 1.436 million metric tons (1.583 million short tons), a slight drop from the 1.469 million metric tons (1.619 million short tons) reported in 1991. The drop in output partly came as the result of a temporary mine closure at yearend. Total production value moved up slightly from $250.9 million in 1991 to $256.6 million in 1992. In terms of value, potash contributed 29% of New Mexico's total nonfuel mineral value. Aggressive marketing by foreign potash sources into the Brazilian market caused potash prices to drop to below $158 per ton. The Carlsbad producers are generally unable to sell all their product domestically and depend on Latin American markets to maintain sales levels.

All New Mexico's potash is mined from the Permian Basin. Six companies operated between Calsbad and Hobbs in the southeastern part of the State. Five companies mined sylvinite (a mixture of the minerals sylvite and halite) to produce muriate of potash: Eddy Potash Inc. (a subsidiary of Trans-Resources Inc.), Horizon Potash Inc., IMC Fertilizer Inc., Mississippi Chemical Corp., and New Mexico Potash Corp. (another subsidiary of Trans-Resources Inc.). Two companies—Western Ag-Minerals Co. (a subsidiary of Rayrock Yellowknife

Resources Inc.) and IMC Fertilizer Inc.—produced langbeinite (potassium magnesium sulfate) and were the only producers of langbeinite in the world. The largest potash producer in the area continued to be IMC Fertilizer. New Mexico potash was primarily assimilated by the agricultural industry as fertilizer; langbeinite, in particular, reputedly aids the growth of citrus fruits, oil palms, vegetables, tobacco, cotton, and corn. Some potash (i.e., from New Mexico Potash) was pure enough to be used in glass for television picture tubes. Some also was used by the oil industry for drilling and well-fracturing fluids.

A surge of low-cost exports from the Russia, Belarus, and the Ukraine to Latin American countries began a period of unease for the Carlsbad potash producers. Citing a late harvest and a world market glutted with Russian potash, Horizon Potash laid off 275 workers, or about 75% of the company's work force, in November. The company anticipated rehiring some workers in January 1993. During the year, Horizon Resources Corp. completed acquisition of Amax Potash Corp.'s assets for $6 million. The corporate name of Amax Potash changed to Horizon Potash Inc.

A 5-year agreement that halted 1988 Canadian potash dumping was scheduled to expire in January 1993. Impending lapse of the agreement triggered reactivation of the Ad Hoc Potash Committee, inactive since successfully halting the dumping. The city (Carlsbad)-county-producers committee first formed in 1983 to seek solutions to the then growing problem of Canadian imports that threatened jobs in the Carlsbad area. On December 1, the U.S. Commerce Department began taking public comments concerning extension of the agreement.

Western Ag-Minerals completed construction of a new compaction plant, which became fully operational in late 1992. The plant used a new process developed by the company to convert standard and fines inventories into a coarser product in demand by the fertilizer industry. Western Ag-Minerals reported that it sold 298,000 metric tons (329,000 short tons) during the year.

Mississippi Chemical furthered its plans to mine the fifth ore zone. Mississippi Chemical indicated it sold 308,000 metric tons (339,000 short tons) of product in 1992.

Eddy Potash, Horizon Potash, Mississippi Chemical Corp., and New Mexico Potash agreed to allow Potash Corp. of Saskatchewan Inc. (PCS), the industry giant, to market part of their local product. By agreement, PCS would act as the sales agent for Horizon in southwestern U.S. markets and in Latin America; PCS would have the same role in Latin American markets for the other three companies.

Union workers at Eddy Potash Inc. accepted a company contract in August to avoid a walkout. The Steelworkers, International Association of Machinists, and the International Brotherhood of Electrical Workers unions ratified a 3-year agreement that allows an average $1.30-per-hour increase; workers did not receive a requested cost of living allowance.

Pumice.—New Mexico moved up from third to second place during 1992 (behind Oregon) among six pumice-producing States. Partly reflecting actual increases and partly arising from improved production estimates for one company, State pumice production essentially doubled in 1992. The largest producer, Copar Pumice Co., operated the Guaje Canyon Mine (Santa Fe County), the Las Conchas Mine (Sandoval County), the Cuyamungue Mill (Santa Fe County), and the San Ysidro screening plant (Sandoval County). General Pumice Corp. reported pumice production from its Rocky Mountain Mine in Rio Arriba County. According to State records, American Pumice also processed pumice at its mill in Santa Fe County and Utility Block Co., Inc. reported production from its U.S. Forest Service Mine in Sandoval County and operated a mill in Bernalillo County. Total milled material, as reported to the State, was 60,510 metric tons (66,700 short tons) that was valued at $1.5 million.[19]

A Federal judge dismissed a lawsuit filed in 1989 by several environmental groups opposed to further mining of pumice in the Jemez Mountains. The environmental groups contended that the Forest Service erred when it decided not to prepare an Environmental Impact Statement (EIS) for Copar Pumice Co.'s proposed mining of an additional 135 acres on the east side of the Jemez River. Copar filed a mine plan in September to expand the existing 33-acre Las Conchas Mine site an extra 135 acres (the proposed El Cajete Mine); the company reported that the 33-acre tract would be exhausted next year. The mine plan called for mining 907,000 metric tons (1 million short tons) of pumice from the area over the next 10 years. With the revisions of the 1872 Mining Act that occurred in the 1950's, pumice at least 3/4 inch in size or larger falls into the locatable minerals category. All parties agreed to the preparation of an EIS.

Copar also filed for patenting of 1,520 acres of unpatented claims, in response to which New Mexico legislators introduced bills into the U.S. House and Senate for a proposed 57,000-acre Jemez Recreation Area. The legislation passed the Senate but died in the House. Copar's owner indicated that he would sue the Federal Government for an illegal taking of his property if any legislation were passed prohibiting him from acquiring the land under the provisions of the General Mining Law of 1872.

Salt.—New Mexico's salt production dropped about 27% during 1992; value also decreased about 11%. The State continued to place 11th of 14 States in national salt output, however. Three companies—New Mexico Salt and Minerals Corp. and United Salt Corp. in Eddy County and Unichem International Inc. in Lea County—continued to process potash tailings to recover salt. In addition, Don McKibben Trucking Co. recovered salt from brines in Lea County. United Salt and Unichem were the clear leaders in State salt production. Output from New Mexico's four companies was used in oil/gas well drilling, in animal feed as a nutrient, and for deicing roads.

TABLE 2

NEW MEXICO: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	2,925	$13,878	$4.74
Plaster and gunite sands	197	1,251	6.35
Concrete products (blocks, bricks, pipe, decorative, etc.)	W	W	4.79
Asphaltic concrete aggregates and other bituminous mixtures	2,534	11,077	4.37
Road base and coverings[1]	2,703	9,670	3.58
Fill	460	1,181	2.57
Snow and ice control	W	W	1.50
Railroad ballast	W	W	5.36
Other miscellaneous uses[2]	514	2,301	4.48
Unspecified:[3]			
Actual	117	199	1.70
Estimated	1,760	6,619	3.76
Total	11,210	46,176	4.12
Total[4 5]	10,170	46,176	4.54

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

As it has done intermittantly for many years, the Zuni Nation also recovered salt from Zuni Salt Lake in Catron County for human and animal consumption.

Sand and Gravel (Construction).— Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

According to the State Bureau of Economic Research, construction jobs increased by 6% during 1992, and the New Mexico construction industry began moving out of an economic slump. Job increases arose primarily from robust growth in the home building industry where permits for single-family residences climbed 21%. Low-mortgage interest rates, according to the annual economic review published by one of the State's banks, provided the impetus for new housing starts. The State reported that total value of new nonresidential and nonbuilding contracts (i.e., for dams, highways, bridges) decreased. Value for all contracts (residential, nonresidential, and nonbuilding) dropped 3.7% to $1.35 billion, in spite of a 30.4% increase in residential contracts.[20] Another construction activity indicator, the New Mexico Highway and Transportation Department's operating budget, was about $375 million for 1992-93 (the agency's fiscal year runs from July 1, 1992, through June 30, 1993), up from the 1991-92 operating budget of $208 million. The Intermodal Surface Transportation Efficiency Act, enacted by the Federal Government in 1991, began to impact the State transportation agency's budget in its 92-1993 fiscal year. The act allocates $151 billion over 6 years in highway and bridge improvements in the 50 States; more than one-half of the monies, however, can be channeled into mass transit and other nonhighway purposes.

New Mexico ranked 29th in the Nation of 49 States reporting sand and gravel production for the year. Total State production was 11.2 million short tons valued at $46.2 million; both production and value increased significantly for the year. In decreasing order of output, the top five producers were: Calmat Co. (Bernalillo County), Redland PLC/ Western Mobile New Mexico Inc. (Bernalillo and Sandoval Counties), James Hamilton Construction Co. (Eddy, Lea, Luna, Roosevelt, and Socorro Counties), San Juan Concrete Co. (San Juan County), and Taos Gravel Products Inc. (Taos County). Leading counties, in terms of output, were Bernalillo, Sandoval, and San Juan. Excavated materials were primarily used as concrete or asphaltic concrete aggregate, road base, and fill material. Minor quantities were reportedly used for plaster and gunite sands, road stabilization, filtration media, deicing, and railroad ballast. District 1, which included Albuquerque and Santa Fe, supplied most of New Mexico's output. When transporting their sales, the State's producers moved their materials by truck.

Population pressures in the developing West continued to spark land use conflicts. Because of its low unit value, weight, and high transportation costs, aggregate must be mined near its customers. As a consequence, conflicts between city residents and owners of nearby, unaesthetic aggregate mines were especially bitter. Santa Fe County, a stronghold for environmental concerns, unanimously rejected the plan for a sand and gravel operation on the Gallisteo River near Lamy and sought a court order barring further mining on the property until the operator's applications for mine expansion and rezoning were complete. In September, a district judge ruled mining could continue while county officials reviewed the operator's application. After negotiations with the operator, however, the county dropped its appeal of the judge's decision in November.

The San Juan Pueblo and New Mexico Citizens for Clean Air and Water filed a

TABLE 3

NEW MEXICO:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2	
	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	2,334	10,651	591	3,227
Plaster and gunite sands	W	W	W	W
Concrete products (blocks, bricks, etc.)	W	W	—	—
Asphaltic concrete aggregates and other bituminous mixtures	1,784	8,645	651	2,257
Road base and coverings[2]	1,481	5,913	1,182	3,696
Fill	209	425	251	756
Snow and ice control	W	W	—	—
Railroad ballast	W	W	W	W
Other miscellaneous uses[3]	673	3,379	37	174
Unspecified:[4]				
Actual	113	169	4	30
Estimated	939	3,715	821	2,905
Total[5]	7,533	32,897	3,537	13,045
Total[6 7]	6,834	32,897	3,209	13,045

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Excludes 140,000 short tons valued at $235,001, not reported by county.
[2]Includes road and other stabilization (cement).
[3]Includes filtration.
[4]Includes production reported without a breakdown by end use and estimated for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value reported in thousand metric tons and thousand dollars.

lawsuit in Federal court in December against Espanola Transit Mix (Santa Fe County) for allegedly violating the Clean Water Act. The suit claimed that the company severely damaged the Rio Grande, particularly along San Juan Pueblo lands, including loss of vegetation, erosion, and a drop in the area's water table. The pueblo permitted the operator to mine in 1989, but it terminated his lease in 1991 because of the alleged damage and lack of reclamation according to an agreed-upon restoration plan. The tribe asserted that negotiations with the company owner in an effort to avoid the lawsuit proved futile. The owner had been fined $25,000 by EPA, which alleged he knowingly clogged two arroyos with fill material after he had been fined $2,500 for similar violations in 1988. The Agency alleged that dredged material released into the Rio Grande temporarily increased water turbidity that adversely affected aquatic habitat.

Stone.—**Crushed.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

New Mexico's production of crushed stone is estimated to have risen about 7% in 1992, climbing to about 3.0 million short tons. Likewise, value increased by an estimated 10% compared to 1991 actual data.

Hanson PLC acquired the aggregates portion of Santa Fe Pacific Corp. which included six stone quarries in Arizona, California, New Mexico, and Oklahoma. According to Santa Fe Pacific's annual report, primary production from these quarries was for railroad ballast; smaller amounts were dedicated for highway and road aggregate, riprap, and other crushed stone products.

Several Dona Ana County quarrying operations attracted controversy during 1992. Mountain States Constructors Inc. leased the north side of Vado Hill from Daniel Guillen Inc. and set up an asphalt plant for the paving of I-10 from Las Cruces to Antony. Mountain States operated the plant without a permit because its nonconforming use was grandfathered by the county zoning ordinance. In contrast, Jobe Concrete Products' 1991 permit application for the south side of Vado Hill was approved by the county zoning commission but later revoked after residents complained of damage from blasting. Jobe took the issue to court where the company contended that its due process rights were violated and that county zoning ordinances were unconstitutional. At yearend, the case was still pending in State District Court. If the judge ruled in favor of Jobe, the county would have to rewrite its zoning laws, at a cost of more than $150,000.

Owners of the Las Cruces Transit Mix in Dona Ana County applied to the Extra

Territorial Zone Commission to move an operation from A Mountain east of Las Cruces closer to Cox Mountain, which the BLM acquired more than 2 years ago from the Nature Conservancy. The proposed zoning change was opposed heatedly by residents in a subdivision within 2 miles of the proposed new location. The owner eventually withdrew his application, claiming the proposed exchange of 40 new acres for 240 acres in use was not in the company's best interest.

Dimension.—Like crushed stone, dimension stone production is estimated for 1992. New Mexico remained 16th of 34 States (New Mexico held that rank during 1991 according to 1993 revisions of production data) reporting dimension stone production during 1992. Both State production and value appear to have declined.

Other Industrial Minerals.—Production or production changes occurred during the year for several other New Mexico industrial mineral commodities, including carbon dioxide, clays, gemstones, Grade-A helium, humate, siliceous smelter flux, byproduct sodium sulfate, byproduct sulfur, sulfuric acid, exfoliated vermiculite, and zeolites.

The Bravo Dome (Harding, Union, and Quay Counties), a unitized field operated by Amoco Production Co., continued to supply gaseous carbon dioxide. New Mexico remained a major U.S. producer of carbon dioxide and one of only a handful of States that produced the gas from wells. Gaseous carbon dioxide was transported by pipeline to the Permian Basin for use in tertiary oil recovery. The Bravo Dome in northeastern New Mexico is believed to have the Nation's largest reserve of carbon dioxide, about 15 trillion cubic feet. According to the New Mexico Oil Conservation Division, total 1992 carbon dioxide sales was 102.1 billion cubic feet valued at $33.3 million.[21]

New Mexico produced common and fire clays during 1992. Total State clay production and value rose during 1992. To protect individual company production figures, the table 1 clay total includes only 1992 common clay production. Companies mining common clay included El Paso Brick Co. (Dona Ana County), Garcia and Son Inc. (San Juan County), and Kinney Brick Co. Inc. (Bernalillo and Santa Fe Counties). New Mexico's common clay production, a total of 32,600 metric tons in 1992, was largely used to make brick. A fraction of the total output, however, was used to make abrasives and roofing granules. Relative to 1991 totals, common clay production rose 17%, and its value increased 7%. Mathis and Mathis Mining and Exploration Co. (Luna County) was the State's sole reporting producer of fire clay.

Gemstones produced in the State included agate, smithsonite, and turquoise. The value of gemstone production decreased during the year.

In contrast to 1991, Navajo Refined Helium Co. had no helium production during 1992; the company permanently closed its natural gas processing plant and helium extraction/purification facility near Shiprock (San Juan County) during the first part of the year.

Humate continued to be mined by Agronics Inc. (Sandoval County) and Mesa Verde Resources Co. (two mines in McKinley County). This humic-acid-rich material (generally, an oxidized coal or a carbonaceous mudstone) was used as a soil conditioner and to neutralize pesticides and herbicides. The New Mexico Occupational Health and Safety Bureau sought $660,400 in penalties against Agronics Inc. alleging 123 violations of the law. Enforcement actions concerned the bagging area, warehouses, blending plant, and maintenance shop. Agronics and the agency had locked horns since an Agronics worker died in February when a load of humate fell on him as he was clearing a hopper. The company declared it would fight the citations. In August, a State district judge in Santa Fe ruled that the Federal Mine Safety and Health Administration had final jurisdiction over the mine.

Lordsburg Mining Co. continued to market siliceous flux to New Mexico and Texas smelters from its properties near Lordsburg (Hidalgo County). The Lordsburg operations sold 12,200 metric tons (13,400 short tons) of barren siliceous flux to copper smelters, compared with 3,600 metric tons (4,000 short tons) sold in 1991. Goldfield Corp.'s other subsidiary, St. Cloud Mining Co., sold mineralized flux but no barren silica flux in 1992. The Mining and Minerals Division, New Mexico Energy, Minerals, and Natural Rescources Department, registered several other mines as active silica flux operations in its 1992 list of State mines and producing facilities. Most of these were in Grant and Hidalgo Counties and they included Mount Royal Mining and Exploration's Center Mine.

As a result of financial difficulties, Climax Chemical Co. closed its hydrochloric acid plant at Monument (Lea County), which recovered byproduct sodium sulfate.

Seven companies—Northern Natural Gas Co., Marathon Oil Co., Phillips Petroleum Co., Chevron Corp., Amoco Production Co., Trident NGL Inc., and Western Gas Resources Inc.—recovered byproduct sulfur from New Mexico refineries. Output from Eddy, Lea, Roosevelt, and San Juan Counties increased from 53,552 metric tons reported in 1991 to 54,435 metric tons. Value of sales fell to $1.4 million, however, or about one-half that of 1991.

Phelps Dodge's Chino (or Hurley) smelter continued to be the State's largest producer of sulfuric acid. The smelter's acid plant produced about 1,500 metric tons (1,700 short tons) of acid per day, used primarily in the manufacture of phosphatic fertilizer. Other major applications were in petroleum refining, in the production of coal products, and for the SX-EW process. The acid also was sold to Phelps Dodge's El Paso refinery, where it was used to dissolve copper anode to produce electroplated, high-purity copper cathode.

Solico Co., Inc. expanded vermiculite at its facility in Bernalillo County. Most material sold from the plant was used in manufacturing fireproofing materials, but some was used to make loose fill

insulation and in horticulture as a soil additive.

Behind only Texas, New Mexico was second of seven States in 1992 zeolite production. St. Cloud Mining Co., a subsidiary of Goldfield Corp., escalated its zeolite production from its property in the Winston-Chloride area (Sierra County) where it mined zeolite from an altered ash fall unit. The company's 1992 clinoptilolite sales ballooned to 4,350 metric tons (4,800 short tons), up from 1,680 metric tons (1,850 short tons) sold in 1991. During the year, St. Cloud added another bagging line and a new warehouse. Its zeolites were mainly used as animal feed supplements, floor drying compound, pet waste absorbent, and aquarium filtering media.

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[1]State mineral specialist, U.S. Bureau of Mines, Denver, CO. She has 14 years of mineral-related work with government and industry.

[2]Senior mining engineer, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM.

[3]New Mexico Progress Economic Review of 1992. Boatmen's Sunwest Inc.

[4]New Mexico Labor Market Review. V. 22, No. 2, Mar. 31, 1993.

[5]New Mexico Progress Economic Review of 1992. Boatmen's Sunwest Inc.

[6]Much of the information in this section was taken from M. S. Fulp's exploration reviews for the southwest region in the Society of Economic Geologists quarterly newsletter.

[7]The lead author thanks the New Mexico Mining Association for much of the information in this section.

[8]Petroleum Supply Monthly. Energy Information Administration. Apr. 1993.

[9]New Mexico Oil and Gas Fact Sheet. Mining and Miner. Div., New Mexico Energy, Miner. and Nat. Resour. Dep. July 1993.

[10]Natural Gas Supply Monthly. Energy Information Administration. Mar. 1993.

[11]Work cited in footnote 9.

[12]Resume 1992. Petroleum Information Corp.

[13]Work cited in footnote 5.

[14]Weekly Coal Production. Energy Information Administration. for week ended May 8, 1993.

[15]Uranium Industry Annual 1992. Energy Information Administration. Oct. 1993.

[16]Unless noted, individual company production data in this section is from company annual or form 10-K reports.

[17]Fulp, M. S. Exploration Review—Southwest. Soc. Econ. Geol. Newsletter. Jan. 1993.

[18]Hatton, K. S. Mines, Mills and Quarries in New Mexico (registered as of July 1, 1992). Mining and Miner. Div., NM Energy, Miner. and Nat. Resour. Dep.

[19]New Mexico Selected Industrial Minerals Fact Sheet. Mining and Miner. Div., NM Energy, Miner., and Nat. Resour. Dep. July 1993.

[20]Work cited in footnote 5.

[21]Bland, D. Private communication. Mining and Miner. Div., NM Energy, Miner. and Nat. Resour. Dep. July 15, 1993.

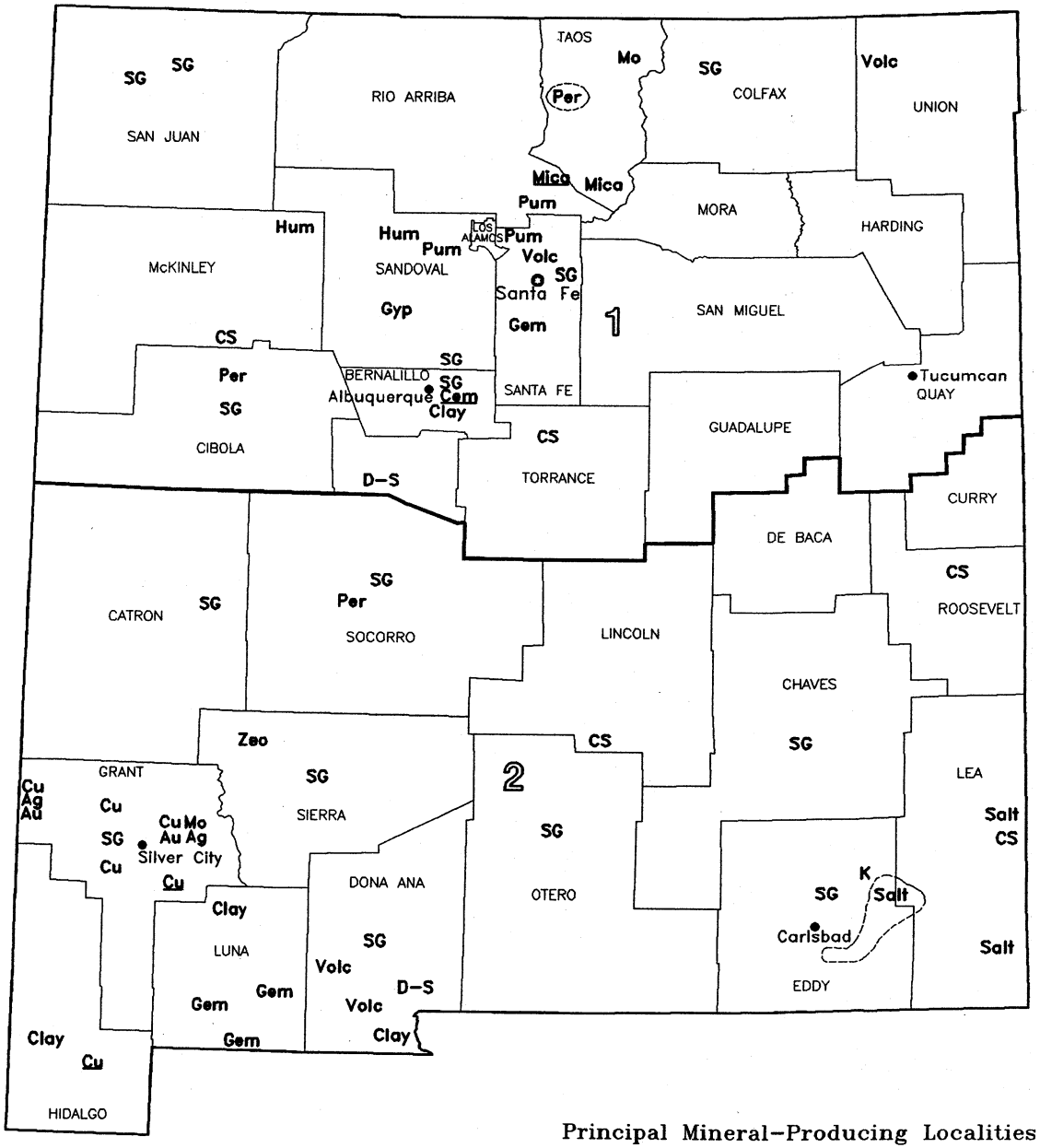
NEW MEXICO

LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Ag	Silver
Au	Gold
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
Cu	Copper
Cu	Copper plant
D–S	Dimension Stone
Gem	Gemstones
Gyp	Gypsum
Hum	Humate
K	Potash
Mica	Mica
Mica	Mica plant
Mo	Molybdenum
Per	Perlite
Pum	Pumice
Salt	Salt
SG	Sand and Gravel
Volc	Volcanic cinder
Zeo	Zeolites
	Concentration of mineral operations



Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Holnam Inc. (formerly Ideal Basic Industries Inc.)[1]	Box 100 Tijeras, NM 87059	Dry process, two rotary-kiln plants	Bernalillo.
Clays:			
El Paso Brick Co.	1000 McNutt Rd. Sunland Park, NM 88063	Pit	Dona Ana.
New Mexico Brick Co. Inc. (doing business as Kinney Brick Co. Inc.)	Box 1804 Albuquerque, NM 87102	Pit	Bernalillo and Santa Fe.
Copper:			
Burro Chief Copper Co., a subsidiary of Phelps Dodge Corp.	Drawer B Tyrone, NM 88065	Solvent extraction-electrowinning plant	Grant.
Chino Mines Co., a subsidiary of Phelps Dodge Corp.-Mitsubishi Metal Corp. partnership.[2 3 4]	Box 7 Hurley, NM 88043	Surface mine, flotation mill, precipitation plant, smelter	Do.
Cyprus Pinos Altos Corp., a subsidiary of Cyprus Minerals Corp.[2 3 5]	Box 2198 Silver City, NM 88062	Underground mine and mill	Do.
Phelps Dodge Corp.:			
Hidalgo Smelter	Box 67 Playas, NM 88009	Smelter	Hidalgo.
Tyrone Branch[2 3]	Drawer B Tyrone, NM 88065	Surface mine, mill, solvent extraction-electrowinning plant	Grant.
Gold:			
Mount Royal Mining & Exploration Co.[3 5 6 7]	100 Mesquite Ave. Duncan, AZ 85534	Underground mine	Do.
Lordsburg Mining Co.[3 5 6 7]	Box A Lordsburg, NM 88045	do.	Hidalgo.
Gypsum:			
Centex American Gypsum Co.	8001 Jefferson NE Albuquerque, NM 87113	Pit and plant	Bernalillo and Sandoval.
Humate:			
Agronics Inc.	701 Madison NE, #207 Albuquerque, NM 87107	Surface mine	Do.
Mesa Verde Resources	Box 8632 Albuquerque, NM 87198	Surface mine and mill	McKinley and Sandoval.
Mica:			
Franklin Industrial Minerals	Box 3648 Fairview, NM 87533	Pit and mill	Rio Arriba and Taos.
Perlite:			
Dicaperl Corp., Mineral Div., a subsidiary of General Refractories Co.	Box 1436 Socorro, CO 87801	Surface mines; crushing, screening, air separation	Socorro and Taos.
Harborlite Corp.	Box 338 Antonito, CO 81120	do.	Taos.
U.S. Gypsum Co., a subsidiary of USG Corp.	Box 216 Grants, NM 87020	Surface mine and crushing plant	Cibola.
Potash:			
Horizon Potash Inc., a subsidiary of Horizon Resources Corp.	Box 279 Carlsbad, NM 88221	Underground mine and plant	Eddy.
Eddy Potash Inc., a subsidiary of Trans-Resources Inc.	Box 31 Carlsbad, NM 88220	do.	Do.
IMC Fertilizer Inc.	Box 71 Carlsbad, NM 88220	do.	Do.
Mississippi Chemical Corp.	Box 101 Carlsbad, NM 88220	do.	Do.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Potash—Continued:			
New Mexico Potash Corp., a sub sidiary of Trans-Resources Inc.	Box 610 Hobbs, NM 88240	Underground mine and plant	Eddy.
Western Ag-Minerals Co., a subsidary of Rayrock Yellowknife Resources Inc.	Box 511 Carlsbad, NM 88220	do.	Do.
Pumice:			
Copar Pumice Co. Inc.	Box 38 Espanola, NM 87532	Surface mines and crushing and screening plant	Sandoval and Santa Fe.
General Pumice Corp.	Box 5135 Santa Fe, NM 87502	Surface mine and crushing and screening plant	Rio Arriba and Santa Fe.
Salt:			
New Mexico Salt & Minerals Corp.	Box 2262 Carlsbad, NM 88220	Tailings treatment	Eddy.
Unichem International Inc.	Box 1499 Hobbs, NM 88240	Solution mining	Lea.
United Salt Corp., Carlsbad Div.	1434 Potash Mines Rd. Carlsbad, NM 88220	Tailings treatment	Eddy.
Williams Brine Co.	2501 Dona Ana Carlsbad, NM 88220	do.	Lea.
Sand and gravel:			
Armstrong Construction Co., Inc.	Box 1873 Roswell, NM 88202	Pit and plant	Chaves.
Blaze Construction Inc.	Box 6253	do.	McKinley, Rio Arriba, San Juan
Calmat Co.	Box 829 Albuquerque, NM 87103	do.	Bernalillo.
Connie H. Danley Construction Inc.	Drawer K Alamogordo, NM 88310	do.	Otero.
Espanola Transit Mix Co.	1301 N. Riverside Dr. Espanola, NM 87532	do.	Rio Arriba.
James Hamilton Construction Co.	Box 1287 Silver City, NM 88062	do.	Eddy, Lea, Luna, Roosevelt, Socorro.
Mountain States Constructors Inc.	Box 6325 Albuquerque, NM 87197	do.	Dona Ana
San Juan Concrete Co.	Box 16 Farmington, NM 87499	do.	San Juan.
Taos Gravel Products Inc.	Drawer A El Prado, NM 87529	do.	Taos.
Western Mobile New Mexico Inc., a subsidiary of Redland, PLC	Box 91570 Albuquerque, NM 87199	do.	Bernalillo and Sandoval.
Silver:			
St. Cloud Mining Co.[267]	Box 1670 Truth or Consequences, NM 87901	Underground and surface mines, mill	Sierra.
Stone:			
Crushed:			
Big Chief Stone Inc.	900 North Morton Lane Las Cruces, NM 88005	Quarries	Colfax, Dona Ana, Santa Fe.
Hamilton Brothers Inc.	Box HH Gallup, NM 87305	Quarry	McKinley.
Western Rock Products Inc.	Box 135 Encino, NM 88321	do.	Torrance.
Wylie Corp.	Box 3921 Albuquerque, NM 87190	do.	Chaves.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone—Continued:			
Dimension:			
Apache Springs Co.	Box 1 Radium Springs, NM 88054	Quarry	Dona Ana.
Daniel F. Guillen Construction Inc.[1]	4007 Mission Bell Las Cruces, NM 88001	do.	Do.
Rocky Mountain Stone Co.	Box 6608 Albuquerque, NM 87197	Quarries	Socorro and Valencia.
Uranium/vanadium:			
Quivira Mining Co., a subsidiary of Rio Algom Ltd.	Box 218 Grants, NM 87020	Underground mines, concentrator, ion-exchange from mine waters	Do.

[1]Also crushed stone.
[2]Also gold.
[3]Also silver.
[4]Also molybdenum.
[5]Also coppper.
[6]Also lead.
[7]Also silica flux.

THE MINERAL INDUSTRY OF NEW YORK

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the New York State Education Department, New York Geological Survey, for collecting information on all nonfuel minerals.

By Donald K. Harrison[1] and William M. Kelly[2]

The value of nonfuel mineral production in New York in 1992 was $765.7 million, a $67 million increase over that of 1991. Leading mineral commodities produced, in terms of value, were crushed stone, salt, portland cement, construction sand and gravel, and zinc. Other mineral commodities produced included masonry cement, clays, garnet, gypsum, peat, industrial sand, dimension stone, byproduct lead and silver, talc, and wollastonite. Industrial minerals processed or manufactured included abrasives, aluminum, ferroalloys, graphite, indium, iodine, mullite, perlite, slag, and tungsten.

Nationally, the State ranked 14th in the value of nonfuel minerals produced. New York was the only State in the Nation that produced wollastonite and one of only two States where garnet was mined. The State ranked third in output of salt and zinc, fourth in crude talc production, and sixth in calcined gypsum output. Of the minerals processed in the State, it ranked third in synthetic graphite and sixth in primary aluminum output. New York was one of only three States where synthetic mullite was produced.

EMPLOYMENT

In 1992, the average number of workers[3] employed in the mineral extractive industries in New York was 4,690, about 300 less than that of 1991. This included 2,652 workers at surface mining operations, most of whom worked at sand and gravel operations. The number of workers at underground mines in the State totaled 533. Of these, 420 worked at nonmetal mines and 113 at metal mines. In addition, a total of 1,505 employees worked at mineral-related mills and preparation plants in the State.[4]

ENVIRONMENTAL

In October, the U.S. Environmental Protection Agency (EPA) placed Li Tungsten Corp.'s defunct tungsten and molybdenum processing plant in Glen Cove, Long Island, on the Superfund National Priorities List. The priorities list identifies uncontrolled hazardous waste sites that warrant further investigation to determine if a long-term cleanup project is necessary. From the 1940's to 1985, Li Tungsten smelted imported tungsten ores at the facility to produce tungsten-carbide powder, tungsten wire, and welding rods. Ground water at the site is contaminated with arsenic, barium, cadmium, chlorides, chromium, lead, polychlorinated

TABLE 1
NONFUEL MINERAL PRODUCTION IN NEW YORK[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	490,552	$2,906	421,003	$2,417	414,766	$2,412
Gemstones		NA	365	NA	125	NA	170
Peat	thousand short tons	W	W	1	21	W	W
Salt	thousand metric tons	4,900	162,900	4,534	173,837	4,703	164,729
Sand and gravel (construction)	thousand short tons	r,e29,912	r121,780	e23,700	e95,500	31,458	130,379
Stone:							
Crushed	do.	e39,900	e207,600	34,871	195,639	e36,800	e212,700
Dimension	short tons	r,e20,981	r,e3,918	r17,959	r3,162	e18,217	e2,779
Combined value of cement, garnet, (abrasive), gypsum (crude), lead, sand and gravel (industrial), silver, talc and pyrophyllite, wollastonite, zinc, and values indicated by symbol W		XX	273,954	XX	228,142	XX	252,578
Total		XX	r773,423	XX	r698,843	XX	765,747

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

biphenyls (PCB's), silver, sulfates, and tungsten.[5]

LEGISLATION AND GOVERNMENT PROGRAMS

A study was completed by the New York State Department of Environmental Conservation (DEC), Division of Solid Waste, that examined various methods of assessing the leachability of contaminants present in municipal solid waste incinerator ash residue. One of the primary goals of this ongoing project is to get a complete picture of the ash residue leachate characteristics to assist in evaluating potential beneficial uses of the material. DEC test results, published in the report "Ash Residue Characterization Project," indicated that, under conditions prevalent in the Department's 6 NYCRR Part 360 regulations, landfills designed for ash residues (ash monofills), the amount of heavy metals leaching from the residues was very small. In nearly all cases, water samples collected from drain pipes in New York State ash monofills contained heavy-metal concentrations at or below New York State's regulatory standards for ground water.[6]

Near yearend, the New York State Court of Appeals agreed to hear a case challenging the Adirondack Park Agency's (APA) jurisdiction over mining in the Adirondacks. The APA is seeking to have the State Court of Appeals overrule the decision made in June by the Supreme Court, Appellate Division, which held that the supersession clause in the State's Mined Land Reclamation Law (MLRL) precluded jurisdiction of the APA to approve, approve with conditions, or disapprove a company's mining operation. The lower court's decision was in favor of Hunt Bros. Inc., Hamilton County, which operated a mineral extraction operation in the park. In 1988, the DEC issued a permit authorizing sand and gravel mining on 6 acres of Hunt's land. The operator requested and received a permit modification in 1989 to allow blasting of hard-rock reserves on a 1-acre portion of the permitted land. After a limited amount of blasting occurred, the APA received complaints from neighboring residents about the use of explosives within the park site.

The APA argued that, minimally, it should be permitted to retain some token of jurisdiction over a mining operation within the park's boundaries and that a local government's imposition of certain conditions on mining operations such as relating to use of access roads, noise, dust emissions, and other factors relating to health and safety outside of the boundaries of the operation should be permissible.[7]

The New York State Geological Survey, an agency incorporated in the New York State Museum, continued programs of basic and applied geologic research statewide. Programs included bedrock mapping at a scale of 1:62,500 in the Adirondack Mountains; paleontologic and stratigraphic studies; review of environmental impacts of waterfront revitalization projects and low-level radioactive waste repository sites; earthquake history studies and public education about earthquakes; and landslide and disaster preparedness investigations. The Geological Survey sponsored a symposium on the geologic complexities in the highway environment and a conference on surficial geology studies in New York. The conference marked the publication of the fifth and final sheet of the surficial geologic map of the State.

The Geological Survey began a 3-year project to delineate seismic hazards in New York State in terms of ground response of soils and soil stratigraphy to plausible seismic events. The first year of the study involved data collection and digitization of the surficial geology from maps scaled at 1:250,000. Subsequent investigations will involve studies of the engineering properties of critical soil units and vulnerability studies of crucial facilities, infrastructure, and transportation corridors.

Offshore nonfuels mineral resource evaluation by the Geological Survey continued with a program of drilling in State and Federal waters south of western Long Island. Vibracore was recovered from 1 to 11 kilometers offshore in water depths up to 40 meters. Analysis of the sediment in the cores revealed a large area of fine sand suitable for onshore fill or cover material for submerged contaminated sediment dumps.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Cement.—New York ranked 9th of 37 States that produced portland cement; it also ranked 12th of 36 States that reported masonry cement production. Four companies operated four cement plants in the State. Both portland and masonry cement were produced by Atlantic Cement Co. Inc. at Ravena, Lehigh Portland Cement Co. at Cementon, and The Glens Falls Cement Co. Inc. at Glens Falls. Only portland cement was produced by the Independent Cement Corp. at its plant near Catskill. In 1992, shipment and value of portland cement rose 13% and 4%, respectively, over 1991 estimates. Although shipments of masonry cement remained essentially the same, value rose 20%. The cement was used primarily for ready-mixed concrete and concrete products and by building material dealers and highway contractors. Most of the cement was shipped by barge; rail and truck accounted for the remainder.

Clays.—Common clay was produced by five companies at seven operations in four counties. Leading counties, in order of output, were Albany, Ulster, Orange, and Onondaga. The clay was used principally in the manufacture of portland cement, face brick, and lightweight aggregate for use in structural concrete and block.

In May, Norlite Corp., a producer of lightweight aggregate, received State DEC permits to continue to burn hazardous wastes in its kilns and to install new air pollution control equipment at its plant in Cohoes, Albany County. In granting the permits, the DEC, responding to neighbors' complaints, will

require the company to further minimize dust from the plant. Norlite, formerly a subsidiary of P. J. Keating Co., was purchased in December 1991 by American NuKEM of Mahwah, NJ, an engineering and waste management firm.

Garnet.—Nationally, New York ranked second in garnet production but first in value. Garnet was produced by three companies in New York in 1992. U.S. production of technical-grade garnet was limited to Barton Mines Corp.'s operation in Warren County. Garnet from there is shipped worldwide and is used in coated abrasives, glass grinding and polishing, and metal lapping. The company also imported garnet from Perth, Western Australia, for use in abrasive blasting.[8] The NYCO Division of Processed Minerals Inc., Essex County, recovered andradite garnet as a byproduct from its wollastonite mining operation. The company sold both crude garnet concentrate and refined garnet for blasting and filtration media. International Garnet Abrasives Inc., Essex County, processed garnet supplied by NYCO primarily for use as blasting and filtration. Some of the refined garnet was exported overseas.

Gemstones.—Value of mineral specimens and gemstones collected by mineral dealers and amateur collectors in New York, based on a survey by the curator of mineralogy of the New York State Museum, was estimated at $650,000 in 1992. Of this amount, approximately $455,000 entered the market as specimens and educational-grade samples and $195,000 remained in private collections and museums. The value of mineral specimens reported in 1992 increased by a factor of four relative to 1991 owing to the unusual discovery of magnetite crystals with rare cubic and tetrahexahedral morphology in the ZCA mine in St. Lawrence County. This appears to have been a one-time discovery from which perhaps 10,000 specimens were recovered. The ore zone that yielded the crystals is now completely mined out. In addition to the zinc and talc mines in St. Lawrence County, other favored gem- and mineral-collecting areas include Gore Mountain, Warren County, limestone and dolomite quarries in Monroe and Niagara Counties, and sites in Herkimer and Montgomery Counties where quartz crystals known as "Herkimer diamonds" are collected for a fee.

Gypsum.—USG Corp., the State's only crude gypsum producer, mined gypsum from an underground mine in Oakfield, Genesee County. Although output declined 16% from that in 1991, value rose 13% because of higher unit values. The crude gypsum was calcined and made into wallboard at an adjoining plant.

Imported gypsum also was calcined at three plants in the State. USG calcined gypsum imported from Nova Scotia, Canada, at Stony Point, Rockland County. National Gypsum Co. operated a plant in Rensselaer, Rensselaer County, and Georgia-Pacific Corp. operated a plant at Buchanan, Westchester County. Total gypsum calcined in 1992 remained relatively unchanged from that of 1991.

Paul Blum Co. Inc., Greene County, resold byproduct gypsum that the company purchased from other processors.

Near yearend, work was nearly completed on the final environmental impact statement for a major development on a 288-acre site in Amherst. Since 1988, three developers have been seeking rezonings for construction of 440 homes, 280 multifamily dwelling units, and possibly a nursing home on the site. However, controversy continued at the site because a large portion of the area is believed to be over abandoned gypsum mines, which could potentially cause subsidence problems. The magnitude and the exact locations of the mines' workings are not accurately known since there are no reliable and accurate maps that show the mines' extent.

Peat.—Two companies mined peat in 1992; one in Seneca County and one in Broome County. All of the peat was sold in bulk and was used for soil improvement and as an ingredient in potting soils.

Salt.—New York continued to rank third in the Nation in salt sold or used; it was first in value. Salt sold or used totaled 4.7 million short tons and was valued at nearly $165 million. Although sales increased nearly 4% from that of 1991, total value decreased by 5%, the result of lower unit prices. Rock salt was produced by Akzo Salt Inc. in Livingston County and by Cargill Inc. in Tompkins County. Both companies also produced vacuum pan salt at plants in Schuyler County. Morton International also produced vacuum pan salt near Silver Springs in Wyoming County, and Texas Brine Corp. produced brine at two operations in Wyoming County for use as feedstock to chlor-alkali producers in the region.

Akzo Salt Inc. was investigating a process that would use incinerator ash to backfill empty cavities in the company's Retsof Mine in Livingston County. Under the proposal, incinerator ash will be mixed with a cementing agent and salt water to form a slurry. The slurry would then be pumped into the empty salt cavities 1,100 feet below the surface where it would harden into a solid material resembling concrete. According to the company, about 80 million cubic yards of empty cavity space is available to store the cement-hardened incinerator ash. Akzo indicated that backfilling the mine with the hardened material would improve mine stability and reduce seepage of saline water into the mine. The company also indicated that it would create a citizens advisory plan to address community concerns.

Sand and Gravel.—Construction.—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

TABLE 2

NEW YORK: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	7,088	$38,346	$5.41
Plaster and gunite sands	166	809	4.87
Concrete products (blocks, brick, pipe, decorative, etc.)	337	1,774	5.26
Asphaltic concrete aggregates and other bituminous mixtures	2,784	15,563	5.59
Road base and coverings[1]	6,403	22,271	3.48
Fill	3,099	6,665	2.15
Snow and ice control	1,537	5,830	3.79
Railroad ballast	75	265	3.53
Other miscellaneous uses[2]	359	1,962	5.47
Unspecified:[3]			
Actual	2,101	8,246	3.92
Estimated	7,510	28,647	3.81
Total[4]	31,458	130,379	4.14
Total[5 6]	28,538	130,379	4.57

[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

New York construction sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 3 presents end-use data for the commodity in the eight New York districts.

Construction sand and gravel, New York's third leading mineral commodity in terms of value, accounted for nearly one-fifth of the total State mineral value. In 1992, a total of 424 companies mined construction sand and gravel from 543 pits in 52 counties. Leading counties, in order of output, were Rensselaer, Suffolk, Cattarauga, Tioga, and Erie. Construction sand and gravel was used mostly for road base and coverings, concrete aggregate, and fill.

Early in the year, the DEC gave the final approval needed for sand and gravel mining to begin on a hill in Sidney that Native Americans believe to be an ancient Indian burial ground. Burton F. Clark Inc. of Delhi received its mining permit in February from the DEC. The permit ends 4 years of battles for the company, which hopes over the next 20 years to mine gravel from 10 acres of land. The State granted the permit after three archeological studies since 1988 turned up evidence of Indian presence, but no hard signs of Indian burials.

In October, the DEC assessed a $1.5 million fine against the owners and operators of a sand and gravel operation in the town of Dover. The fine against Ten Mile River Holding Ltd., a company based in Switzerland and the Long Island-based MAC Sand & Gravel Inc., was one of the largest ever against a gravel mining operation. DEC's ruling, accepting the findings of a department enforcement hearing in 1991, settled hundreds of violations brought by the department. DEC also ordered Ten Mile River Holdings Ltd. to post a performance bond of $285,000 to ensure reclamation of 75 acres of mined land, and ordered the owner to submit a plan for reclamation within 2 years.

Industrial.—Two companies mined industrial sand in New York in 1992. Whitehead Bros. Inc. operated two pits, one each in Oneida and Saratoga Counties. G. W. Bryant Core Sand Inc. operated a pit near McConnellsville, Oneida County. Although production rose by 6% over that of 1991, the total value of industrial sand rose nearly 40% during the same period. Major uses for the industrial sand were for molding and core, glassmaking, and for traction.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—New York ranked 16th of 49 States that reported crushed stone production. Crushed stone was the State's leading mineral commodity produced and accounted for more than one-quarter of the State's total mineral value. Estimated crushed stone output was 36.8 million short tons valued at $212.7 million. The estimated 1992 output of crushed stone was 5% higher than that of 1991. Limestone was the primary type of crushed stone produced. Other rock types quarried, in descending order of tonnage, were dolomite, granite, traprock, sandstone, marble, and slate. The crushed stone was used mainly for cement manufacture, bituminous aggregate, and road base and fill.

Explaura Holdings, a Newfoundland quarry operation, reportedly shipped 62,500 short tons of limestone from its Lower Cove quarry to Valente Industries Corp., a major New York concrete producer. The delivery was made by the m/v Nelvana, the largest ship to be loaded at the quarry since it became operational in 1990. The delivery is part of a 7-million-ton, 10-year supply agreement with Valente.[9]

Dimension.—Dimension stone was produced by 13 companies operating 17 quarries. Sandstone accounted for the

TABLE 3

NEW YORK: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	1,792	10,888	828	6,150	903	3,469
Plaster and gunite sands	114	586	—	—	W	W
Concrete products (blocks, brick, etc.)	W	W	W	W	24	79
Asphaltic concrete aggregates and other bituminous mixtures	W	W	286	2,063	87	305
Road base and coverings[1]	14	50	381	1,915	1,227	3,956
Fill	W	W	137	472	696	1,083
Snow and ice control	48	209	231	1,376	138	542
Railroad ballast	—	—	14	92	60	172
Other miscellaneous uses[2]	483	2,023	153	738	27	119
Unspecified:[3]						
Actual	—	—	39	89	—	—
Estimated	196	493	1,063	5,692	2,367	7,036
Total[4]	2,647	14,249	3,132	18,586	5,529	16,761
Total[5 6]	2,401	14,249	2,841	18,586	5,016	16,761

	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	293	962	838	4,085	995	5,582
Plaster and gunite sands	24	117	—	—	6	42
Concrete products (blocks, brick, etc.)	W	W	W	W	87	384
Asphaltic concrete aggregates and other bituminous mixtures	411	2,102	W	W	1,443	8,428
Road base and coverings[1]	673	1,662	477	1,565	1,120	3,559
Fill	254	431	259	480	984	1,531
Snow and ice control	268	728	194	517	455	1,609
Railroad ballast	—	—	—	—	—	—
Other miscellaneous uses[2]	27	179	85	332	68	236
Unspecified:[3]						
Actual	409	1,318	64	282	221	749
Estimated	1,040	4,229	358	1,405	296	1,236
Total[4]	3,398	11,726	2,275	8,666	5,675	23,357
Total[5 6]	3,083	11,726	2,064	8,666	5,148	23,357

See footnotes at end of table.

TABLE 3—Continued

NEW YORK: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 7		District 8	
	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	571	2,777	868	4,435
Plaster and gunite sands	W	W	W	W
Concrete products (blocks, brick, etc.)	80	411	W	W
Asphaltic concrete aggregates and other bituminous mixtures	154	1,058	250	966
Road base and coverings[1]	1,178	3,866	1,333	5,698
Fill	W	W	423	1,916
Snow and ice control	124	549	79	301
Railroad ballast	1	1	—	—
Other miscellaneous uses[2]	139	489	45	203
Unspecified:[3]				
Actual	287	1,577	1,080	4,231
Estimated	1,561	5,673	629	2,884
Total	4,095	16,401	4,707	20,634
Total[5 6]	3,715	16,401	4,270	20,634

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

majority of the stone quarried, followed by slate, granite, and limestone. Sandstone was quarried in Albany, Delaware, Franklin, and Tompkins Counties. Granite was quarried in Essex and Westchester Counties. Slate was quarried in Washington County, and Onondaga County accounted for all of the State's dimension limestone production.

Talc.—Nationally, New York ranked fourth in output and second in value of eight States that produced talc in 1992. The Gouverneur Talc Co., a subsidiary of R. T. Vanderbilt Co. Inc., mined talc from both an underground and surface operation in St. Lawrence County. The ore was ground and processed at an on-site mill. Most of the talc is used in ceramics and paints. Some is exported to other countries.

Effective May 29, the Occupational Safety and Health Administration (OSHA) rescinded the 1986 regulation that would have treated nonasbestiform actinolite, tremolite, and anthrophyllite (AT&A) as asbestos. Based upon an extensive rulemaking record, OSHA made a determination that substantial evidence was lacking to conclude that nonasbestiform AT&A present the same type or magnitude of health effects as asbestos. OSHA further indicated that substantial evidence did not support a finding that exposed employees would be at significant risk because nonasbestiform AT&A was not regulated in the asbestos standards. Because Vanderbilt's New York talc contains high concentrations of tremolite (50% to 70%) in addition to anthophyllite (10%), the company had been in the forefront involving the resolution of the health and safety issues relating to asbestiform and nonasbestiform minerals.[10] The latest ruling by OSHA found that "insufficient evidence" existed that Vanderbilt's talc presented the same type or size health risk as asbestos.[11]

Wollastonite.—New York continued to be the only State in the Nation where wollastonite was produced. Two companies, one in Essex County and one in Lewis County, each operated a mine and plant in the State. The largest producer, NYCO Minerals Inc., operated the Lewis surface mine about 14 miles west of Willsboro, Essex County. The ore was sent to a nearby mill for processing.

During the year, NYCO completed a $14.4 million rehabilitation and expansion at its Willsboro plant. The company, which mines wollastonite, indicated that the rehabilitation and expansion at the plant will increase productivity of the plant by 50% over the next 5 years. Improvements included installing new primary and secondary crushers and adding a statistical process control.

Other Industrial Minerals.—In addition to the commodities listed in table 1, the production and value of certain processed or manufactured mineral commodities were surveyed by the U.S. Bureau of Mines.

High-purity fused aluminum oxide was produced by Washington Mills Electro Minerals (US) Corp. and by General

Abrasives, Triebacher Inc., both in Niagara Falls. General Abrasives also produced regular fused aluminum oxide. Cut wire shot used for abrasives was produced by Pellets Inc. at a plant in Tonawanda, Erie County.

Elkem Metals Co., a Norwegian-owned company, produced a calcium-silicon-barium-aluminum alloy at its plant in Niagara Falls. SKW Alloys Inc., Niagara Falls, produced alloys of ferrosilicon and silicon for use by the steel industry.

New York ranked third of 13 States that produced synthetic graphite. Three companies, all in Niagara County, produced and shipped graphite. Principal uses were for electrodes, anodes, unmachined graphite shapes, crucibles and vessels, and motor brushes.

Indium Corp. of America was one of two indium producers in the United States. The company produced indium primarily from imported zinc residues, low-grade indium bullion, and indium scrap at a plant in Utica.

Crude iodine was shipped into New York by two companies and was used to produce specialty organic chemicals, pharmaceuticals, catalysts, and sanitation products.

Electric-furnace-fused mullite was produced by Washington Mills Electro Minerals Corp. at Niagara Falls. The mullite was used primarily by the steel industry for furnace linings.

Crude perlite, shipped from out-of-State, was expanded by Scolite International Corp., Rensselaer County, and sold for cavity fill insulation and soil conditioning.

Buffalo Crushed Stone Corp., Buffalo, processed air-cooled, iron-blast-furnace slag and sold the material for road base and asphaltic concrete aggregate.

Buffalo Tungsten Inc., a subsidiary of Cleveland Tungsten Inc., Cleveland, OH, operated a tungsten processing plant in Depew. The company converted ammonium paratungstate into tungsten powder and tungsten carbide powder for use in drill bits and cutting tools.

Metals

Aluminum.—In 1992, New York ranked sixth in output among the 14 States that produced primary aluminum. Primary aluminum was produced by two companies, both in Massena, St. Lawrence County. Reynolds Metals Co. operated a 123,000-metric-ton-per-year smelter, and Aluminum Co. of America (Alcoa) operated a 125,000-metric-ton-per-year plant.

Alcoa and Reynolds Metals Co. will jointly spend almost $200 million to clean up hazardous waste contamination near the companies' Massena, NY, primary aluminum smelters. The cleanup may take a decade to complete. Alcoa and Reynolds are under separate EPA orders to investigate and remediate stretches of the St. Lawrence and Grasse Rivers where PCB releases from the plants have accumulated in river sediments. The New York State DEC also is pursuing a natural resource damage claim for the Massena area.

Lead and Silver.—Lead and silver were recovered as byproducts at Zinc Corp. of America's (ZCA) zinc operations in St. Lawrence County.

Zinc.—New York continued to rank third behind Alaska and Tennessee in zinc output. In 1992, both output and value increased 8% and 22%, respectively, over that of 1991. ZCA was the only producer in the State. The company operated two mines (Balmat and Pierrepont) and a 3,900-metric-ton-per-day mill at Balmat, St. Lawrence County. In 1992, the Balmat Mine was the Nation's fourth leading mine in terms of total output; the Pierrepont Mine ranked fifth. Concentrate from the Balmat mill was shipped by rail to a company-owned smelter in Monaca, PA.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related experience and has covered the mineral activities in New York for 10 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Senior scientist, New York Geological Survey, Albany, NY.

[3]"Average number of workers" is a summary of the average number of workers at individual mining establishments during periods (not necessarily continuous) of active operations.

[4]U.S. Department of Labor, Mine Safety and Health Administration. Mine Injuries and Worktime Quarterly, Jan.-Dec. 1992, 32 pp.

[5]American Metal Market. Four Former Metals Plant Sites Added to EPA's Superfund List. V. 100, No. 204, Oct. 20, 1992, p. 4.

[6]Waste Line. DEC Releases Report on Ash Residue Characterization. NY State Dep. of Environmental Conservation, v. 5, No. 3, Summer 1992, p. 5.

[7]Pit and Quarry. New York Park Has No Control Over Mining. V. 85, No. 7, Jan. 1993, p. 21.

[8]Mining Engineering. 1992 Annual Review. V. 45, No. 6, June 1993, pp. 569-570.

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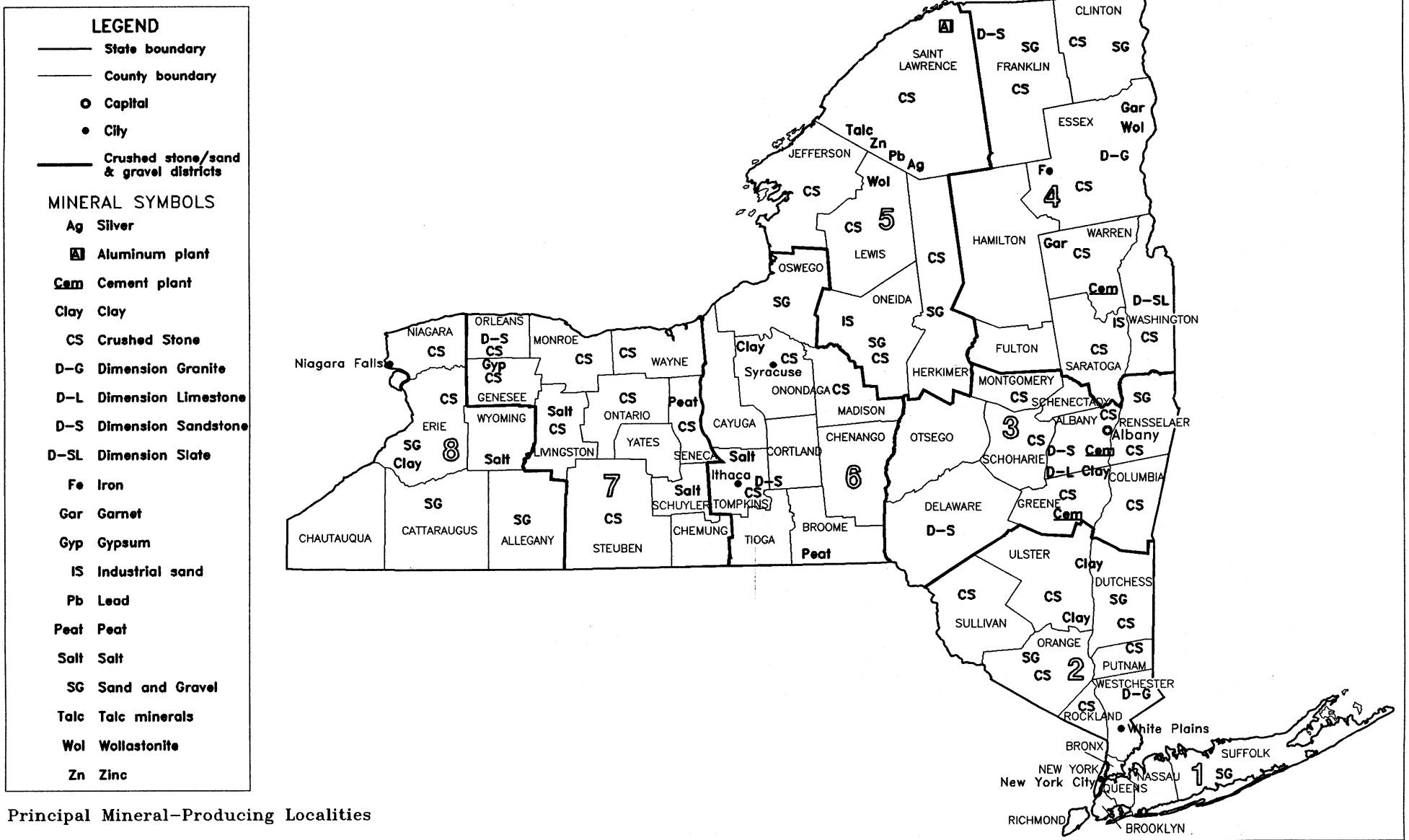
[10]Industrial Minerals. Talc Review, Consolidation and Competition. No. 294, Mar. 1992, p. 30.

[11]Watertown Daily Times. OSHA Rules Vanderbilt Talc Doesn't Fall Under Asbestos Regulations. June 3, 1992.

NEW YORK



Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Abrasives:			
General Abrasives, Triebacher Inc.	2000 College Ave. Niagara Falls, NY 14305	Plant	Niagara.
Pellets Inc.	531 South Niagara St. Tonawanda, NY 14150	do.	Erie.
Washington Mills Electro Minerals (US) Corp.	1801 Buffalo Ave., Box 423 Niagara Falls, NY 14302	do.	Niagara.
Aluminum (primary):			
Aluminum Co. of America	1210 Alcoa Bldg. Pittsburgh, PA 15222	Smelter	St. Lawrence.
Reynolds Metals Co.	Box 27003-2A Richmond, VA 23215	do.	Do.
Cement:			
Atlantic Cement Co. Inc., a subsidiary of Blue Circle Ind., PLC[1 2]	Box 3 Ravena, NY 12143	Quarry and plant	Albany.
The Glens Falls Portland Cement Co. Inc., a subsidiary of Dyckerhoff AG[1]	Box 440 Glens Falls, NY 12801	Quarries and plants	Schoharie and Warren.
Independent Cement Corp., a subsidiary of St. Lawrence Cement Inc.	Box 12-310 Albany, NY 12212	Quarry and plant	Greene.
Lehigh Portland Cement Co., a subsidiary of Heidelberger Zement AG[1]	718 Hamilton Mall Allentown, PA 18105	do.	Do.
Clays:			
Grosso Materials	R.D. 2, Collabar Rd. Box 391 Montgomery, NY 12549	Pit	Orange.
Norlite Corp., a subsidiary of NuKEM	Box 367 Fitchburg, MA 01420	Pit	Albany.
Northeast Solite Corp., a subsidiary of Solite Corp.	Box 27211 Richmond, VA 23261	Pit	Ulster.
Powell & Minnock Brick Works Inc.	Route 144 Coeymans, NY 12045	Pit	Albany.
Syracuse Pottery Inc.	6551 Pottery Rd. Warners, NY 13164	Pit	Onondaga.
Garnet:			
Barton Mines Corp.	Box 400 North Creek, NY 12853	Pit	Warren.
Gypsum:			
Calcined:			
Georgia-Pacific Corp.	Box 105605 133 Peachtree St., NE Atlanta, GA 30348	Plant	Westchester.
National Gypsum Co.	2001 Rexford Rd. Charlotte, NC 28211	do.	Rensselaer.
Crude:			
USG Corp.[4]	101 South Wacker Dr. Chicago, IL 60606	Underground mines, plant	Genesee and Rockland.
Peat:			
Malcuria Bros Inc.	1436 Gates Rd. Geneva, NY 14456	Bog	Seneca.
Bob Murphey Inc.	3129 Vestal Rd. Vestal, NY 13850	Bog	Broome.
Perlite (expanded):			
Scolite International Corp.	6 Madison St. Troy, NY 12181	Plant	Rensselaer.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Salt:			
Akzo Salt Inc.	Abington Executive Park Clarks Summit, PA 18411	Underground mine	Livingston and Schuyler.
Cargill Inc.	Box 5621 Minneapolis, MN 55440	do.	Tompkins.
Morton International Inc.	110 North Wacker Dr. Chicago, IL 60606	Well	Wyoming.
Texas Brine Corp.	2000 West Loop South Houston, TX 77027	Wells	Do.
Sand and gravel:			
Construction:			
Broad Hollow Construction Estates Inc.	170 Cabot St. West Babylon, NY 11704	Pit	Suffolk.
Clemente Latham Concrete Corp.	R.D. No. 5, Box 56 Troy, NY 12108	Pit	Rensselaer.
Dan Gernatt Gravel Products	Richardson Rd. Collins, NY 14034	Pits	Cattaraugus and Erie.
Roanoke Sand & Gravel	Box 8H Middle Island, NY 11953	Pit	Suffolk.
Troy Sand & Gravel	Box 189 Waterviliet, NY 12189	Pit	Rensselaer.
Industrial:			
Whitehead Bros. Inc.	Box 259, River Rd. Leesburg, NJ 08327	Pits	Oneida and Saratoga.
Slag (iron):			
Buffalo Crushed Stone Corp.[2 3]	2544 Clinton St. Buffalo, NY 14224	Plant	Erie.
Stone (1989):			
Crushed:			
Beazer East Inc., a subsidiary of Beazer USA[3]	Koppers Building Pittsburgh, PA 15219	Quarries	Various (11 counties)
Blue Circle Atlantic Inc.	Box 3 Ravena, NY 12143	Quarry	Albany.
Buffalo Crushed Stone Corp.	Box 710 West Seneca, NY 14224	Quarries	Erie.
Callahan Industries Inc.	South St. South Bethlehem, NY 12161	do.	Albany, Madison, Montgomery, Rensselaer, Ulster.
Dolomite Products Inc.	1150 Penfield Rd. Rochester, NY 14625	do.	Genesee, Monroe, Ontario, Wayne.
New York Trap Rock Corp., a subsidiary of Lone Star Industries Inc.	Box 432 Montvale, NJ 07645	do.	Dutchess and Rockland.
Dimension:			
Champlain Stone Ltd.	Box 852 Glens Falls, NY 12801	Quarry	Washington.
Finger Lakes Stone Co. Inc.	Box 401 Ithaca, NY 14850	do.	Tompkins.
New York Quarries Inc.	Box 43, Box 111 Alcove, NY 12007	Quarries.	Albany and Delaware.
Rainbow Quarries Inc.	132 East Main St. Malone, NY 12953	Quarry	Franklin.
Ritchie Bros. Slate Co.	Box 202 Middle Granville, NY 12849	Quarries	Washington.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Talc:			
Gouverneur Talc Co. Inc., a subsidiary of R. T. Vanderbilt Co. Inc.	Box 89 Gouverneur, NY 13642	Underground and surface mine	St. Lawrence.
Wollastonite:			
NYCO Div. of Processed Minerals Inc.[5]	Box 368 Willsboro, NY 12996	Surface mine	Essex.
R. T. Vanderbilt Co. Inc.	30 Winfield St. Norwalk, CT 06855	Underground mine	Lewis.
Zinc:			
Zinc Corp. of America[6]	Sylvia Lake Rd. Balmat, NY 13607	Underground mines	St. Lawrence.

[1]Also clays.
[2]Also stone.
[3]Also sand and gravel.
[4]Also calcined gypsum.
[5]Also garnet.
[6]Also byproduct lead and silver.

THE MINERAL INDUSTRY OF NORTH CAROLINA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Division of Land Resources, North Carolina Department of Environment, Health, and Natural Resources, for collecting information on all nonfuel minerals.

By Steve W. Sikich,[1] P. Albert Carpenter III,[2] and Leonard S. Wiener[3]

The value of nonfuel minerals produced in North Carolina increased by 7% from that of 1991 to a record high. The value grew from the revised[4] total of $556.7 million in 1991 to $595.6 million in 1992. The increase in the value of mineral production indicated that the State's hoped-for rebound from the recession that had impacted the Nation in recent years had materialized. The increase was led by a 9.4% gain in sales of the State's two leading mineral commodities, crushed stone and phosphate rock. Other mineral commodities that showed increases included clays, feldspar, gemstones, and sand and gravel. These increases were offset by declines in the value of scrap mica, dimension stone, and most minerals for which production data are withheld.

North Carolina continued to lead the Nation in the quantity and value of feldspar, lithium minerals, scrap mica, olivine, and pyrophyllite produced. The State also led the Nation in the production of clay used for the manufacture of bricks and ranked second in the production of phosphate rock. Overall, North Carolina's national ranking in the value of all mineral commodities produced improved from 18th in 1991 to 17th in 1992.

TRENDS AND DEVELOPMENTS

The increase in mineral production marked a reversal of 1 year of declining output following 9 years in which North Carolina's mineral production had attained record-high values. The new record high indicated an end to North Carolina's recession.

For the first time in several years, there were no major corporate changes or

TABLE 1
NONFUEL MINERAL PRODUCTION IN NORTH CAROLINA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	[2]2,179,428	$9,356	[2]2,063,875	[2]$9,015	2,119,890	$9,775
Feldspar	do.	418,402	[r]14,460	402,448	13,027	438,624	15,498
Gemstones		NA	1,057	NA	785	NA	1,219
Mica (scrap)	thousand metric tons	65	3,796	64	3,747	51	2,967
Peat	thousand short tons	13	W	21	W	W	108
Sand and gravel:							
Construction	do.	[r]11,289	[r]42,530	[e]9,900	[e]35,000	10,233	42,717
Industrial	do.	1,177	15,338	1,174	15,565	1,199	17,533
Stone:							
Crushed	do.	[e]52,900	[e]276,200	[3]46,514	[3]243,920	[e] [3]48,600	[e] [3]262,400
Dimension	short tons	[r] [e]36,163	[r] [e]9,758	[r]37,056	[r]10,568	[e]25,369	[e]7,469
Combined value of clays [kaolin (1990-91)], lithium minerals, olivine, phosphate rock, stone [crushed volcanic cinder (1991)], talc and pyrophyllite, and values indicated by symbol W		XX	213,112	XX	225,011	XX	235,962
Total		XX	[r]585,607	XX	556,638	XX	595,648

[e]Estimated. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; value included with "Combined value" figure.
[3]Excludes certain stones; value included with "Combined value" figure.

acquisitions in North Carolina. Martin-Marietta Aggregates moved its group headquarters from Bethesda, MD, to Raleigh.

Major news related to the State's minerals industry involved highway planning, the construction of new plants, and the expansion of existing facilities. On the negative side were a drastic decline of exploration activity, especially with respect to titanium and gold; the postponement of several projects that were expected to begin in 1992; and continued opposition to mining activity by environmentalists.

A draft of the 1993-99 Transportation Improvement Program (TIP) was presented to the North Carolina Board of Transportation in July. TIP is a $5.5 billion plan that sets transportation priorities throughout the State for the 7-year period. The construction will be funded by a combination of Federal and State funds.

Vulcan Materials Co. began site work at a new crushed stone quarry and crushing plant at High Shoals, Gaston County, in August. The Balfour Granite Quarry, near Granite Quarry in Rowan County, inactive since 1969, was reopened as the Pink Camellia Quarry in June. North Carolina Granite Co. began construction of a new finishing plant to cut stone for buildings and monuments. KMG Minerals Co. began reconstruction of its Patterson mica processing plant in Kings Mountain, Cleveland County, after a fire on June 16 caused more than $1 million damage. ECC International constructed a 40,000-ton-per-year capacity precipitated calcium carbonate plant at the Champion International Paper Co. mill in Canton.

Several companies that do not actually mine minerals in North Carolina, but use large amounts of minerals in their manufacturing processes, announced major plant construction plans. Timken Co. continued construction of a carbon and alloy bar and tapered bearing plant begun in late 1991. Cormetech Inc., a joint venture formed by Corning Inc., Mitsubishi Heavy Industries Ltd., and Mitsubishi Petrochemical Co. Ltd., began production of ceramic-based catalysts for control of air pollution from power generation, chemical manufacturing, and other industrial sources at its new manufacturing facility and corporate headquarters in Durham. RSR Corp. announced plans to build a secondary lead smelter in either North Carolina or South Carolina.

Titan Cement Co. postponed plans to reopen the idle Ideal Cement Co. plant in Castle Hayne. Development of titanium leases owned by RGC Minerals Inc. and TiSand Joint Venture in northeastern North Carolina were essentially on hold in 1992 because of low prices caused by overcapacity of the TiO_2 pigment industry. At yearend, FMC Corp., Lithium Div., announced that it planned to back out of a contract it signed in February to develop substantial lithium reserves in Bolivia. FMC indicated that the life of North Carolina's lithium industry may have been extended well into the 21st century had the venture been completed successfully.

Throughout the year the mining community continued to increase its efforts to improve its image and to stress importance of mining in attaining and maintaining the high quality of life enjoyed by most Americans. Included in their efforts were landscaping and reclamation of mine and plant sites; establishing and enhancing wildlife habitat areas; and continuing programs to reduce dust, noise, and other irritants to their immediate neighbors. Educational efforts included providing speakers and materials to elementary and secondary school students and teachers and visits by school and other interested groups to mining operations and processing facilities.

EMPLOYMENT

Preliminary data reported[5] by the Mine Safety and Health Administration showed an average of 3,777 people directly employed by North Carolina's mining industry in 1992. This represents a 4.8% decrease from the 3,967 reported for 1991. Of the total number, 2,183 were employed in surface mines and 1,594 were employed in mills and preparation facilities. North Carolina's mining industry reported more than 7.3 million employee-hours worked with no fatalities and only one injury resulting in more than 1 day of lost work in 1992.

According to data compiled by the American Mining Congress, the annual salary of the average mine worker was $37,496 in North Carolina compared with a national average of $28,813. Gross State revenues from mining were $578.3 million.

ENVIRONMENTAL ISSUES

Recycling of mineral products has become an important source of the raw materials used in manufacturing the products needed for everyday living. In the United States in 1991, the last year for which data were available, the U.S. Bureau of Mines (USBM) estimated that the value of metals recovered from recycling programs actually exceeded the value of native ore mined by more than $2 billion. In North Carolina, recycled minerals are used in the manufacture of a wide variety of products. The diverse uses of recycled product can be illustrated by a creative project in Cary, Wake County. The city's Planning and Development Department and a private environmental planning and landscape architecture firm, Greenways Inc., created a greenway composed entirely of recycled material, the first of its kind in the United States. A greenway is a strip of land set aside in developed areas to preserve open space and provide a place for recreational activities, such as walking, jogging, and cycling. The Cary greenway, which was completed in November 1992, is a 1.3-kilometer (0.8-mile) trail that links an industrial business park with two residential subdivisions. Culverts for storm drainage and park benches were manufactured from milk jugs, detergent bottles, and shopping bags. Scrap aluminum and industrial waste such as the excess fibrous material used in manufacturing disposable baby diapers were used to make informational signs and signposts. Bottom ash, a byproduct of coal-burning electrical generating plants; industrial waste; asphalt recycled from streets, driveways,

and parking lots; and rubber from shredded tires were used to pave the trails. All of the materials and services were donated by private businesses or provided at significant discounts.

Major environmental issues directly affecting the mining industry related to the use of hazardous waste for fuel by lightweight aggregates producers and the permitting of expanded mining operations. Carolina Stalite Co. received a permit to treat up to 329,000 tons annually of contaminated soil derived principally from leaking underground petroleum storage tanks. The soil will be processed in two rotary kilns at Stalite's lightweight aggregate facility at Gold Hill, Rowan County. The soil will be heated to 2,000° F to volatilize the contaminants, which are then treated in the plants emission control system and released into the atmosphere as harmless gasses. The treated soil will be used to manufacture lightweight aggregate and as horticultural products or fill material. Construction required for the new process was estimated at more than $350,000. The Cherokee Sanford Group of Sanford continued to recycle petroleum-contaminated soil to manufacture bricks. Cherokee has eliminated a disposal problem by using the petroleum in the soil to fuel its kilns and by using the resulting uncontaminated soil as an ingredient in manufacturing the bricks.

Carolina Solite Co. began construction of four baghouses in September. The first of the baghouses is expected to be completed at a cost of $1 to $1.5 million no later than June 1, 1993. The company plans to resume burning of hazardous waste to fire kilns at its lightweight aggregate facility at Aquadale, Stanly County, after construction of the baghouses and required compliance testing is completed. Solite has been using coal for fuel since August 1991. The company manufactures lightweight aggregate from clay.

Texasgulf Inc.'s (Tg) applications for permits to extend its phosphate mining operations in Beaufort County were pending at yearend. The Beaufort County Board of Commissioners on September 2 sent a letter to State officials stating that the county's land use plan does not prohibit Tg from mining approximately 700 acres near its existing Aurora mining operation. The commissioners decision followed the denial by the North Carolina Coastal Management Commission (CMC) of a mining permit sought by Tg. CMC refused to approve the permit on the grounds that the application violated provisions of Beaufort County's 1987 Land-Use Plan. In December, the U.S. Army Corps of Engineers (COE) sent copies of the Draft Environmental Impact Report (DEIR) for Tg's requested expansion of its mining operations to interested government and regulatory agencies. After the DEIR is reviewed by the various agencies, COE will incorporate their comments in a Draft Environmental Impact Statement that will be publicly distributed.

In other news related to environmental issues, Tg's water management system was certified by the U.S. Environmental Protection Agency (EPA). The project, designed to reduce discharges of phosphorus and fluoride by 90% and 75%, respectively, took 4 years to complete and cost more than $30 million. The permitted discharge of phosphorus into the Pamlico River averaged 468 metric tons (516 short tons) for the 7-year period between 1980 and 1988. This was reduced by 94% to a yearly average of 28.8 metric tons per year during the system's first month of operation in September 1992. Reductions of fluoride discharge for the same periods totaled 88%, dropping from an average of 305.7 metric tons per year for the 7-year period to 3.1 tons in September 1992, an average of 37.2 tons per year. Only nonprocess rainwater that does not enter any chemical plant is discharged into the Pamlico River. The rest of the water, including all spills, seepage, used process water, and part of the stormwater runoff, are collected and recycled in plant processes.

Tg also met its goal to reduce solid waste disposed offsite to 72.5 metric tons (80 short tons) per month in 1992. The goal was first met in April, and the monthly average for the final 9 months of 1992 was 65.4 tons, an estimated reduction of more than 90% from the previous year. Tg also has reduced its hazardous waste production and disposal by 90% over the past 4 years. Hazardous waste is defined by EPA as any waste that includes solid or liquid wastes that are corrosive, ignitable, reactive, or toxic. As a result of EPA's mixture rule, a small amount of hazardous waste mixed with a large amount of nonhazardous waste makes the entire mixture a hazardous waste.

Tg management approved a new Operations Environmental Department (OE) that became effective on July 1. OE is responsible for the operation and maintenance of the water management system, the wastewater treatment plant, the plant site septic system, plant site drinking water systems, and the elementary neutralization facility for liquid corrosive hazardous waste.

Drilling of an offshore natural gas well by the Mobil Oil Co. continued to be delayed pending action on a report that the Secretary of Interior submitted to Congress in April. The report evaluated oceanographic, ecological, and socioeconomic data and contained his recommendation to conduct additional studies prior to permitting the drilling of the well. The action served to delay consideration of Mobil's application at least until 1993.

Levels of arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver in excess of State and Federal maximum levels were discovered in Island Creek and in ground water near the abandoned Tungsten Queen Mine in Vance County during 1991. At yearend, the North Carolina Department of Environment, Health, and Natural Resources (DEHNR) and EPA were continuing studies of the area to determine the extent of potential danger posed by the minerals. The Tungsten Queen Mine, which opened in 1942, was closed in 1971 as a result of processing difficulties and a weak tungsten market. Tungsten is an important strategic material vital to metalworking, machinery, construction, transportation, mining, and oil and gas drilling industries

in the United States. The area contains one of the largest reserves of tungsten found in the United States.

Although a decision was expected within 2 weeks after RSR Corp. announced its plans to build a secondary lead smelter, a site had not been selected by yearend. The proposed smelter would employ 150 permanent workers and process more than 6 million automotive and industrial batteries, each containing an average of 20 pounds of lead. The project will cost an estimated $60 million and is anticipated to take 3 to 5 years for permitting and construction.

EXPLORATION ACTIVITIES

The boom in exploration for titanium minerals in ancient beach sands in northeastern North Carolina and neighboring Virginia virtually died in 1992. Development of titanium leases in the area were essentially on hold in 1992 because of low prices caused by overcapacity of the TiO_2 pigment industry that consumes almost 90% of the world's titanium mineral production. In the fall of 1992, Hanson PLC announced that its controlling interest in Renison Goldfields Consolidated Ltd. (RGC) was for sale. RGC later announced that it was taking a $20 million write-down on the reported value of the titanium leases held by its American subsidiary, RGC Minerals Inc., in North Carolina and Virginia. RGC indicated that it planned to develop the titanium deposits when market conditions improved.

The other company holding extensive titanium leases in North Carolina, TiSand Joint Venture, also scaled back its development activities in 1992. TiSand, formed by Becker Minerals Inc. of England and Consolidated Rutile Ltd. of Australia, also indicated that it planned to continue development of the titanium deposits when economic conditions improved.

Piedmont Mining Co., Charlotte, reported that soil sampling, trenching, and core drilling were continuing at the Russell-Coggins property in Montgomery County. Core drilling resumed in October and by yearend, three core holes totaling 475 meters (1,550 feet) had been drilled. Five trenches with a total length of 365 meters (1,200 feet) also had been completed.

Otherwise, gold exploration in North Carolina remained at a minimal level because of the continued depressed price of gold. However, some small operations were reported, including the reworking of old dumps at the Conrad Hill Mine in Davidson County.

LEGISLATION AND GOVERNMENT PROGRAMS

The North Carolina Legislature did not enact any laws directly affecting the minerals industry in 1992. In legal decisions affecting the minerals industry, a U.S. District Court judge dismissed a $5 million suit filed by Nello L. Teer Co. against Orange County in 1989. Teer sued the county, maintaining that it was prohibited from operating a quarry on 146 acres it owned because of a series of zoning actions designed expressly to block the quarry. In July, the town of Boone won a $48,100 civil judgement from Radford Quarries. Boone had accused Radford, which operates a crushed stone quarry east of the town, of constructing berms and dikes within the town limits on the floodplain of the New River without proper permits. The settlement represented a $100 per day fine levied against the company by the city. Radford appealed the case to the State Court of Appeals. A decision was not expected until mid-1993.

The North Carolina Division of Land Resources (NCDLR) conducted programs related to the survey, evaluation, conservation, development, regulation, and protection of North Carolina's mineral and related resources. Regulatory functions included the administration and enforcement of mining, sedimentation pollution control, dam safety, and oil and gas conservation laws. The division is divided into the North Carolina Geological Survey (NCGS), Geodetic Survey, and Land Quality sections. Major activities of the NCGS in 1992 included serving on interagency committees for both the low-level radioactive waste (LLRW) and the hazardous waste disposal facilities that have been proposed for North Carolina, geologic and topographic mapping, and cooperative programs with the Minerals Management Service (MMS).

NCGS involvement in the LLRW program included providing technical geologic advice and oversight to the State agencies charged with granting or denying the facility a license (Division of Radiation Protection) and with establishing the facility (LLRW Management Authority). In 1992, NCGS conditionally approved the site characterization plans for two sites selected by the authority. Resolution of the licensing of the selected sites remains uncertain and highly speculative, although the facility is scheduled to open in January 1996. NCGS also provided similar geological input for the Hazardous Waste Management Commission, which is evaluating potential sites for a proposed incinerator, solvent recovery plant, and landfill facility. Additional funding was approved by the General Assembly in mid-1992 to assist LLRW regulation. This allowed NCGS to increase the total complement of its staff from 15 to the fully authorized strength of 18.

Geologic Mapping focused upon the Raleigh and Asheville 1:100K sheets and the Clayton, Middlesex, and Zebulon 7½-minute quadrangles. Contract geologic mapping as part of a Cooperative Geologic Mapping Program (COGEOMAP) project continued in the Cokesbury, Flowers, Raleigh West, Selma, and Zebulon 7½-minute quadrangles. The U.S. Geologic Survey (USGS) released an open file map of its geologic mapping in the Wake Forest and Bayleaf 7½-minute quadrangles.

The COGEOMAP project with the USGS included the photorevision, limited revision, and complete revision of older topographic maps and continuation of 1:100K-scale mapping. A State Mapping Advisory Committee under a Geographic Information Coordinating Council was established by an executive order signed by the Governor.

Cooperative programs with MMS

included the assessment of minerals on the Continental Shelf and shallow high-resolution seismic surveys off the Outer Banks to study possible sources of beach nourishment sand.

As of the December 31, 1992, a total of 1,297 mining operations had been permitted by NCDLR. Of these, 665 were currently active, 132 were inactive, and 500 had been released. Comparable figures for December 31, 1991, were 638 active, 127 inactive, and 462 released. The estimated total acres that were permitted for the 797 mines that have not been released was 89,559, or less than 0.3% of North Carolina's total land area. Of these, only 27,241 acres had actually been affected and had not yet been reclaimed. The largest number of permits, 512, were issued for sand and gravel pits. There were 130 permitted crushed stone quarries and 64 clay pits.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Thirteen industrial mineral commodities were mined in North Carolina in 1992. At least nine additional industrial mineral commodities were produced from raw materials mined within the State, shipped from other States, or imported. These included andalusite, barite, synthetic graphite, byproduct gypsum, calcined gypsum, iodine, expanded perlite, sodium sulfate, and steel slag. The 13 mined commodities accounted for all of the value of minerals reported in table 1.

Clays.—Nationally, North Carolina ranked 6th in the quantity of clay mined, but only 13th in value. The quantity of clay mined in North Carolina increased in 1992, but failed to reach the record-high level achieved in 1989. Production was 2.1 million metric tons (2.7% more than that of 1991) valued at almost $9.8 million. The value showed an increase of 8.4% over that of 1991, but was 37.1% less than the record high of $15.5 million set in 1989. Common clay and kaolin were the two types of clay produced in 1992.

Common Clay and/or Shale.—Nationally, North Carolina ranked third in quantity and improved from fifth to fourth in the value of common clay mined. The quantity mined increased 2.7% from 2.06 million metric tons in 1991 to 2.12 million tons in 1992. Its attendant value increased 8.4% from $9.02 million to $9.78 million.

The State continued to lead the Nation in the production of common clay used in the manufacture of brick. Production of common clay increased 2.7% to 2.06 million metric tons valued at $6 million, an 8.4% increase over that of 1991. The second major use of common clay was in the manufacture of lightweight aggregate. North Carolina production remained at the 1991 level of 327,000 metric tons valued at $3.7 million, but its national ranking dropped from third to fourth. The principal uses of lightweight aggregate were in the manufacture of concrete blocks and structural concrete. The principal producers of clay used in the manufacture of lightweight aggregate were the Carolina Solite Corp. in Stanly County, the Virginia Solite Corp. in Rockingham County (subsidiaries of the Solite Corp., Richmond, VA), and the Carolina Stalite Corp. in Rowan County. Minor uses of clay included floor, wall, and quarry tile; ceramics; and miscellaneous clay products.

Nineteen companies, 13 of which belonged to the Brick Association of North Carolina, reported the mining of common clay from 43 pits in 20 counties. The major producing counties, in order of quantity mined, were Lee, Rockingham, Stanly, Rowan, and Chatham. The largest producers in terms of quantity of common clay mined were Solite Corp., Hammill Construction Co., Cherokee Sanford Group Inc., Pine Hall Brick and Pipe Co., and Boren Clay Products Co.

Kaolin.—Kaolin was recovered as a byproduct of Unimin Corp.'s quartz and mica processing operation at Spruce Pine from ore mined at the Brushy Creek Quarry, Avery County. Recovery of marketable kaolin from the other feldspar operations in the area was not reported. The only other kaolin production reported was a byproduct from KMG Minerals Inc.'s mica operation at Kings Mountain, Cleveland County. The kaolin was sold primarily for the manufacture of white brick.

Feldspar.—Feldspar production increased significantly in 1992, but was considerably less than the record high of 477,800 tons valued at $17.3 million attained in 1986. However, the trend that showed feldspar production decreasing each year since 1986 was finally reversed. This resulted in part from the country's emergence from its lingering recession. A prime indicator of the Nation's economic condition, housing starts, increased by 20% from 1991 to 1992. This led to an increase in the demand for ceramic plumbing fixtures, flat glass, fiberglass insulation, and tile. Feldspar is an important component in the manufacture of all these products.

The value of feldspar produced was $15.5 million, $2.5 million or 19% more than that of 1991. The tonnage produced showed a more modest increase of 9% to 438,624 metric tons.

Five companies reported feldspar production in North Carolina. The Feldspar Corp., K-T Feldspar Corp., and Unimin produced feldspar as a coproduct with mica from Alaskite deposits in Mitchell and Avery Counties. KGM Minerals Inc. and FMC Corp., Lithium Div., mined and processed feldspar from pegmatites in Cleveland County.

Gemstones.—The value of gemstones produced in North Carolina increased 55.3% to an alltime high of $1.22 million in 1992. The increase was in marked contrast to the 25.7% decline suffered in 1991. As a result of the increase, North Carolina climbed from 12th to 10th nationally in the value of gemstones produced. Historically, North Carolina is the only State in which all four major gem minerals, diamond, ruby, sapphire, and emerald, are found. The last year in which all four varieties were found was

1988, when a diamond was found in a gold placer mine. In 1992, rubies and sapphires were recovered at pan-for-fee operations in Cowee Valley and emeralds were found near Hiddenite and Little Switzerland.

Lithium.—North Carolina continued to lead the Nation in the production of lithium compounds. The only other domestic lithium production was from geothermal brine deposits in Nevada. The lithium in North Carolina was produced from the mineral spodumene, a lithium aluminum silicate that occurs in pegmatites in the Kings Mountain area. Two companies, FMC Corp.-Lithium Div. and Cyprus Foote Mineral Co., mined spodumene and processed it for lithium carbonate. FMC produces a full range of downstream lithium compounds at a nearby plant in Bessemer City. Cyprus Foote continued to operate on a scaled-down basis in 1992. FMC processes the spodumene concentrate at a plant in Cherryville and produces a full line of lithium chemicals and compounds at its main processing facility in Bessemer City. The company also operated a butyllithium plant in Bay City, TX. Lithium carbonate produced by Cyprus Foote at Kings Mountain is shipped primarily to a sister plant in New Johnsonville, TN, where a full range of lithium chemicals and compounds are produced.

In mid-February, FMC signed a contract to develop substantial lithium reserves in the Salar de Uyuni near Potosi in southern Bolivia. The agreement was signed by the President of Bolivia and ratified, with amendments, by the Bolivian Congress. On December 31, 1992, FMC informed the Bolivian Government that the amendments were unacceptable, but agreed to extend the deadline for making the contract effective for an additional 30 days. The amendments focused on taxation determination, terms of exploitation, and the mechanism by which the prices would be fixed for the end products. An earlier attempt by FMC to develop the deposit ended in May 1990 when the Bolivian President withdrew a similar lithium feasibility study and development agreement that he had submitted to the Bolivian Congress.

FMC had planned to extend the life of its Bessemer City operations by processing lithium carbonate from the Bolivian deposit at the North Carolina facility. The company was continuing to explore potential lithium deposits in northern Argentina and Chile.

Mica.—Scrap mica production continued to decrease as it has every year since 1987, when 91,000 metric tons valued at $5.6 million was produced. In 1992, mica production and its attendant value decreased approximately 20.5% from 64,000 metric tons valued at $3,747,000 in 1991 to 51,000 tons valued at $2,967,000 in 1992. Mica was produced by six companies in 1992. Cyprus Foote Minerals Co. recovered mica as a byproduct of its lithium operations in Cleveland County. The Feldspar Corp. recovered mica from three pits in Mitchell County. FMC Corp.-Lithium Div. recovered mica from spodumene pegmatites in Gaston County. K-T Feldspar Corp., a subsidiary of Hecla Mining Co., mined mica from one pit in Mitchell County. KGM Minerals recovered mica from pegmatites in Cleveland County. Unimin produced mica from quarries in Avery and Mitchell Counties. The mica produced by the Feldspar Corp., K-T Feldspar, and Unimin in the Spruce Pine area was recovered from alaskite deposits. Alaskite is a generally coarse-grained granitic rock that is relatively free of iron-bearing minerals. Typically, it is composed of 45% plagioclase feldspar, 20% microcline feldspar, 15% quartz, and 10% muscovite mica. Feldspar and high-purity quartz sand are usually recovered along with the mica. Kaolin also may be recovered from deeply weathered alaskite bodies.

Cyprus Foote, FMC, and KGM recovered mica from pegmatites in the Kings Mountain-Bessemer City area of Cleveland and Gaston Counties. Feldspar, kaolin, lithium, and industrial sand were recovered in addition to the mica.

The dry-ground plants of Deneen Mica Co. at Micaville in Yancey County and J. M. Huber at Kings Mountain and Spruce Pine remained inactive during the year. Huber discontinued mining operations and offered its operations for sale on April 1, 1990; as of yearend 1992, the operation was still for sale. In March 1992, DEHNR ordered J. M. Huber to correct deficiencies and reclaim all affected acreage at the inactive Huber No. 1 Mine near Grover, Cleveland County.

Cleveland County Commissioners, on July 20, unanimously approved a zoning ordinance that will preclude the expansion of mica mining activities along a 6-mile corridor between Grover and Kings Mountain. The only operation to be immediately impacted by the ordinance is a recently permitted 10-acre tract owned by Rednour Mining Co. Rednour, which had not yet begun mining on the tract, had applied to increase the permitted acreage by an additional 113 acres. The corridor currently contains 2,060 permitted acres that can be mined without rezoning.

Junaluska Mica Co. processed scrap mica in Andrews, Cherokee County, for use in the backing material of roofing shingles.

Olivine.—North Carolina remained the leading producer of olivine in the United States, although both the quantity produced and its value declined as it has each year since 1984. In past years, most of the decrease resulted from increased imports from Norway. Much of the decline in olivine production in the past 3 years resulted from a decline in steel production, which is the largest user of olivine in the United States. Olivine acts as a flux and a slag conditioner, improving the performance of sinter and reducing coke consumption.

Applied Industrial Minerals Corp. (AIMCOR), headquartered in Deerfield, IL, operated the Day Book Mine in Yancey County and remained North Carolina's sole olivine producer. AIMCOR's mine in Avery County was worked on a limited basis, but final reclamation was completed on its Jackson County mine, which was closed in 1987.

TABLE 2

NORTH CAROLINA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	2,667	$8,569	$3.21
Plaster and gunite sands	W	W	2.47
Concrete products (blocks, brick, pipe, decorative, etc.)	612	1,450	2.37
Asphaltic concrete aggregates and other bituminous mixtures	1,036	3,735	3.61
Road base and coverings[1]	713	2,897	4.06
Fill	943	2,066	2.19
Snow and ice control	27	116	4.30
Other miscellaneous uses[2]	460	5,400	11.74
Unspecified:[3]			
Actual	2,694	15,615	5.80
Estimated	1,081	2,869	2.65
Total	10,233	42,717	4.17
Total[4 5]	9,283	42,717	4.60

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

Peat.—Nationally, North Carolina ranked 11th in the quantity produced and 13th in its attendant value of 20 States in which peat was produced in 1992. Actual data on peat production were withheld because only one company mined and processed peat in the State. American Peat Co. Inc. mined peat from pits in Hyde County and processed it for sale in horticultural applications.

Phosphate Rock.—North Carolina ranked second nationally, behind Florida, in both the quantity and value of phosphate produced. Phosphate was the second most valuable mineral commodity mined in North Carolina, ranking below crushed stone. According to USBM projections, planned phosphate rock production in North Carolina will hold at 5.5 million metric tons through 1994, then increase to 6.8 million metric tons for 1995 and 1996.

Phosphate was mined in North Carolina by one company, Tg, a subsidiary of the French conglomerate, Elf Aquitaine. Although the USBM withholds statistics on North Carolina phosphate production to protect proprietary company data, Tg published[6] generalized marketing data on its North Carolina production. In 1992, Tg was the third largest of 17 companies producing phosphate in the United States. Tg employs approximately 1,300 workers in North Carolina, where it manufactures and markets more than $400 million worth of phosphate products each year. Because Tg is the only phosphate producer on the east coast, it enjoys a freight advantage over producers in Florida and the gulf coast. This allows Tg to market phosphate products competitively in the Northeast, Middle Atlantic, and Eastern Cornbelt Regions of the United States.

Tg is the largest domestic marketer of superphosphoric acids, a premium-priced liquid phosphate fertilizer. It sells phosphate fertilizer in 35 States and 10 foreign countries. Total phosphate fertilizer sales are 0.73 million metric tons (0.8 million short tons) of P_2O_5, which is equally divided between domestic and foreign markets. This represents approximately 8% of the total phosphate fertilizer market. Tg also controls approximately 33% of the phosphate feed and 65% of the purified phosphoric acid markets in the United States.

Tg set a production record in March 1992 when the Aurora plant produced 99,800 metric tons (110,000 short tons) of 30% phosphoric acid. A monthly production record was set by Tg's bucket wheel excavators in April when they achieved throughput of 1,504,300 bank cubic yards and mined 27.65 acres. The bucket wheel excavator system consists of two bucket wheel excavators, five mobile transfer conveyors, four overland conveyors, and a spreader. The new record exceeded the old record set in October 1988 by 4%.

Sand and Gravel.—Construction.—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

North Carolina construction sand and gravel statistics are compiled by geographical districts as depicted in the State map. These data are summarized by major use category in table 2 and by district and use in table 3.

Production of construction sand and gravel increased 3.4% to 10.2 million short tons from 9.9 million tons in 1991. Correspondingly, its value increased 22.0% from $35 million 1991 to $42.7 million 1992.

An analysis of increases by district shows a significant contrast between districts. In mountainous district 1, where sand and gravel is relatively scarce and most construction aggregate is derived from crushed stone, the quantity produced decreased by 12.6% and the value by 15.4%. Coastal district 3, where sand and gravel is abundant, showed decreases of 9.4% and 12.6%, respectively. Central district 2, which was intermediate but contained the major

TABLE 3

NORTH CAROLINA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	318	1,316	655	2,406	1,694	4,847
Plaster and gunite sands	—	—	W	W	W	W
Concrete products (blocks, brick, etc.)	—	—	251	461	361	989
Asphaltic concrete aggregates and other bituminous mixtures	420	2,204	156	490	461	1,042
Road base and coverings[1]	499	2,364	78	173	137	359
Fill	W	W	W	W	544	1,244
Snow and ice control	W	W	14	62	W	W
Other miscellaneous uses[2]	64	257	775	5,906	34	113
Unspecified:[3]						
Actual	217	859	1,211	9,076	1,266	5,679
Estimated	83	189	145	424	853	2,256
Total[4]	1,600	7,189	3,283	18,999	5,350	16,529
Total[5 6]	1,451	7,189	2,978	18,999	4,853	16,529

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

urban areas, had a decrease of 17.8% in quantity but an increase of 8.7% in value. The tremendous increase in unit price in district 2 reflects the increasing difficulty in obtaining suitable aggregate in urban areas because of population encroachment, zoning laws, and the "not in my backyard" syndrome. The trend can be expected to continue, leading to higher construction costs for urban roadways and buildings and to increased competition from foreign aggregate sources. All aforementioned comparisons are between 1990 and 1992 because construction sand and gravel production was not canvassed in 1989.

Construction sand and gravel production was reported from 123 pits operated by 94 companies in 53 of North Carolina's 100 counties. The five largest companies, in order of quantity produced, were B. V. Hedrick Gravel & Sand Co. Inc. with operations in Anson, Buncombe, and McDowell Counties; Beazer, USA/Hanson Plc with two operations in Harnett County; W. R. Bonsal Co. with one operation in Anson County; G. S. Materials Co. with one operation in Harnett County; and APAC Carolina Inc. with seven operations in Hertford, Johnston, Lenoir, Montgomery, Moore, and Wayne Counties. The leading counties were Harnett, Anson, Cumberland, New Hanover, and Northhampton.

Construction sand and gravel companies that received permits to open new pits or expand existing pits included Barrus Construction Co. in Johnston County, Hammill Construction Co. in Moore County, Larco Construction Co. in Yadkin County, Mellott Contractors (Bullhead Stone Products) in Alleghany County, and Nello L. Teer Co. in Davidson County.

Industrial.—The value of industrial sand and gravel produced in 1992 was $17.5 million, 12.6% more than that of 1991. The quantity mined increased by a much smaller percentage reflecting a significant average-price increase of 10.3% from $13.26 per ton to $14.62 per ton. Production increased 2.1% from 1.17 million short tons to 1.2 million short tons. North Carolina's national ranking dropped from 6th in 1991 to 8th in quantity and from 7th in 1991 to 10th in value.

Industrial sand and gravel was mined by six companies in 1991 as follows: Becker Sand & Gravel Co., W. R. Bonsal Co., B. V. Hedrick Gravel and Sand Co., KMG Minerals Inc., Southern Production and Silica Co., and Unimin Corp. Becker, Bonsal, and Hedrick produced gravel for ferrosilicon manufacture. Becker's operation is near Lillington, Harnett County; Bonsal and Hedrick have operations near Lilesville in Anson County. KMG produces industrial sand as a coproduct at its mica operation in Kings Mountain. Major applications are in the blasting and glass container industries. Southern Production supplies specialty sand and gravel products for water and chemical filtration applications, sandblasting media, and decorative aggregate from an operation near Hoffman, Richmond County. Unimin produced sand for glass, blasting, roofing

granules, and related applications at its plant near Marston, Richmond County. It also produced an ultrahigh-purity sand for its Quintus and Iota quartz grain and other highly refined quartz products at its feldspar operation in Spruce Pine. The sale is subject to certain closing conditions, including government approval, as specified in the agreement. Unimin's 1991 purchase of Feldspar Corp.'s high-quality silica plant in Spruce Pine was approved by the Justice Department. Included in the sale were certain land, easements, buildings, and equipment, along with trademarks and technology relating to the high-purity sand operation.

The world's largest float glass manufacturing facility is on a 420-acre site at Laurinburg, Scotland County. Libby-Owens-Ford Co. (LOF) produces up to 1,800 metric tons (2,000 short tons) of float glass per day using two 900-metric-ton furnaces. The furnaces are continuously operated ceramic vessels using natural gas or oil for fuel. Raw materials, silica sand, soda ash, and limestone are shipped to the plant by rail. Various other minerals are added to provide other desired characteristics. Silica sand is the basic ingredient that forms glass when it is melted at a temperature of 2,950° F. Soda ash functions as a fluxing agent, and limestone serves as a stabilizer providing durability. Alumina and barite improve chemical durability; color may be imparted by adding chromium, cobalt, iron, or nickel. Feldspathic sands from the beneficiation of lithium, feldspar, or mica ore can be used as a source of silica, alumina, or alkali. Cullet recycled from both the manufacturing process and used glass normally forms 15% to 20% of the material in most glass batches. The name, float glass, is derived from the floating process in which molten tin provides a bed to literally float the glass through the processing. The product is formed into one continuous sheet of glass that goes through the processes of cooling, cleaning, inspection, sizing, and cutting. Any imperfect glass detected in the inspection is computer noted and automatically cut out while on the conveyer. It is then recycled to the furnace as cullet.

There are two float processes in the system. Float No. 1 melts clear, gray, bronze, and blue-green glass, and Float No. 2 melts only clear glass. LOF manufactures clear float glass in thicknesses of 1/8 inch to 1 inch; tinted float glass, 1/8 inch to 3/8 inches thick; and EverGreen High-Performance Tint, 1/8 inch to 1/4 inch thick. The tinted glass is available in shades of blue-green, gray, and bronze. Approximately 1,300 of the 2,000 containers loads that are shipped from the plant annually are exported through the Port of Charleston. The glass is shipped in sheets up to 2.5 centimeters (1 inch) thick with a surface area of approximately 23 meters (90 inches) by 33 meters (130 inches). The sheets are shipped in open-topped containers that weigh from 40,000 to 45,000 pounds. In 1992, much of the glass was shipped to the Far East, where a boom in the construction of high-rise building has created a demand for the glass. Puerto Rico was another important export market.

Stone.—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—Crushed stone once again was the leading mineral commodity produced, accounting for more than 44% of the value of the State's total mineral output. North Carolina's national ranking in the value of crushed stone produced improved from fifth in 1991 to third in 1992. Its ranking in quantity produced failed to improve, remaining in seventh place for both years.

The increase in the estimated value of crushed stone produced accounted for 43.7% of the total increase of the value of nonenergy minerals produced in North Carolina from 1991 to 1992. The increase for all minerals was $42.3 million, while crushed stone alone increased $18.5 million in value. The value of crushed stone produced increased 7.6% from $243.9 million in 1991 to $262.4 million in 1992. Production showed an increase of 4.5% from 46.5 million short tons to 48.6 million tons.

Martin-Marietta Aggregates (MMA) moved its group headquarters from Bethesda, MD, to Raleigh. MMA is an outgrowth of two firms, the former Glenn L. Martin Co., an important military aircraft manufacturer during World War II, and American Marietta, which originally made asphalt-based paint. The company branched out into several fields, one of which was the aggregates group that, according to the USBM, has become the third largest aggregate producer in the country. MMA has 219 operations in 11 States and is the largest aggregate producer in North Carolina with 39 quarries.

MMA's request for a zoning permit to expand its American Stone Co. Quarry in Chapel Hill was pending at yearend. If the request is approved, MMA will donate the property to the Orange Water and Sewer Authority (OWASA) for use as a water supply reservoir when the quarry is depleted in 35 years. By that time, OWASA estimates that Orange County's water usage will increase from 6 million gallons to more than 13 million gallons. The quarry would have a capacity of 5 billion gallons with an availability of 26 million gallons per day.

MMA's request to have the property for a proposed quarry in Maiden, Catawba County, annexed was approved by the town council in November. Annexation was a preliminary step in getting a mining permit for the quarry.

In the September 1992 dismissal of a $5 million suit filed by Nello L. Teer Co. in 1989 against Orange County, a U.S. District Court judge determined that the county's actions did not violate the company's constitutional right because the latter lacked a permit to operate and therefore nothing was taken from it. The judge also ruled Teer's claims exceeded the 9-month statute of limitations for contesting the validity of the zoning ordinance or any amendments to it. Teer had sued the county, maintaining that it was prohibited from operating a quarry on a 146-acre site it owned because of a

series of zoning actions designed expressly to block the quarry.

Nello L. Teer Co. was founded in 1909 by the Teer family of Durham and has grown to be the third largest crushed stone producer in North Carolina with 11 operations and more than 1,000 employees. The firm was sold in 1980 to the Koppers Co. of Pittsburgh, PA, which became the subject of a hostile takeover by Beazer PLC of the United Kingdom in 1988. In late 1991, all of Beazer's holdings were sold to another English company, Hanson PLC. Hanson has continued to use the Teer and Beazer names.

At yearend, Teer had applications pending for permits to expand its Crabtree Quarry in Raleigh and to open new quarries northwest of Bessemer City and in South Lexington.

Vulcan Materials Co. began site preparation for a new quarry at High Shoals. Approximately 25 workers will be employed at the operation if it begins production in mid-1993 as scheduled. Opponents of the quarry filed a lawsuit, which will be heard in January 1993, to overturn Vulcan's zoning permit.

Several other attempts by Vulcan to develop new quarries or expand existing ones were acted on in 1992. In February, the Guilford County Commissioners denied a permit for a quarry in East Guilford. In March, the Charlotte City Council approved the expansion of Vulcan's Pineville Quarry in southwest Charlotte. In December, the Wilkes County Commissioners delayed until February 1993 a decision to grant Vulcan a lease that would allow it to expand its 115 Quarry in Wilkesboro. Earlier requests to lease first a 100-acre tract and later a 50-acre tract were rejected after DEHNR personnel indicated that the proposed expansions could have a detrimental impact on the quality and quantity of water available to the town.

Vulcan Materials Co., North Carolina's second largest crushed stone producer, was formed in 1956 from the merger of Birmingham Slag Co. with Vulcan Detinning Co., a New Jersey metals processor. The Birmingham, AL,-based company ranked as the country's 334th largest corporation in 1992. It was the Nation's largest aggregate producer with 205 active operations, 22 of which are in North Carolina.

Bullhead Rock Products was issued a permit to reopen a granite quarry near the Blue Ridge Parkway in Alleghany County. The quarry was last operated in the mid-1970's by the North Carolina Department of Transportation and two private contractors. Actual reopening of the quarry will be delayed until early 1993 because of harsh winter weather. Bullhead expects to quarry approximately 320,000 metric tons per year for road projects and riprap in the Alleghany County area. Presently, the area is being supplied by a quarry in Elkin, 25 miles to the southeast, and by quarries in Virginia.

Dimension.—Dimension stone production was estimated at 25,369 short tons, 31.6% less than that of 1991, which was revised from 32,489 short tons to 37,056 short tons. The value showed a corresponding decrease of 29.3% from $10.6 million (revised) in 1991 to an estimated $7.5 million in 1992. Nationally, North Carolina ranked 8th in the value of dimension stone quarried and 13th in its attendant value. The unit value of $294.41 per short ton versus a national average of $167.39 attests to the high quality of dimension stone quarried in North Carolina.

Dimension stone was produced by Granite Panelwall Co., Jacobs Creek Stone Co. Inc., North Carolina Granite Corp., White Camelia Granite Co., and O.J. Wilson Stone Co.

North Carolina Granite Corp. operates the State's largest dimension stone quarry east of Mount Airy in Surry County and the smaller Cedar Rose Quarry in Cabarrus County. In addition to dimension stone, the company markets grit, crushed stone, granite chips, paving stones, rubblestone, and flagstone. A new granite curbing plant was opened in 1992. Granite curbing is being used in northern climates to replace concrete curbing that deteriorates because of a combination of freezing weather and salt used to deice roadways. The existing dimension stone finishing plant is being replaced by a new facility that is scheduled to be operational by March 1993. The new facility was expected to increase production by 30% to 35% and to increase revenues by nearly $400,000 per year.

L. S. Starrett also operates two quarries in Rowan County and has a processing plant in Mount Airy. There it manufactures precision granite surface plates, meters, and tools. Granite surface plates are used as the standard of flatness when measuring parts that must have exact dimensions. Parts to be measured are placed on the flat plate and then measured with precision gauges that also rest on the surface plate. The Starrett Surface and Plate Div. was formed in 1970 when Starrett Tool purchased the granite monument operation originally owned by Herman Stone Co. of Dayton, OH, from Donald Porter. Starrett built a new fabricating and finishing plant at Mount Airy in the early 1980's and began a $3 million, 85,000-square-foot addition in August 1992.

Talc and Pyrophyllite.—North Carolina remained the only State in which pyrophyllite is mined. Production data are withheld to protect proprietary company data. Since 1987, North Carolina's pyrophyllite production has decreased an average of 2.5% annually while its attendant value has increased by 5%.

Pyrophyllite is a naturally occurring hydrous aluminum silicate formed during hydrothermal alteration of felsic volcanic rocks. It is often confused with talc because of its appearance and physical properties, such as a creamy white to translucent green color, a pearly luster, and a soapy or waxy feel. It is used in making pesticide diluents and carriers (particles to which pesticide chemicals adhere), rubber foam, paints, wall tiles, and refractories.

Pyrophyllite was mined by two companies, Piedmont Minerals Co., a subsidiary of Resco Inc., and Standard Minerals Co. Inc., a subsidiary of R. T. Vanderbilt Co. Piedmont operated the

Hillsborough Mill in Orange County. Standard Minerals mined pyrophyllite at the Glendon and Robbins pits in Moore County and processed the ore at Robbins Mill.

Titanium.—Although titanium minerals are not mined in North Carolina, there has been a high level of activity related to the exploration and development of potentially world-class heavy-mineral sand deposits discovered in 1988. Unfortunately, a weak worldwide market for titanium minerals brought the activity to a virtual standstill. Developments related to titanium in 1992 are discussed in the Trends and Development and the Exploration Activities sections.

Other Industrial Minerals.—Several industrial minerals mined in other States or countries were marketed or processed into higher value products. Their quantity and value are included in the data for the State or country in which they were mined and are not included in table 1 for North Carolina.

A revival of the cement industry in North Carolina appeared to be on hold after Titan Cement Co. postponed plans to reopen the idle Ideal Cement Co. plant in Castle Hayne, New Hanover County. Titan, based in Greece, purchased the property in May 1991 and had originally scheduled its reopening as the Carolinas Cement Co. for early 1993.

Arsenic trioxide was converted to arsenic acid for use in the production of arsenical wood preservatives by Chemical Specialties Inc. (CSI) in Harrisburg, Cabarrus County. CSI, which also does commercial physical research, is a subsidiary of Mineral Research Ltd., Luton, England. Two boron-rich minerals imported from Turkey, colemanite and ulexite, were used by PPG Industries Inc. in its fiberglass manufacturing facilities at Shelby and Lexington. Other mineral commodities used in PPG's manufacturing process included kaolin from Georgia and South Carolina, boric acid from California, and industrial sand from North Carolina.

Synthetic graphite electrodes, unmachined shapes, and motor brushes are manufactured by Great Lakes Carbon Corp. in Morganton, Burke County. Morganite Inc., headquartered in Dunn, Harnett County, machined purchased graphite into motor and generator brushes.

Cormetech Inc. produced ceramic-based catalysts for control of air pollution from power generation, chemical manufacturing, and other industrial sources at its new manufacturing facility in Durham. The catalysts remove up to 90% of the NO_x compounds in flue gases when fossil fuels such as coal, oil, or gas are burned.

Gypsum, imported from Nova Scotia, was calcined and used to manufacture wallboard by National Gypsum Co., Wilmington. Byproduct gypsum produced during the phosphoric acid manufacturing process was mixed with clay overburden to backfill mined areas before reclamation by Texasgulf Inc.

Crude iodine was imported by Mallinckrodt Inc., Raleigh, to manufacture potassium iodate, calcium iodate, and diatrizoic acid.

Carolina Perlite Co. Inc. expanded perlite for use as horticultural aggregate, cavity-fill insulation, concrete aggregate, oil-water absorbent, filter aid, and fillers at Gold Hill, Rowan County.

Sodium sulfate was recovered as a byproduct during the processing of spodumene ore into lithium carbonate by FMC, Lithium Div., at Bessemer City. Sodium sulfate also was produced during the sodium dichromate manufacturing process by Occidental Chemical Co., Castle Hayne.

Heckett Div. of Harsco Corp. processed steel slag obtained from Florida Steel Co.'s plant in Charlotte for use as aggregate.

Metals

Although there were no metals mined in North Carolina, a variety of foreign and domestic ores, intermediate metal products, and scrap were processed into higher value finished products. Economically, aluminum, steel, and ferroalloys were most valuable, but numerous other metals were processed.

Aluminum.—The only primary aluminum produced in North Carolina was manufactured by Aluminum Co. (Alcoa) of America at Badin, Stanly County. Easco Aluminum produced aluminum billets at its primary aluminum facility in Ahoskie, Hertford County. Alcoa Kobe Steel Tube Specialties Ltd., a joint venture between Alcoa and Kobe Steel Ltd. of Tokyo, Japan, produced aluminum photoreceptor tubes and automotive components at its 40,000-square-foot plant at Charlotte. The tubes are used in facsimile laser printers, copy machines, personal computers, and word processors. Installation of a 2,500-metric-ton press to supply stock for the tube line was expected to be completed in 1993. The extrusion press also would produce automotive heat-exchanger components.

Ferroalloys and Steel.—Numerous facilities manufacturing or processing steel and ferroalloys also were part of the mineral industry in North Carolina. Florida Steel, Charlotte, produced steel using a 70-short-ton electric arc furnace in which scrap is preheated and continuously refined. The system, which was completed in 1990 and became fully operational in 1991, was designed by Intersteel Technology Inc. A similar Intersteel system was formerly used by Nucor Steel Corp., Charlotte, at its minimill in Charleston, SC. Insteel Industries Inc. operates one of the nation's largest wire-products plants in Mount Airy. Insteel produces welded wire reinforcements, high- and low-carbon industrial wire, galvanized fencing products, nails, and specialty wire fabrics. The company originated as Dixie Concrete Co. in Mount Airy in 1958 with the purchase of a ready-mix concrete and concrete block plant. In 1975, the company began manufacturing welded wire reinforcing for precast concrete and subsequently sold its Dixie Concrete and Precast Div. In the early 1980's, the company diversified into high-carbon

wire products by building a new plant in Virginia and into specialty steel products and nails.

Other Metals.—Kennametal Inc. produced tungsten carbide wear parts for cutting tools at its plant in Roanoke Rapids. Occidental Chemical Corp. produced chromium chemicals, sodium bichromate, and chromic acid in Castle Hayne.

Carolmet Inc., a subsidiary of Acer Union Miniere of Belgium, produced extra-fine cobalt powders used as binder material in the production of carbide-tipped cutting tools, drill bits, tools, and other machinery, as well as for wear parts. Glidden Metals Div. of SCM Corp. produced atomized copper powder at its Durham County plant. The copper powder is used to fabricate oil-retaining bearings and parts for the automotive and appliance industries. Halstead Industries Inc. manufactured innergrooved copper tubing, primarily used for air conditioning applications, at Pine Hall, Stokes County.

Lithium metal was manufactured by FMC, Lithium Div., at its Cherryville plant in Cleveland County. Teledyne Allvac supplied titanium billet to the company's fully automated bar and rod mill at Richmond, SC, from its melting and forging facility at Monroe, Union County.

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[1]State Minerals Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 34 years of mineral-related experience in industry and government and has covered the mineral activities in North Carolina since 1989. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

[2]Senior geologist, North Carolina Geological Survey, Raleigh, NC.

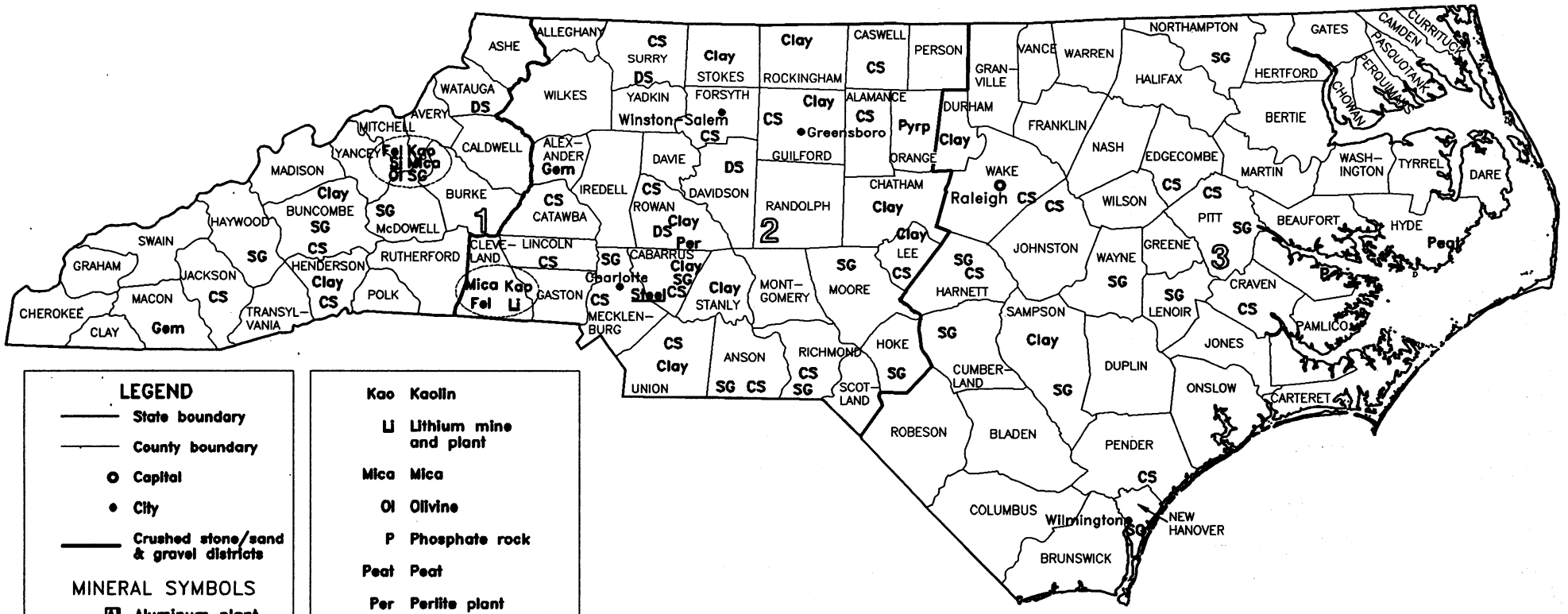
[3]Senior geologist, North Carolina Geological Survey, Asheville, NC.

[4]The total value for 1991 was revised from $552,898,000 to $553,338,000 because of a revision of the value of dimension stone from $10,128,000 to $10,568,000.

[5]U.S. Department of Labor. Mine Injuries and Work Time, Quarterly. Jan.-Dec. 1992, p. 13.

[6]TgTimes (Aurora, NC). Tg Executive Discusses Phosphate Business. Feb. 1992, pp. 4-5.

NORTH CAROLINA



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

- Al — Aluminum plant
- Clay — Clay
- Co — Cobalt plant
- CS — Crushed Stone
- DS — Dimension Stone
- Fel — Feldspar
- Gem — Gemstones
- Kao — Kaolin
- Li — Lithium mine and plant
- Mica — Mica
- Ol — Olivine
- P — Phosphate rock
- Peat — Peat
- Per — Perlite plant
- Pyrp — Pyrophyllite
- SG — Sand and Gravel
- Si — Silica plant
- Steel — Iron and Steel plant
- Concentration of mineral operations

Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Aluminum, smelter:			
Aluminum Co. of America	Box 576 Badin, NC 28009	Plant	Stanly.
Clays:			
Boren Clay Products Co.	Box 368 Sanford, NC 27330	Open pit mines and plant	Chatham, Guilford, Henderson, Sampson.
Carolina Solite Corp.	Box 987 Albemarle, NC 28001	do.	Rockingham and Stanly.
Pine Hall Brick Co. Inc.	Box 836 Madison, NC 27025	do.	Rockingham and Stokes.
Feldspar:			
The Feldspar Corp., subsidiary of Zemex Corp.[1]	Box 99 Spruce Pine, NC 28777	do.	Mitchell.
K-T Feldspar Corp.,[1] Div. of Hecla Mining Co.	Box 309 Spruce Pine, NC 28777	do.	Do.
Unimin Corp.[2 3]	23157 Sanders Rd. Northbrook, IL 60062	do.	Do.
Lithium:			
Cyprus Foote Mineral Co.[4]	Box 689 Kings Mountain, NC 28086	Open pit mine and plant	Cleveland.
FMC Corp., Lithium Div.[1 4]	Box 795 Bessemer City, NC 28016	do.	Gaston.
Mica:			
KMG Minerals Inc.[2 3 4]	Box 729 King Mountain, NC 28086	do.	Cleveland.
Olivine:			
AIMCOR	Route 2, Box 167-C Green Mountain, NC 28740	do.	Avery and Yancey.
Peat:			
American Peat Co. Inc.	RFD #1, Box 79 Pantego, NC 27860	Mine	Hyde.
Perlite (expanded):			
Carolina Perlite Co. Inc.	Box 158 Gold Hill, NC 28071	Plant	Rowan.
Phosphate rock:			
Texasgulf Inc.[5]	Box 48 Aurora, NC 27806	Open pit mine and plant	Beaufort.
Pyrophyllite:			
Piedmont Minerals Co., Div. of Resco Products Inc.[6]	Box 7247 Greensboro, NC 27407	do.	Orange.
Standard Minerals Co. Inc., subsidiary of R. T. Vanderbilt Co.	Box 278 Robbins, NC 27325	do.	Moore.
Sand and gravel:			
Becker Sand & Gravel Co.[3]	Box 698 Lillington, NC 27546	Pits	Anson and Harnett.
W. R. Bonsal Co.[3]	Box 38 Lilesville, NC 28091	do.	Anson.
B. V. Hedrick Gravel and Sand Co.[3]	Box 8 Lilesville, NC 28091	do.	Anson, Buncombe, McDowell.
Steel:			
Florida Steel Corp.	2126 Garner Road Raleigh, NC 27611	Plant	Meclenburg.

See footnotes at end of table.

TABLE 4—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone:			
Crushed:			
Martin Marietta Corp.	Box 30013 Raleigh, NC 27622	Quarries and plants	Various.
Nello L. Teer Co., subsidiary of Hanson, PLC	Box 1131 Durham, NC 27702	do.	Do.
Vulcan Materials Co., Mideast Div.	Box 7497 Winston-Salem, NC 27109	do.	Do.
Dimension:			
Granite Panelwall Co.	Box 898 Overton, GA 30635	do.	Rowan.
Jacob's Creek Stone Co. Inc.	Box 608 Denton, NC 27339	do.	Davidson, Montgomery, Stokes.
North Carolina Granite Corp.	Box 988 Mt. Airy, NC 27030	do.	Cabarrus and Surry.

[1]Also mica.
[2]Also clay.
[3]Also industrial sand.
[4]Also feldspar.
[5]Also byproduct gypsum.
[6]Also sericite.

THE MINERAL INDUSTRY OF NORTH DAKOTA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the North Dakota Geological Survey for collecting information on all nonfuel minerals.

By Robert H. Wood II[1] and Robert F. Biek[2]

North Dakota's nonfuel mineral production was valued at almost $26 million in 1992, an increase of about 48% from the value established in 1991. North Dakota ranked 48th nationally in nonfuel mineral production, accounting for less than 1% of the Nation's total nonfuel mineral value for the year.

The increase in value from that reported in 1991 was due to substantial increases in reported production of clay and sand and gravel, the principal construction minerals produced in the State. Construction sand and gravel contributed the greatest amount to the State's nonfuel mineral value, accounting for more than 80% of the total. Other nonfuel mineral commodities produced included clay, gemstones, industrial sand and gravel, lime, peat, and crushed stone. Elemental sulfur, not included in U.S. Bureau of Mines (USBM) estimates, was recovered from natural gas processing. Krypton, xenon, anhydrous ammonia, liquid nitrogen, and cresylic acids, recovered during natural gas processing and coal gasification, also were not included in USBM statistics.

TRENDS AND DEVELOPMENTS

Most of North Dakota's nonfuel mineral production was used in construction. According to the U.S. Department of Commerce, 2,570 permits for residential units were issued in 1992, an increase of 464 (22%) over the number issued in 1991. The value of nonresidential construction awards (offices, motels, stores, industrial plants, etc.) was $60 million, a decrease of about $68 million compared with that of 1991.

The North Dakota State Soil Conservation Committee reported that, of the 26 mining operations reporting in 1992, there were 92 noncoal pits affecting 189 hectares (467 acres) in the State. The pits ranged in size from 0.1 hectare to 12 hectares (one-fourth of an acre to 30 acres). Minerals mined included 4.0 million cubic meters (4.4 million cubic yards) of sand and gravel, scoria, clays, and stone. Production increased about 57% from the 1991 figure of 2.1 million cubic meters (2.8 million cubic yards).[3]

Potential uses of selected clays that occur in North Dakota and Minnesota have been the subject of the research conducted at the Natural Resources Research Institute, University of Minnesota-Duluth. Testing revealed that Glacial Lake Agassiz clays, which are widespread in the central and northern Red River Valley of North Dakota and Minnesota, exhibit a characteristic spherical bloating habit when fired to 2,050° F. Some Lake Agassiz clays expanded up to 300% when fired. In their expanded state, the clays are ideal for use in lightweight aggregate suitable for structural concrete and landscaping materials. Further processing produces a uniform spheroidal aggregate, potentially useful in adding insulating properties to concrete, as a filler, and as a substitute for perlite in potting soil mixes. The bloating clays are widespread, flat-lying,

TABLE 1
NONFUEL MINERAL PRODUCTION IN NORTH DAKOTA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	50,485	W	27,825	W	W	W
Gemstones		NA	$10	NA	$6	NA	$643
Lime	thousand short tons	82	4,623	98	5,360	111	4,288
Sand and gravel (construction)	do.	r7,046	r16,111	e5,000	e12,000	8,740	20,609
Stone (crushed)	short tons	e1,000	e4,600	11	W	11	W
Combined value of other industrial minerals and values indicated by symbol W		XX	116	XX	(2)	XX	210
Total		XX	r25,460	XX	3,17,366	XX	25,750

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Value excluded to avoid disclosing company proprietary data.
[3]Partial total, excludes values that must be concealed to avoid disclosing company proprietary data.

and occur within 9 meters (30 feet) of the surface. Missouri and Tennessee have supplied most of the lightweight aggregate used in the northern plains States. Development of North Dakota's bloating clays could bring jobs to the State and reduce the State's import dependence.[4]

EMPLOYMENT

According to the North Dakota Job Service, mining was the only major industry to show a drop in employment in 1992. Services continued to be the State's fastest growing industry, accounting for 43 % of the total growth. Health services recorded the largest increase, adding 900 new jobs.

Employment in the State's mining industry, including fuel and nonfuel extractive industries, averaged 3,902 workers during the year, a decrease of 347 workers compared with data released in 1991. The average number of workers employed in nonfuel mining was 472, an increase of 94 workers over 1991 figures, which was probably a reflection of the increases in production of sand and gravel and clays. Coal mining employment remained nearly steady at 1,034 workers. Employment in the oil and gas industry averaged 2,396 workers, down 427 compared with 1991 figures. The decline in the State's oil and gas employment is related to high costs associated with oil production and lower profits involved in extracting North Dakota crude.[5]

Employees in North Dakota's mining industry are among the highest paid workers in the State. The average annual wage in 1991 for nonfuel mining employees was $28,884, up more than 10% from that of 1991. Coal mining wages averaged $49,423, up more than 7% from those of 1991.[6]

The U.S. Department of Labor reported that during the 2 million employee-hours worked in 1992 at surface mining operations in North Dakota, there were no fatalities, 14 injuries resulting in lost workdays, and 24 injuries resulting in no workdays lost. At mills and preparation plants associated with mining operations, where an average of 21 workers were employed, 1 additional injury resulted with no lost workdays. A total of 35,883 employee-hours was worked at mills and plants during the year.[7]

ENVIRONMENTAL ISSUES

The North Dakota Public Service Commission requested bids for reclamation of three abandoned mine sites in the State. The mine sites included a strip mine near Elgin (Grant County), underground mines near Beulah (Mercer County), and mines near Wilton (Burleigh County).

In June, the Bureau of Land Management (BLM) signed an assistance agreement with the North Dakota Geological Survey (NDGS). The agreement awards NDGS $250,000 to study oil and gas drilling mud, reclamation of drilling sites, and the old Rugby landfill. BLM was concerned with an interpretation made by Congress in the late 1970's that oil and gas drilling mud was not to be considered a potential hazardous waste. Because the results of this study could reopen that controversial issue, the BLM terminated the contract with NDGS in August.[8]

LEGISLATION AND GOVERNMENT PROGRAMS

The NDGS participated in a regional industrial minerals workshop sponsored by the U.S. Geological Survey (USGS), USBM, and Minnesota Geological Survey in cooperation with the Geological Surveys of Illinois, Indiana, Michigan, Ohio, South Dakota, and Wisconsin. Mineral resource demands and availability, land use conflicts, and research needs in the region were major topics evaluated at the September meeting in Minneapolis. The "Program with Abstracts" from that meeting (USGS Open File Report 92-514) provides information about the regulation of industrial minerals in North Dakota and other upper Midwest and Great Lakes States, a list of State and Federal agencies involved with these resources, and abstracts of presentations. The report also included a section on State regulations affecting mining of industrial minerals.

The North Dakota Supreme Court ruled in favor of the city of Sherwood (Renville County) for airport land mineral rights. The State claimed that in 1945 the city only acquired a surface easement.

FUELS

Lignite

North Dakota ranked 10th in the Nation in total coal-lignite production during the year. The State contributed about 3.2% of the total U.S. coal-lignite produced in 1992.[9] The North Dakota Lignite Council estimated 1992 lignite production in the State to be a record of 29 million metric tons (32 million short tons), topping the 26.8 million metric tons (29.6 million short tons) set in 1988. Valuable commercial byproducts produced from converting lignite into synthetic natural gas at the Great Plains Synfuels Plant in Beulah, Mercer County, include phenol, cresylic acid, naphtha, liquid nitrogen, anhydrous ammonia, sulfur, krypton, and xenon.

After operating for 75 years, the Indian Head Mine closed in April. North American Coal Corp. owns the open pit mine 97 kilometers (60 miles) northwest of Bismarck. Reclamation work is expected to be completed by the end of next year. The mine supplied lignite to a United Power Association's electricity generating plant near Stanton. That plant will obtain lignite from the nearby Freedom Mine. Lignite reserves were reportedly exhausted, and the contract with United Power expired. Thirty-nine workers were affected by the mine closure.

Minnesota Power Co. proposed to build a 160-megawatt powerplant near Center, in Oliver County. The new $330 million plant would be designed to convert lignite coal to gas. The new plant would be the first "commercial" plant of that type to operate in the Nation. Mine production would be

increased by 900,000 metric tons (1 million short tons) annually at the company's 3.6-million-metric-ton-per-year (4-million-short-ton-per-year) lignite mine near Center. The company hopes for U.S. Department of Energy (DOE) approval by May 1993.[10] North Dakota lignite has a high moisture content (40%) and low heat value, making it more profitable to use locally. North Dakota is a major exporter of electrical power to nearby States. Successful conversion of lignite to gas would provide the State with another exportable commodity.

Petroleum and Natural Gas

North Dakota ranked 9th in total crude oil production[11] and 15th in natural gas production[12] in the United States. The North Dakota Petroleum Council reported that crude oil production declined to 32.9 million barrels, down 8% from that of 1991. DOE reported 1.3 billion cubic meters (47.4 billion cubic feet) of natural gas was produced in North Dakota during 1992, down 11% from that of 1991. About 66% of North Dakota's crude oil is refined within the State's borders. One crude oil refinery and 10 natural gas processing plants operated in North Dakota during the year.[13]

Only 166 wells were completed during 1992, 41 fewer than the previous year. There were 42 wildcats wells and 124 development and extension wells. Of the wildcats, 11 produced oil for a 26% success rate; 83 of the development or extension wells produced oil for a success rate of 67%. Seven new fields or pools were discovered by wildcat drilling.[14]

The NDGS initiated a new publication series that will provide useful models for exploration and further development work in the State's oilfields and gasfields.[15] Field Study 1, expected to be published in 1993, will discuss carbonate shoreline traps in the Wabek and Plaza Fields. Other projects in progress include the Rocky Ridge, Lucky Mound, Landa, and South Antler Creek Fields.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Clays.—Hebron Brick Co. continued mining clay from three pits in Morton County for processing into brick and tile. D. H. Blanter & Sons mined clay from a pit in McLean County. Both output and value showed substantial increases from 1991 figures. According to State figures, 422,403 cubic meters (505,190 cubic yards) of clay was produced in 1992 compared with 145,471 cubic meters (173,567 cubic yards) in 1991.[16]

Lime.—Lime was produced by American Crystal Sugar Co. at plants in Pembina and Traill Counties and by Minn-Dak Farmers Coop. at a plant in Richland County. Only quicklime was produced, and it was all used in sugar beet refining. Reported output increased moderately as value decreased moderately from 1991 figures. Lime was produced from limestone mined outside the State. Lime for other commercial uses also was imported.

Peat.—After a 1-year absence from USBM reports, Peat Products Co. resumed reporting peat production during 1992. Peat Products was the only company that reported peat production in North Dakota during the year. Production was a reed-sedge peat from a bog in Bottineau County in the northern part of the State. Peat produced in the State was used as an ingredient in potting soil and on golf courses.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

North Dakota's production of construction sand and gravel increased substantially (more than 70% in quantity and value) over 1991 estimates. Moderate increases also were realized over figures reported in 1990. Reported production of construction sand and gravel was about 7.9 million metric tons (8.7 million short tons) valued at more than $20.6 million.

Statistics collected by the North Dakota Soil Conservation Committee also show a substantial increase from 1991[17] to 1992[18] in construction sand and gravel production (41%), from 2.0 million cubic meters (2.6 cubic yards) in 1991 to 2.8 cubic meters (3.6 cubic yards) in 1992.

Stone (Crushed).—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991. Only cinker (scoria in North Dakota Soil Conservation Committee reports) production was reported to the USBM. Cinker, which is a baked shale, has been produced at two operations in McKenzie County and at four operations in Mercer County.[19]

Although USBM estimates show no increase over company data surveyed in 1991, the North Dakota Soil Conservation Committee reports indicate that the 1992[20] State's combined "scoria" and "rock" production increased significantly (425%) over its 1991 data.[21] All of the increases reported by the State were in scoria production, from 9,450 cubic meters (12,360 cubic yards) in 1991 to 188,646 cubic meters (246,739 cubic yards) in 1992. Rock production decreased from 27,233 cubic meters (35,620 cubic yards) in 1991 to 3,976 cubic meters (5,200 cubic yards) in 1992.

Sulfur (Recovered).—Although not included in USBM statistics, recovered elemental sulfur was the third most important mineral produced in North Dakota, in terms of value. Four natural gas processing plants in western North Dakota (Billings, McKenzie, and Williams Counties) and one oil refinery (Morton County) reported elemental sulfur recovery during the year. Sulfur recovered amounted to 82,200 metric tons

TABLE 2

NORTH DAKOTA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	228	$1,802	$7.90
Asphaltic concrete aggregates and other bituminous mixtures	456	1,308	2.87
Road base and coverings	1,910	3,624	1.90
Fill	229	267	1.17
Snow and ice control	W	W	3.49
Railroad ballast	W	W	9.99
Other miscellaneous uses[1]	4	16	4.00
Unspecified:[2]			
Actual	760	1,358	1.79
Estimated	5,154	12,234	2.37
Total	[3]8,740	20,609	2.36
Total[4 5]	7,929	20,609	2.60

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes filtration.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data do not add to total shown because of independent rounding.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

valued at $1.7 million; both output and value decreased from those reported in 1991.

Other Industrial Minerals.—Volcanic ash has been sporadically produced in small quantities by VolAsh of North Dakota Inc. near Linton, in Emmons County. Small quantities of the ash were shipped to 3M Co. for use in a ceramic material used to contain burning oil spills. The ash was chosen for its buoyancy and fire-resistant quality. The company has been working on identifying markets for the ash.

Abrasives Inc. reported production of a small quantity of industrial sand near Elgin, Grant County. The sand was used for sandblasting.

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[1]State Mineral Officer, U.S. Bureau of Mines, Denver, CO. He has 16 years of mineral-related work with the Government.

[2]Geologist, North Dakota Geological Survey, Bismarck, ND.

[3]North Dakota State Soil Conservation Committee. Surface Mining Report 1992, 10 pp.

[4]NDGS Newsletter, v. 19, No. 2, Winter, 1992, 33 pp.

[5]Job Service North Dakota. North Dakota Employment and Wages, 1992.

[6]Work cited in footnote 5.

[7]U.S. Department of Labor. Mine Injuries and Worktime, Quarterly. Jan.-Dec. 1992.

[8]Work cited in footnote 4.

[9]Weekly Coal Production. Energy Information Administration, May 1993.

[10]Coal. Minnesota Power Proposes New 160-MW Plant in North Dakota. Oct. 1992.

[11]Energy Information Administration. Petroleum Supply Monthly. Apr. 1993.

[12]———. Natural Gas Monthly. Mar. 1993.

[13]North Dakota Petroleum Council. North Dakota Oil and Gas Industry, Facts & Figures, 1993 Edition.

[14]Heck, T. J. Oil and Gas Exploration and Development Activity in 1992. NDGS Newsletter, v. 20, No. 3, 1993, 18 pp.

[15]McClellan, W. A. New Publican Series Coming Soon. NDGS Newsletter, v. 20, No. 3, 1993, 18 pp.

[16]Work cited in footnote 3.

[17]North Dakota State Soil Conservation Committee. Surface Mining Report 1991, 9 pp.

[18]Work cited in footnote 3.

[19]Work cited in footnote 3.

[20]Work cited in footnote 3.

[21]Work cited in footnote 14.

NORTH DAKOTA

LEGEND

- State boundary
- County boundary
- Capital
- City

MINERAL SYMBOLS

Clay	Clay
CS	Crushed Stone
Lime	Lime plant
Peat	Peat
S	Sulfur
SG	Sand and Gravel
VA	Volcanic Ash

Principal Mineral–Producing Localities

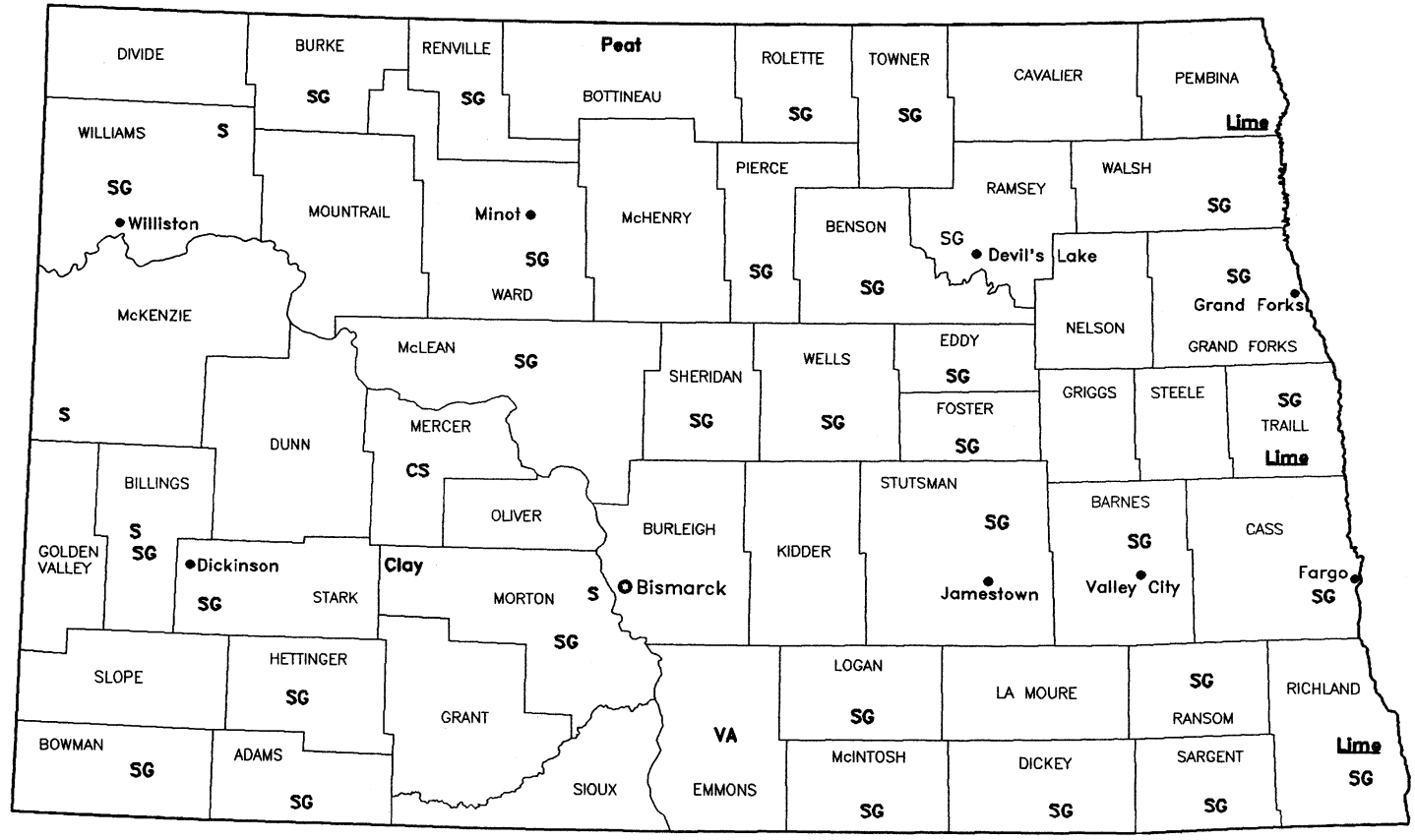

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Clays:			
Hebron Brick Co.	Box 5 Hebron, ND 58638	Pit and plant	Morton.
Lime:			
American Crystal Sugar Co.	Box 190 Drayton, ND 58225	Shaft kilns at beet sugar refineries	Pembina and Traill.
Minn-Dak Farmers Coop.	Wahpeton, ND 58075	do.	Richland.
Peat:			
Peat Products Co.	821 4th St. Bismarck, ND 58501	Bog	Bottineau.
Sand and gravel (construction, 1990):			
Aggregate Construction Inc.	Box 1034 Minot, ND 58206	Pit	Ward.
Des Lacs Sand & Gravel Inc.	Box 1254 Des Lacs, ND 58733	Pits	McIntosh and McKenzie.
Fisher Sand & Gravel Co.	Box 1034 Dickinson, ND 58602	Pits and plants	Various.
Gravel Products Inc.	Route 1, Box 5 Minot, ND 58701	Pits	Eddy and Ward.
Schriock Construction Inc.	3009 South Broadway Minot, ND 58701	Pit and plant	Various.
Sulfur (recovered):			
Amerada Hess Corp.	1185 Avenue of the Americas New York, NY 10036	Plant	Williams.
Chevron USA Inc.	Box 1589 Tulsa, OK 74101	do.	Billings.
Koch Hydrocarbon Co.	Box 2256 Wichita, KS 67201	Plants	McKenzie and Williams.
Western Gas Processors Ltd.	10701 Melody Dr. Northglenn, CO 80234	Plant	Billings.

THE MINERAL INDUSTRY OF OHIO

By L. J. Prosser, Jr.[1]

The value of nonfuel mineral production in Ohio in 1992 was about $742 million. Improved demand for minerals used in construction resulted in a $58 million increase in value over that of 1991. The combined output of construction sand and gravel and crushed stone was the highest recorded in State history. Higher production was reported for all major nonfuel minerals produced in the State. Nationally, Ohio ranked 15th in value of nonfuel mineral production in 1992.

TRENDS AND DEVELOPMENTS

Since 1987, Ohio's mineral industry has produced $4.4 billion in nonfuel minerals, an average of about $727 million per year. About one-half or $2.3 billion of that total was attributed to the production of sand and gravel and crushed stone. During the 1987-92 period, the State produced an average of about 92 million short tons of sand and gravel and crushed stone. For the 1981-86 period, Ohio produced an average of about 67 million tons of these two commodities. A comparison of these two periods shows a 37% increase in production of these commodities.

In contrast, Ohio's coal industry has reported a 12% decline in production from an average of 36.1 million tons from 1981-86 to 31.8 million tons from 1987-92. That trend was expected to continue because of the high-sulfur content of Ohio's coalbeds. The average sulfur content in Ohio coal is about 3.5%. The burning of coal releases airborne compounds, including sulfur dioxide, nitrogen oxides, carbon monoxide, and volatile organic compounds, whose emissions are limited and regulated under the Clean Air Act (CAA). In 1990, amendments to CAA mandated further reduction of these limits by 1995 because of health and environmental concerns. These limitations were expected to further reduce the market for Ohio coal.

EMPLOYMENT

Mining employment declined to about 14,000 in 1992 according to the Ohio

TABLE 1
NONFUEL MINERAL PRODUCTION IN OHIO[1]

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
Cement:							
Masonry	thousand short tons	124	$10,880	e109	e$9,591	113	$10,260
Portland	do.	1,426	72,883	e1,356	e69,156	1,455	77,053
Clays	metric tons	2,546,151	13,334	2,204,635	11,015	2,288,245	12,062
Gemstones		NA	W	NA	57	NA	5
Lime	thousand short tons	1,884	92,817	1,783	85,976	1,841	96,739
Peat	do.	12	182	9	222	W	W
Sand and gravel:							
Construction	do.	r45,717	r170,319	e42,300	e160,100	47,260	177,508
Industrial	do.	1,349	24,205	1,294	23,462	1,406	26,445
Stone:							
Crushed	do.	e48,400	e190,900	2 47,310	2 184,177	2 e48,500	2 e194,500
Dimension	short tons	2 r e33,976	2 r e2,202	r 2 47,031	r 2 2,443	e35,059	e2,244
Combined value of abrasives, gypsum (crude), salt, stone [crushed limestone and dolomite (1991-92), dimension limestone (1990-91)], and values indicated by symbol W		XX	r154,938	XX	137,550	XX	145,087
Total		XX	r732,660	XX	r683,749	XX	741,903

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain stones; kind and value included with "Combined value" data.

TABLE 2
OHIO: LIME SOLD OR USED BY PRODUCERS, BY USE

Use	1991		1992	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Steel, basic oxygen	923,449	$44,678	959,739	$49,065
Steel, electric	W	W	89,740	455
Other[1]	859,850	41,298	791,541	47,219
Total	1,783,299	85,976	1,841,020	96,739

W Withheld to avoid disclosing company confidential data; included with "Other."
[1]Includes acid water neutralization, agriculture, alkalies, calcium carbide and cyanamide, finishing lime, glass, ladle desulfurization, magnesia from seawater or brine, mason's lime, metallurgy, other chemical and industrial, other environmental, refractory, sewage treatment, soil stabilization, sugar refining, sulfur removal, water purification, and uses indicated by symbol W.

Bureau of Employment Services (OBES). About 70% of the employment was in the fuels sector. In construction, employment increased by about 20% to 187,000 workers. That gain reflected the State's increased production of aggregates used in construction.

LEGISLATION AND GOVERNMENT PROGRAMS

In November, Ohio voters, by about a 4-to-1 margin, defeated the Toxic Labeling and Notification Issue (Issue-5). If enacted, the State's mineral aggregate producers would have been required to label materials such as crystalline silica, radon, lead, cadmium, diesel exhaust, gasoline, and solvents. In addition, businesses would have been required to notify residents within a 2-mile radius of use of these items every 6 months. According to the Ohio Aggregates Association, labor, management, and farm groups spent well over $5 million to inform voters of the consequences of this referendum issue.

The Ohio Division of Geological Survey (DGS), Department of Natural Resources, was the primary State agency involved in mineral resource and research investigations. In 1992, the DGS reported 533 active industrial mineral operations, an increase of 19 from the 1991 total. The number of active coal mines declined again, dropping from 199 in 1991 to 191 in 1992.[2] The Ohio Division of Oil and Gas reported a decline in oil and gas well permitting and drilling in 1992. For the year, about 9 million barrels of oil and 145 million cubic feet of natural gas were produced with a market value of about $511 million.[3]

As part of a continuing effort to map the geology of Ohio, the DGS drilled core holds in Champaign and Shelby Counties. Open file core descriptions for these holes and holes drilled by the U.S. Army Corps of Engineers in Highland County are available at DGS offices in Columbus.

Clean coal technology research and development remained an ongoing effort in the State. Ohio's Coal Development Office (OCDO), Department of Development, was created in 1985 to develop and commercialize technologies that can use the State's high-sulfur coal. One ongoing OCDO project, sponsored by Dravo Lime Co., was examining land application uses for byproducts of dry flue gas desulfurization (FGD) technology. During the year, test sites were selected for demonstrating field applications for reclamation of abandoned mine lands, active surface coal mines, and agronomic liming plots in different soils. In addition to OCDO and Dravo Lime, the U.S. Department of Energy, the Electric Power Research Institute, Ohio Edison Co., American Electric Power Co., and Ohio State University were participating in the project.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Industrial minerals were produced in Ohio at about 443 operations according to data reported to the U.S. Bureau of Mines and listed in table 1. Construction sand and gravel was produced at 242 pits, crushed stone at 110 quarries, clays and shale at 40 pits, dimension stone at 15 quarries, industrial sand at 9 pits, lime at 9 plants, fire clay at 4 pits, cement at 4 plants, salt at 4 operations, peat at 3 bogs, and gypsum at 1 mine. Output from these operations accounted for the State's value of nonfuel mineral production of $742 million in 1992. The number of operations increased by 34 from that in 1991, most of which were sand and gravel pits.

In addition, the following mineral commodities were processed in Ohio: calcined gypsum, iron and steel slag, expanded perlite, sulfur (recovered), and exfoliated vermiculite. The combined value of these commodities as reported to the U.S. Bureau of Mines was about $45 million.

Cement.—Output of portland and masonry cement increased in 1992, reflecting general improvement in demand from the construction industry. Nationally, Ohio ranked 8th of 36 States producing masonry cement and 16th of 37 States in portland cement.

The burning of hazardous waste in cement kilns remained an issue at Southwestern Portland Cement Co.'s plant in Fairborn, Greene County. In February, the Ohio Environmental Protection Agency (OEPA) ordered a halt to the burning of hazardous waste at the plant because stack tests showed excess emissions. OEPA removed the halt order in September when new testing showed emissions were in compliance with regulations. However, a citizens coalition filed a lawsuit and, subsequently, an appeal to OEPA to prohibit burning of hazardous waste. Southwestern Portland agreed to

TABLE 3

OHIO: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	10,656	$39,128	$3.67
Plaster and gunite sands	93	430	4.62
Concrete products (blocks, brick, pipe, decorative, etc.)	918	3,355	3.65
Asphaltic concrete aggregates and other bituminous mixtures	7,869	31,370	3.99
Road base and coverings[1]	13,321	50,916	3.82
Fill	5,449	15,761	2.89
Snow and ice control	196	574	2.93
Other miscellaneous uses[2]	630	2,663	4.23
Unspecified:[3]			
Actual	6,439	26,613	4.13
Total[4]	47,260	177,508	3.76
Total[5 6]	42,874	177,508	4.14

[1]Includes road and other stabilization (cement).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

additional testing and the OEPA review before resuming burning of waste. Testing and review procedures continued through yearend. (On November 4, 1993, OEPA approved permits to resume burning of liquid hazardous waste at the cement plant.)

Lafarge Corp. in Paulding was the only other cement company burning hazardous waste in Ohio.

Lime.—Ohio remained the Nation's second leading producer of lime. Output of about 1.8 million short tons of lime was slightly higher than that of 1991 and represented about 10% of the U.S. total.

Most of Ohio's production was concentrated in the north-central part of the State in proximity to the State's major steel-producing areas. About 50% of Ohio's lime was used in steel manufacturing.

In April, Ohio Lime Co. received permission from the OEPA to test burn waste oil at its lime kilns in Millersville and Woodville. However, by yearend the company had not conducted the test. Apparently other types of fuels were available at lower costs in that area.

Salt.—Ohio salt production increased by about 8% in 1992. Nationally, Ohio ranked fourth in output with two companies producing salt at four operations. Most of the salt produced in Ohio was mined underground in Cuyahoga and Lake Counties. Salt from these mines was used primarily for highway deicing.

The U.S. Bureau of Mines published a report titled, "The Material Flow of Salt."[4] The report included historical data on domestic production, trade, and consumption illustrating the long-term trends in the U.S. salt industry. The impact that highway deicing salt has had on the environment and the ecosystem also was discussed.

Brine salt was produced from wells in Summit and Wayne Counties. Salt from these operations was used primarily in food-related applications. During the year, speculation and interest continued on the potential startup of a salt operation in Mahoning County. Akzo Salt Inc. was investigating a site in Jackson Township for brine extraction wells and a salt processing plant. It was expected that some of the firm's operations in Akron would be replaced by the new operation. Salt production would begin in mid-1996 if the operation is approved, according to the company.

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Ohio sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 4 presents end-use statistics for Ohio's six districts.

Output of 47.3 million short tons of sand and gravel was the highest since 1973 when 48.2 million tons was produced. Nationally, Ohio ranked third in output, accounting for about 5% of U.S. production.

Of the State's 88 counties, 13 produced more than 1 million tons and 62 reported production. The top five counties in output were Hamilton, Franklin, Portage, Butler, and Greene. The average price per ton statewide was $3.76, up only slightly from the 1990 price of $3.71.

TABLE 4

OHIO: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	1,000	4,130	3,342	13,019	2,895	10,248
Plaster and gunite sands	W	W	32	170	—	—
Concrete products (blocks, brick, etc.)	W	W	333	1,194	235	1,023
Asphaltic concrete aggregates and other bituminous mixtures	788	W	2,364	9,399	1,192	4,461
Road base and coverings[1]	1,140	4,520	1,073	4,879	8,072	28,979
Fill	107	368	1,078	3,887	2,642	5,432
Snow and ice control	—	—	57	242	19	74
Other miscellaneous uses[2]	158	3,772	198	1,085	238	899
Unspecified:[3]						
Actual	—	—	1,821	7,287	3,329	14,413
Estimated	204	429	525	2,912	728	2,463
Total[4]	3,399	13,220	10,822	44,075	19,350	67,992
Total[5 6]	3,084	13,220	9,818	44,075	17,554	67,992

	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	953	3,351	1,290	3,923	1,176	4,457
Plaster and gunite sands	W	W	—	—	—	—
Concrete products (blocks, brick, etc.)	115	465	194	535	35	111
Asphaltic concrete aggregates and other bituminous mixtures	701	W	1,349	6,313	1,476	5,613
Road base and coverings[1]	1,489	6,427	1,158	4,657	388	1,453
Fill	1,204	4,958	348	916	68	200
Snow and ice control	W	17	109	219	W	22
Other miscellaneous uses[2]	63	2,613	32	117	18	49
Unspecified:[3]						
Actual	12	47	888	3,514	390	1,351
Estimated	—	—	160	612	72	281
Total[4]	4,537	17,878	5,528	20,807	3,624	13,536
Total[5 6]	4,116	17,878	5,015	20,807	3,288	13,536

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

Stone (Crushed).—Crushed stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed stone production in Ohio of about 48.5 million short tons was the highest reported since 1987. Demand for crushed stone has remained steady in Ohio for the past 5 years. The high mark in production during that period was 1992 and the low was 46.4 million tons in 1989. Nationally, the State ranked eighth in output.

During the year, two of the State's major producers completed renovation projects. Both projects were designed to lower costs while increasing capacity. As with much of the mining industry, increased competition has necessitated use of state-of-the-art technology to improve productivity. Oftentimes these renovation projects result in a reduction of the work force.

At American Aggregates Corp.'s quarries in Hillard, a $4 million plant upgrade doubled capacity to nearly 2 million tons per year, while cutting the

labor force from 49 to 24.[5] The plant was equipped with computer-aided monitoring and control equipment and an automated, programmable logic controller.

Lafarge Corp., at its Marblehead Quarry in Ottawa County, completed a 2-year, $10 million operations improvement program. Plant capacity was doubled to approximately 2 million tons per year and the work force reduced from 90 to 30 workers.[6] Equipment upgrades were made at the plant and quarry, including programmable logic controllers.

Other Industrial Minerals.—In addition to the mineral commodities previously discussed, Ohio also produced abrasives, common and fire clays, gypsum, peat, industrial sand, and dimension stone.

In 1992, Ohio produced about 2.2 million metric tons of common clay valued at $8.8 million. Nationally, the State ranked second in U.S. production of common clay, following Texas. Fire clay output of about 108,000 metric tons was valued at $3.3 million with the State ranking fourth in production in the United States for this commodity.

Ohio was also among the top States in output of industrial sand, ranking sixth. Most of the sand was mined in Geauga, Knox, Perry, and Ross Counties. Major end uses included molding and core, flat and specialty glass, and golf courses.

Dimension stone was produced in moderate quantities in Ohio, which ranked the State 11th. Most of the stone was sandstone sold as rough blocks. Crude gypsum was mined in Ottawa County, and abrasives were produced at a sandstone quarry in Lorain County again in 1992.

Metals

No metals were mined in Ohio in 1991. Information on processed and manufactured metals is presented in this section.

Aluminum.—Ohio ranked fifth nationally in primary aluminum production. One smelter at Hannibal accounted for all the production. Nationally, aluminum was produced in 14 States and U.S. output for 1992 was about 4 million metric tons.

Beryllium.—Brush Wellman Inc. in October received a contract extension from the Defense Logistics Agency for 26,000 pounds of beryllium billets to be processed at the firm's Elmore facility. The contract had a value of $7 million with completion scheduled for June of 1994. Since 1990, Brush Wellman has processed 134,000 pounds of billets delivered to the Strategic Materials Stockpile. Brush Wellman was one of two companies in the United States that produced beryllium alloys.

Iron and Steel.—Ohio ranked second nationally to Indiana in steel production in 1992. Combined output of these two States of nearly 36 million tons accounted for about 39% of the Nation's total. In 1992, Ohio's production increased by about 9% to 15.5 million tons. Nationally, steel production increased by about 6% to about 93 million tons. Although demand for steel nationally and in Ohio improved in 1992, it remained below the levels produced from 1988-90. During that period, U.S. production averaged about 99 million tons per year and in Ohio, about 17 million tons per year.

Titanium.—RMI Titanium Co. closed its facilities in Ashtabula as announced in late 1991. The shutdown included operations with capacity to produce 10,900 short tons of titanium sponge, 140,000 tons of sodium chloride, and 22,700 tons of sodium and sodium hypochlorite. The plant began operation in 1957 and had a labor force of about 300 workers when it closed.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related and government experience and has covered the mineral activities in Ohio for 7 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Weisgarber, S. L. 1992 Report on Ohio Mineral Industries. Dep. Nat. Resour., Div. Geol. Surv., 138 pp.

[3]McCormac, M. P. 1992 Ohio Oil and Gas Developments. Dep. Nat. Resour., Div. of Oil and Gas, 43 pp.

[4]Kostic, D. S. The Material Flow of Salt. USBM IC 9343, 1993, 32 pp. Details on purchasing this report from GPO are available by calling (202) 501-9410.

[5]Turley, W. Out With Old, In With New. Rock Products, v. 95, No. 11, Nov. 1992, pp. 50-51.

[6]———. Keeping It Simple. Rock Products, v. 95, No. 9, Sept. 1992, pp. 38-44.

OHIO

Principal Mineral-Producing Localities

LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Al	Aluminum plant	D-S	Dimension Sandstone	Lime	Lime plant
CC-Sh	Common Clay & Shale	FC	Fire Clay	Peat	Peat
Cem	Cement plant	Gyp	Gypsum	Salt	Salt
CS	Crushed Stone	Gyp	Gypsum plant	SG	Sand and Gravel
D-L	Dimension Limestone	IS	Industrial Sand	Steel	Iron and Steel plant

Concentration of mineral operations

TABLE 5
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Abrasives (natural):			
Cleveland Quarries Co.[1]	Box 261 Amherst, OH 44001	Quarry and plant	Lorain.
Cement:			
Essoroc Materials Inc.[2]	8282 Middlebranch Rd. Middlebranch, OH 44652	Plant	Stark.
Lafarge Corp.[2 3 4]	Box 160 Paulding, OH 45879	do.	Paulding.
Midwest Portland Cement Co.	Box 1531 Zanesville, OH 43702	do.	Muskingum.
Southwestern Portland Cement Co.	Box 191 Fairborn, OH 45324	do.	Greene.
Clays:			
Common:			
Belden Brick Co.	Box 910 Canton, OH 44701	Pits	Tuscarawas.
Glen-Gery Corp.	Box 207 Iberia, OH 43325	Pit	Marion.
Hydraulic Press Brick Co.	Box 31330 Independence, OH 44131	Pit	Cuyahoga.
Kimble Clay & Limestone Co.[5]	Route 1, Box 386 Dover, OH 44622	Pits	Tuscarawas.
Fire:			
Cedar Heights Clay Co.	Box 295 Oak Hill, OH 45656-0295	do.	Jackson.
Waterloo Coal Co. Inc.	Box 626 Jackson, OH 45640	Pit	Do.
Gypsum:			
Crude:			
Celotex Corp.	Box 280 Port Clinton, OH 43452	Pit and plant	Ottawa.
Lime:			
Huron Lime Co.	Box 451, 100 Meeker Huron, OH 44839	Quarry and plant	Erie.
LTV Steel Co. Inc.	Box 298 Grand River, OH 44045	Plant	Lake.
Martin Marietta Corp.	Box 187 Woodville, OH 43469	Quarry and plant	Sandusky.
Ohio Lime Co.	128 East Main St. Woodville, OH 43469	Quarries and plants	Do.
Peat:			
Sphagnum Moss Peat Farm	9797 Thompson Rd., Route 1 West Liberty, OH 43357	Bog	Champaign.
Salt:			
Akzo Salt Inc.	Box 6920 Cleveland, OH 44101	Underground mine, well, and plants	Cuyahoga and Summit.
Morton International Inc.	Box 337 151 South Industrial St. Rittman, OH 44270	Underground mine, wells, and plants	Lake and Wayne.

See footnotes at end of table.

TABLE 5—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Construction:			
American Aggregates Corp.	Box 147515 Dayton, OH 45413	Pits and plant (13 operations)	Butler, Champaign, Clark, Franklin, Greene, Hamilton, Licking, Montgomery, Pickaway, Warren.
Boyd Gravel Co.	24270 Township Rd. Coshocton, OH 43812	Pits	Clark, Coshocton, Fairfield, Knox, Meigs.
Dravo Basic Materials Co. Inc.	5253 Wooster Rd. Cincinnati, OH 45226	Pits and plants	Hamilton and Meigs.
Hilltop Basic Resources Inc.	630 Vine St. Cincinnati, OH 45202	do.	Clark, Greene, Montgomery.
Olen Corp.	4755 South High St. Columbus, OH 43207	Pits	Franklin and Knox.
S&S Aggregates Inc.	Box 1585 Zanesville, OH 43702	Pits and plants	Knox, Portage, Richland, Ross, Summit.
Watson Gravel Inc.	Box 277 2728 Hamilton-Cleves Rd. Ross, OH 45061	Pits	Butler, Hamilton, Warren.
Industrial:			
Fairmont Minerals Ltd. (Best Sand Corp.)	Box 87, 11830 Ravenna Rd. Chardon, OH 44024	Pit	Geauga.
Oglebay Norton Co. (Central Silica Co.)	Box 4477 Zanesville, OH 43702	Pits and mill	Knox and Perry.
Stone:			
Crushed:			
American Aggregates Corp.	Box 147515 Dayton, OH 45413	Quarries and plants	Darke, Delaware, Fayette, Franklin, Montgomery.
Hanson PLC (The France Stone Co.)	Box 278, 8130 Brint Rd. Sylvania, OH 43560	do.	Lucas, Paulding, Seneca, Wood.
National Lime & Stone Co.	Box 120 Findlay, OH 45839	do.	Allen, Auglaize, Crawford, Delaware, Hancock, Marion, Wyandot.
Rogers Group Inc.	Box 527 Sandusky, OH 44870	Quarry	Erie.
Steetley Quarry Products Inc.	128 East Main St. Woodville, OH 43469	Quarries	Sandusky.
Stoneco Inc.	Box 29A, 1345 Ford St. Maumee, OH 43537	Quarries and plants	Lucas, Ottawa, Paulding, Van Wert, Williams, Wood.
Wagner Quarries Co.	4203 Milan Rd. Sandusky, OH 44870	Quarry and plant	Erie.
Dimension:			
Briar Hill Stone Co.	Box 148, State Route 520 Glenmont, OH 44628	Quarries and plant	Coshocton, Holmes, Knox.
Waller Bros. Stone Quarry Co.	134 County Rd. McDermont, OH 45652	Quarry	Scioto.

[1]Also dimension stone.
[2]Also crushed stone.
[3]Also common clay and shale.
[4]Also sand and gravel.
[5]Also fire clay.

THE MINERAL INDUSTRY OF OKLAHOMA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Oklahoma Geological Survey for collecting information on all nonfuel minerals.

By Jeanne E. Zelten[1] and Robert H. Arndt[2]

The value of Oklahoma nonfuel mineral production was nearly $252.6 million in 1992, a decrease of $22.9 million from that reported to the U.S. Bureau of Mines by State mineral producers in 1991. The value of the top three commodities produced, crushed stone, portland cement, and construction sand and gravel, exceeded $168.8 million and comprised almost 67% of the State's total nonfuel mineral value. Although rebounding from the recessionary period, the growth curve for several minerals produced in the State was minimal, and for several others it moved downward. Oklahoma ranked 35th nationally in total nonfuel mineral value. The State ranked 26th nationally in the production of industrial minerals, contributing about 1.38% of the $20.7 billion revenues received. Oklahoma ranked first in the Nation in crude gypsum production, second in the production of tripoli, and was the only domestic source of iodine.

TRENDS AND DEVELOPMENTS

As 1992 closed, the recession and anticipated slow recovery were expected to continue to influence the construction industry. Consolidation of operations and divestitures of extended company holdings were expected to increase as company strategies shifted to adapt to changing economic conditions. Compliance with Federal, State, and local regulations undoubtedly will occupy a larger percentage of operators' time and resources.

Surface mining permit applications were approved for a number of new sand, gravel, and limestone quarries throughout the State. Many other companies also received approval for the expansion of existing operations.

EMPLOYMENT

At yearend, 35,600 persons were employed in the mining industry, 12.5%

TABLE 1
NONFUEL MINERAL PRODUCTION IN OKLAHOMA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland)	thousand short tons	1,544	$60,457	e1,620	e$63,180	1,026	$39,280
Clays	metric tons	631,302	3,156	e824,176	e4,178	621,944	3,296
Gemstones		NA	W	NA	W	NA	1,863
Gypsum (crude)	thousand short tons	2,184	11,154	2,356	12,925	2,603	14,915
Iodine (crude)	thousand kilograms	1,973	30,486	1,999	31,389	1,995	20,877
Sand and gravel:							
Construction	thousand short tons	r9,145	r21,753	e9,000	e22,300	9,904	24,204
Industrial	do.	1,258	22,984	1,241	20,918	1,071	19,011
Stone:							
Crushed[2]	do.	e25,300	e89,500	25,678	95,509	e27,500	e105,300
Dimension	short tons	r,e2,4,267	r,e2,153	r2,3,777	2,596	e5,182	e706
Tripoli	metric tons	18,801	155	15,885	141	W	W
Combined value of cement (masonry), feldspar, lime, salt, stone [crushed dolomite (1990-91), crushed granite (1992), dimension sandstone (1990-91)], tripoli (1992), and values indicated by symbol W		XX	r19,627	XX	r24,390	XX	23,144
Total		XX	r259,425	XX	r275,526	XX	252,596

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain stones; kind and value included with "Combined value" figure.

fewer than in 1991.[3] This reflects primarily an overall reduction in the oil and gas extraction sector, attributed to low natural gas prices in 1991 and 1992. Development by the petroleum industry in the United States and Canada decreased while international spending increased. Improvement in the United States economy and price stabilization were expected to result in economic growth in the State in 1993. Employment in oil and gas extraction decreased 13.6%, from 39,000 in 1991 to 33,700 in 1992. In mineral-related manufacturing, workers in the stone, clay, and glass products sector increased a total of 3.1% to 10,000 in 1992, and the 5,100 persons employed in the primary metals sector were 500 fewer than in 1991. Employment in the mineral-dependent construction industry increased 8.5% to 38,300 workers.[4]

According to the U.S. Department of Labor, accidents in Oklahoma nonfuel surface and underground mines resulted in 59 injuries with lost workdays and 27 injuries with no lost workdays during more than 3 million hours worked. Workers at mills and preparation plants sustained 34 injuries resulting in lost workdays and 28 injuries with no days lost, in a work period of nearly 863,000 hours. Underground coal mine operators reported two injuries resulting in lost workdays and one injury with no days lost in more than 45,000 hours worked. Surface coal mine operators reported 26 injuries resulting in lost workdays and 10 injuries with no days lost during more than 685,000 hours worked. No injuries were reported at coal plants during more than 9,000 hours worked.[5]

ENVIRONMENTAL ISSUES

The Occupational Safety and Health Administration (OSHA) ruled that six nonasbestiform minerals, including actinolite, tremolite, and anthophyllite, would no longer be treated as forms of asbestos in health and safety regulations. These minerals, commonly found in aggregates, will be regulated as particulates. The ruling could save operators $7 million annually in control measures to deal with the minerals. The rule became effective May 29, after 6 years of debate.

The U.S. Environmental Protection Agency (EPA) issued two regulations to implement air pollution controls required by the Clean Air Act Amendments of 1990. These included regulation of a number of mineral-products industries for toxic air pollutants and the implementation of permitting requirements for all major sources of air pollution. Also, new standards were set for particulate matter that apply to calciners and dryers at plants processing or producing construction products, including lightweight aggregate. EPA anticipated product price increases resulting from the new standards probably would be less than 0.5%, but could be as much as 1.75% for the lightweight aggregate industry.

EPA studied both the process and effects of using waste products as fuel in cement kilns. The studies were in response to public opposition and in an effort to reduce regulatory burdens on industry and to redefine a waste. EPA determined that there was no threat to human health or to the environment from the emissions created by burning certain hazardous wastes in cement kilns. Studies also indicated that cement products did not contain measurable increases of toxic metals. New regulation, expected in late 1994, would eliminate excessive regulations prohibiting the use of hazardous waste in the production of cement and other building materials.

Several industries saw increased competition from alternative products, especially waste products, which often were sold at prices undercutting the prices of mined materials. Because of increasing need to dispose of large quantities of waste material, the trend was expected to increase in coming years. Bottom ash, the residue produced at coal-burning powerplants, was sold for use as a lightweight aggregate in masonry applications. Byproduct lime and gypsum from water-treatment facilities and flue gas desulfurization were used for soil conditioning, gypsum-board manufacture, and portland cement. Alkaline fly ash was used for stack gas cleaning. Concrete and road asphalt also were recycled.

In response to the Clean Air Act Amendments of 1990, research was carried out by Federal and State agencies in an attempt to substitute various materials for traditional mined materials to produce usable byproducts. For example, phosphate was used to replace limestone in flue gas desulfurization, resulting in a salable fertilizer byproduct. Innovative use and handling of waste products, along with demand for a number of industrial minerals and a variety of chemicals, was expected to increase as operators modify their facilities to comply with the new regulations.

Soil, contaminated by lead, zinc, and cadmium from the former Blackwell Zinc smelter, was removed from Washington School and Beatty-Rodgers Park in Blackwell, Kay County. The soil contained bound lead, not considered a danger, and was removed from the sites under the direction of EPA. The smelter site was under consideration for inclusion on the Federal Superfund list because cadmium and zinc were detected in topsoil and ground water. Samples were collected and a report was expected by early 1993.

Halliburton Co., E. I. du Pont de Nemours and Co., and more than a dozen other companies were cited by EPA in connection with mine cleanup in the Tri-State mining district. The district encompasses Ottawa County, OK, Cherokee County, KS, and Jasper County, MO. Preliminary studies revealed lead contamination in soils and waste piles. EPA planned to complete analysis of the site in 1993. The cost of the study to determine the extent of environmental damage will be shared by Halliburton, DuPont, and seven other companies. Cleanup could reach the tens or even hundreds of millions of dollars.

The Oklahoma Department of Health, EPA, and the Agency for Toxic Substances and Disease Control continued their investigation of possible heavy-metal contamination in and around Bartlesville, Washington County, allegedly from

emissions from the Zinc Corp. of America smelter, formerly National Zinc Co. In 1991, neighborhood surveys were conducted and blood samples taken from children, pregnant women, and other concerned citizens to determine levels of lead and cadmium. Soil samples also were taken throughout a 36-square-mile area to evaluate high access areas such as schools, parks, day-care centers, and other public facilities. Preliminary results revealed that 13 preschool children had "borderline lead poisoning." High lead levels were noted in soil samples from six sites. EPA removed soil from contaminated schools and day-care facilities. Testing continued in preparation of a report scheduled for completion in early 1993. The project is unique in that it involves Federal, State, and city agencies working together and because it is more comprehensive than previous lead studies that have focused primarily on paint.

Of 10 sites in the State on EPA's National Priorities List, only the abandoned lead-zinc mining area of Tar Creek in Ottawa County was mining related. Other sites included landfills, abandoned refineries, abandoned salvage yards, and an aircraft maintenance and rebuilding facility. The sites were in various stages of study and remediation.

LEGISLATION AND GOVERNMENT PROGRAMS

A variety of environmental and natural resource legislation was enacted, addressing the consolidation of State agencies regulating environmental protection, hazardous waste disposal and recycling, and other miscellaneous concerns. Much of the regulation was expected to be significant to cement producers throughout the country, many of whom were investigating and in the process of converting their kilns to the use of tires and other hazardous wastes as fuel.

House bill 2227 (Oklahoma Environmental Quality Act) provides a framework for reorganizing the State's environmental agency structure. Provisions of the bill address agency overlap and duplication of effort, public confusion about agency regulatory responsibilities, lack of timeliness and definitive response to questions and complaints, and the elimination of dual water discharge permits from both the State and Federal Governments. A new Department of Environmental Quality and an Environmental Quality Board will be created, after a 1-year transition period, to regulate air and water quality and solid and hazardous waste. A number of functions in pollution and environmental regulation previously performed by several agencies would be transferred to this department.

House bill 1662, effective September 1, requires the Oklahoma Department of Mines to accept written comments from local soil conservation districts and other public entities on the environmental effects of proposed mining operations. In addition, any person who may be adversely affected by any permitted mining activity may request the Department of Mines to hold an informal conference on the matter.

House bill 1736 amends the Recycling and Recycled Materials Procurement Act to further encourage recycling recoverable materials. Use of recycled products is encouraged, and the Department of Central Services is charged with providing information on recycled products.

The passage of House bill 2445 set fees for dumping hazardous waste in the State, encouraged the reduction of hazardous waste production, and contained a provision capping health department fees charged for waste disposal. Without the cap, Zinc Corp. of America in Bartlesville, Washington County, anticipated closure or layoffs to counter increased cost of operation. Zinc Corp. produces about 60,000 tons of zinc per year.

Senate bill 782 and House bills 1807, 2254, 2470, and 2495 authorize and provide for improvements to turnpikes, highways, and county roads.

Under the State Mining and Mineral Resources Research Institute Program Act (Public Law 98-409), the U.S. Bureau of Mines (USBM) awarded a basic allotment grant of $16,000 to the University of Oklahoma. The monies were used to perform basic and applied research related to the State's mineral resources and for the general benefit of the Nation's mineral industry. The University matched this grant on a 2:1 basis.

The U.S. Army Corps of Engineers stated that artificially created lakes and ponds, including those created by aggregate producers, are not included under the definition of jurisdictional wetlands.

Passage in May of the National Geologic Mapping Act of 1992, Public Law 102-285, could result in improved mapping coverage for Oklahoma. The State map component of the act identifies State geological surveys as the lead agencies to establish mapping priorities in their respective States. States must compete for funding, and equal distribution among States is not guaranteed. States are required to match the awarded funds. Despite full authorization of $18 million to States, the program was funded at only $1.39 million for 1993.

Projects completed by several State and Federal agencies provided information beneficial to mineral producers in the State. Work continued on the Ouachita Cooperative Geologic Mapping Program (COGEOMAP) Project, a joint effort between the U.S. Geological Survey (USGS), the Oklahoma Geological Survey (OGS), and the Arkansas Geological Commission. New geological maps of the Ouachita thrust belt in Oklahoma and Arkansas, compiled under this program, could be used for resource exploration and development, land use planning, educational activities, intellectual interests, and tourist and sportsman activities.

Scientists with the OGS studied the mineral resource potential of Permian and Triassic red-bed deposits in the western part of the State. OGS published a catalog of petroleum cores contained in its Core and Sample Library. Industry personnel, geoscientists, and students throughout the United States use the library. The USGS published an open

file report on the Petroleum Geology of the Anadarko Basin Region of Kansas, Oklahoma, and Texas.

A workshop on Industrial Minerals Development in Oklahoma was held in December at the University of Oklahoma in Norman. The workshop was co-sponsored by the OGS, the Oklahoma Department of Mines, and the USBM. The purpose of the workshop was to improve the development and use of Oklahoma's industrial mineral resources.

FUELS

Energy-related legislation enacted by the State Legislature during the year addressed petroleum production enhancement, oil and gas pollution, public education, reduced royalties, and other miscellaneous energy-related issues. Much of this legislation could have a profound effect on producers and production in the State.

Senate bill 663 establishes seasonal restrictions on gas production from natural gas wells and grants the Oklahoma Corporation Commission the authority to increase or decrease the amount of gas that may be produced for the purpose of preventing waste and more closely following market demand. The legislation was expected to help stabilize natural gas prices and to increase the number of nationally competitive Oklahoma producers.

Senate Joint Resolution 42 extends the existence of the Commission on Natural Gas Policy through February 15, 1997, so that the commission may continue to address issues of importance to the State's oil and gas industry. The 15-member commission was established in 1991 to examine the policies, regulations, and laws of Oklahoma, other States producing natural gas, and the Federal Government to create new State and national natural gas energy policies.

House bill 2278 establishes the Oklahoma Independent Energy Education and Marketing Act to educate the general public on the importance of independent oil exploration and production, encourage efficient energy usage, promote environmentally sound production methods, develop oil resources, and support research and education for the benefit of independent petroleum producers. The Oklahoma Independent Energy Resources Board was created to coordinate the program.

The U.S. Bureau of Land Management (BLM) reduced royalty rates for coal on Federal leases in nine eastern Oklahoma counties to encourage development of the coal. The rate for underground coal was reduced from 8% to 2% and that for surface mined coal was reduced from 12.5% to 4%. The new rates are expected to make mining costs for Federal coal more competitive with those for State and private coal, and are retroactive to December 17, 1990.

In January, the U.S. Supreme Court overturned an Oklahoma law requiring State-owned coal-fired generators to burn at least 10% Oklahoma produced coal. The State of Wyoming, as plaintiff, argued that the law violated the U.S. Constitution's interstate commerce clause, caused market disruptions and loss of revenues for the State of Wyoming, and discriminated against out-of-State coal producers. The Oklahoma law was passed in 1986 to boost the State's economy and to reduce dependence on Wyoming coal, especially in the event of a disruption in supply.

Oil, gas, and coal were produced in Oklahoma in 1992, primarily for use as fuels. The State received mineral revenues of about $1.2 million in 1992 from the Minerals Management Service and BLM for onshore mineral leases on Federal lands. This was $473,000 less than the 1991 distributions of $1.7 million.[6]

Oil and gas continued as the major portion of the Oklahoma mineral value produced. Production was reported from 71 of the State's 77 counties. Six refineries were in operation during the year. Almost 10.8% of total natural gas production in the United States was supplied by producers in the State.[7] Crude oil production, including condensate, was more than 101.8 million barrels in 1992, a 5.7% decrease from the revised total of nearly 108 million barrels produced in 1991 and the lowest level since 1919.[8] Natural gas production, including casinghead gas, totaled 1,996,854 million cubic feet in 1992, or 3.3% below the 2,065,729 million cubic feet produced in 1991.[9] Oklahoma ranked sixth nationally in oil production[10] and third in the production of natural gas.[11]

Exploration and development activities were low nationally as companies sought to reduce operating expenses. Unusually mild weather contributed to low sales of oil and gas.[12] Drilling and production increased toward yearend and were expected to increase in 1993 in response to increased demand resulting from Federal legislation, economic recovery, increased use of natural gas by electric utilities and fleet vehicles, and expansion of the interstate pipeline system. Several energy tax proposals will be evaluated during 1993.[13]

Oklahoma ranked second in oil and gas well drilling in the United States again in 1992, with a total of 1,678 completions. This decrease was nearly 23.9% below the 2,206 completions in 1991. Of the 1992 total, 628 were oil wells, 491 were gas wells, and 559 were dry holes. New field wildcats accounted for 73 completions, 56 of which were dry holes.[14]

The Chautauqua Platform, in the northeastern part of the State, continued to lead other provinces in the number of holes drilled. Drilling for natural gas remained at a high level in the Ouachita thrust belt, in the southeastern corner of the State. Exploration and field expansions occurred in a number of oil and gas fields.

Drilling was expected to increase in 1993 due to Federal tax incentives. The Clean Air Act Amendments of 1990 mandated the use of alternative fuels for fleet vehicles in 22 urban areas of the country that do not meet air quality requirements. Conversion to compressed natural gas by vehicles in these areas could increase production and create jobs in Oklahoma.

Debate continued at yearend as to ownership of coalbed methane gas. Despite Federal tax incentives for developing coalbed gas, production was

limited. Estimated reserves of 1 to 1.7 trillion cubic feet of gas occur in Le Flore and Haskell Counties, in the southeastern part of the State.

In 1992, a total of more than 1.9 million short tons of bituminous coal was produced by 15 companies from 21 surface mines in 11 counties and from 1 underground mine in Okmulgee County. Continuous mining methods were used in the underground mine. Production from surface mines increased more than 5.5%, from about 1.8 million short tons in 1991 to about 1.9 million short tons in 1992. Underground production of more than 59,000 short tons was an increase from the 1991 production of about 26,000 short tons. The State ranked 22d out of 27 States producing coal in 1992.[15]

Most of the coal produced in Oklahoma was used by out-of-State utilities. Major instate use was by utilities, the cement and lime industries, the paper industry, and process heat for industry. Coal resources occur in 19 counties in eastern Oklahoma, which are within the Western Region of the Interior Coal Province of the United States. The coal is low, medium, and high volatile bituminous, coking and noncoking, contains 0.4% to 6.5% sulfur, and occurs in beds up to 7 feet thick.

The Interstate Oil and Gas Compact Commission and the Southern States Energy Board cosponsored a conference, Coal and Natural Gas: Partner for Progress, to explore opportunities in cofiring utilities and other industries. Increased environmental regulations will present opportunities for cofiring, particularly at powerplants. Education and cooperation will be essential if such programs are to succeed.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Production of industrial minerals in 1992 was influenced by gradual increases in the construction industry as the economy slowly continued to recover. Highway construction increased in 1992, and at yearend residential construction was improving, but commercial building remained stagnant.

Aggregate and cement production increased in 1992, largely reflecting increased funding for highway construction provided by the $151 billion Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). Good weather was also a factor. ISTEA funds enabled Oklahoma to increase transportation-related construction and anticipate further increases in 1993. The funds are allocated over 6 years for improvements to highways and bridges, but also could be used for mass transit and other nonhighway purposes.

The value of authorized construction in 1992 was $995.1 million, a 14.2% increase from the $871.5 million in 1991. The number of single- and multi-family residential units increased about 11.7%, from 5,248 units in 1991 to 5,862 units in 1992. The value of nonresidential construction increased about 18.2%, from $184.6 million in 1991 to $218.2 million in 1992. Nonbuilding construction, including highways, increased about 7.9%, from $233.4 million in 1991 to $251.8 million in 1992.[16]

Based on anticipated increases in public works projects, residential building, environmental work, and road construction, the demand for aggregate and portland cement in the United States was expected to increase by as much as 6% in 1993. Production in the State also was anticipated to increase similarly in 1993, as the State's highway program gains momentum.

Environmental and zoning regulations were cited as the primary detriments for the construction aggregates industry in expanding existing quarries and developing new quarries.

Crushed stone continued as the leading nonfuel mineral commodity, in terms of value, followed by portland cement and construction sand and gravel. The three accounted for almost 67% of the State's 1992 nonfuel mineral value.

Cement.—Oklahoma ranked 26th nationally in portland cement production and 21st in the production of masonry cement. Portland cement accounted for almost 15.6% of Oklahoma's 1992 total nonfuel mineral value and was the second most valuable nonfuel mineral commodity produced in the State. Sales of more than 1 million short tons, valued at nearly $39.3 million, were $23.9 million and 594,000 short tons less than 1991 estimated totals. They also were 518,000 short tons and $21.2 million less than totals reported by the State's cement producers in 1990. Masonry cement production and value decreased 31% and 16%, respectively, from estimated 1991 levels, and 20.5% and 3.9%, respectively, below reported 1990 totals. Anticipated increases in residential construction, highways, and public works projects in 1993 could increase sales up to 5%.

In 1991, Blue Circle Inc., in Tulsa, Tulsa County, and Lone Star Industries Inc., in Pryor, Mayes County, produced both portland and masonry cements from dry-process kilns. Holnam Inc.'s Ideal Cement Div., in Ada, Pontotoc County, produced portland cement from wet-process kilns.

Cement plant operators nationwide continued to explore the use of waste products as fuel in cement kilns. Faced with low cement prices and a recovering economy, the industry investigated ways to cut fuel costs, which constituted approximately 25% of operating expenses. The high temperatures needed in cement kilns were used to burn waste materials, such as waste fuels, industrial wastes, spent organic solvents, and used tires. Canned wastes and tires were placed directly into the cement kilns along with the other raw materials; the high temperature completely decomposed the organic material. Because portland cement clinker requires a certain amount of iron, the metal containers and the steel radial belts from the tires are simply incorporated into the clinker. Hazardous wastes have been burned in cement kilns for years, and in 1992, waste fuels accounted for about 6.6% of the energy used for making cement in the United States. It appeared to be an environmentally safe and efficient way to dispose of hazardous waste and other

materials that have long been a problem, thereby eliminating the need to mine other resources to satisfy fuel requirements.

Clay and Shale.—In 1992, Oklahoma ranked 18th nationally among 44 States reporting clay and shale production. Nine companies, operating 13 mines in 8 counties, reported production of common clay and shale. Production of 621,944 metric tons, valued at $3.3 million, was 202,232 metric tons and $882,000 less than amounts estimated for 1991. Production reported from companies in Pontotoc, Rogers, and Seminole Counties accounted for approximately 92% of the total. Clay and shale are abundant throughout the State and are used mainly in the manufacture of portland cement (almost 48%), common brick (44%), concrete block (almost 6%), and structural concrete (about 1%). Highway resurfacing, stoneware, and pottery manufacture accounted for a smaller portion of the clay used. The major production was near Oklahoma City and Tulsa.

Four companies manufactured brick at five plants in the State in 1992. Face, common building, and paving brick, as well as crushed brick for landscaping, were produced by Acme Brick Co., at plants in Edmund, Oklahoma County, and Tulsa, Tulsa County, and by Mangum Inc. Brick Co. from a plant at Mangum, Greer County. Commercial Brick Corp. produced face and common building brick from a plant at Wewoka, Seminole County. And Oklahoma Brick produced face, common building, and paving brick from plants at Muskogee, Muskogee County, and Union City, Canadian County.

Feldspar.—Oklahoma ranked third of seven States producing feldspar in 1992. Reported production and value each decreased about 1% below 1991 totals. Arkhola Sand and Gravel Inc., a division of APAC Arkansas Inc., produced a feldspar-silica concentrate that was sold to the glass and ceramics industries. Alumina contained in the feldspar imparts corrosion resistance to the final products. Feldspathic sand was dredged from the Arkansas River near Muskogee, in Muskogee County. The sand was dried, iron impurities were removed by magnetic separation, and the sand was leached with acid to remove other impurities, redried, and bagged for shipment.

Gypsum.—Oklahoma ranked 1st among 19 States reporting crude gypsum production and 7th among 28 States reporting production of calcined gypsum in 1992. Crude gypsum production of more than 2.6 million short tons increased almost 10.5% over that reported by producers in 1991. Value was more than $14.9 million, almost 15.4% above the 1991 value. Seven companies reported crude gypsum production from mines in Blaine, Caddo, Comanche, Jackson, Kingfisher, and Woodward Counties. Calcined gypsum production was reported by three of the same companies in Blaine, Comanche, and Jackson Counties. Harrison Gypsum Co. Inc., Temple-Inland Forest Products Corp., and United States Gypsum Co. were the three largest producers of crude gypsum in the State. Harrison Gypsum Co. Inc.'s Cement Mine, in Caddo County, and Temple-Inland Forest Products Corp.'s Fletcher Mine, in Comanche County, were the fourth and eighth largest producers, respectively, in the United States.

Gypsum was mined in western Oklahoma, from the Nescatunga and Shimer Gypsum Members of the Permian Blaine Formation and from the Permian Cloud Chief Formation. The mineral was used as plaster for interior walls and wallboard, retarder in cement manufacture, fillers, soil conditioners, and a variety of medical and other uses.

The gypsum market continued to be pressured by overcapacity and record-low prices. Substantial increases in available gypsum from flue gas desulfurization could create major concerns for the industry. The industry continued to rebound in 1992, primarily from the increase in residential construction. Commercial construction was somewhat limited to repair and remodeling. The upward trend was expected to continue into 1993.

Iodine.—Oklahoma was the only State reporting iodine production in 1992. Production in 1992, nearly 2 million kilograms, was almost 4,000 kilograms less than that of 1991. Value in 1992 was almost $20.9 million, about 33% less than the 1991 value of nearly $31.4 million. Three companies, IoChem Corp., North American Brine Resources, and Woodward Iodine Corp., in the northwestern part of the State, produced crude iodine from oilfield brines. The brines were obtained from the Pennsylvanian Morrow Group in Dewey, Kingfisher, and Woodward Counties and supplied about 62% of domestic demand for iodine.

Major uses of iodine included animal feed supplements, catalysts, inks and dyes, pharmaceuticals, photographic equipment and recycling processes, sanitary and industrial disinfectants, stabilizers, and radiopaque media. Other uses included batteries, high-purity metals, motor fuels, iodized salt, lubricants, and cosmetics.

Lime.—In 1992, Oklahoma ranked 24th among 32 States reporting lime production, all from the St. Clair Lime Co. plant in Marble City, Sequoyah County. Limestone was mined underground by room-and-pillar methods from the Silurian St. Clair Limestone and converted to crushed limestone, quicklime, and hydrated lime. Total lime production and value decreased 1.6% and 0.3%, respectively, in 1992.

Growth in the lime and limestone industry was expected to increase as a result of the Clean Air Act Amendments of 1990 and other environmental legislation that required installation of stack scrubbers at coal-fired powerplants. Scrubbers utilize lime and pulverized limestone to remove sulfur oxides from stack gases. Other areas of continued growth in usage included water treatment, to achieve proper pH balances, and treatment of sewage sludge and hazardous

TABLE 2
OKLAHOMA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	2,225	$6,173	$2.77
Plaster and gunite sands	W	W	2.77
Concrete products (blocks, brick, pipe, decorative, etc.)	114	250	2.19
Asphaltic concrete aggregates and other bituminous mixtures	152	407	2.68
Road base and coverings[1]	498	1,063	2.13
Fill	2,667	3,586	1.34
Snow and ice control	W	W	2.23
Railroad ballast	W	W	6.00
Other miscellaneous uses[2]	104	309	2.97
Unspecified:[3]			
Actual	2,527	7,798	3.09
Estimated	1,618	4,618	2.85
Total	[4]9,904	24,204	2.44
Total[5 6]	8,985	24,204	2.69

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

wastes. Increased demand for lime in an expanding economy is anticipated for the manufacture of steel and automobiles, construction, industrial and chemical uses, and increased mining, smelting, and environmental controls in the gold and copper industry.

Lime is manufactured by heating or calcining limestone or dolomite in a kiln at high temperatures to drive off carbon dioxide. The resulting product is quicklime. Hydrated lime, the more stable form, is produced when water is added to the quicklime. In addition to the above-mentioned uses, lime is used as a soil conditioner, as plant food, for soil stabilization, as a flux, and as a basic chemical.

Salt.—Vast resources of salt underlie most of the northwestern part of the State. Salt brine, dissolved from underground deposits by ground water, was pumped to the surface, and salt was recovered through solar evaporation of the brine by Cargill Inc. at its operation near Freedom, in Woods County. Production and value increased about 31% and 33.5%, respectively, from the reported 1991 totals. The salt primarily was used for stock feed, water conditioning, agricultural uses, and road deicing. The Salt Institute, of Alexandria, VA, reported that 1992 was the safest year since 1969, in terms of low incidence and severity of accidents, for the salt industry.

Sand and Gravel.—Both construction sand and gravel and industrial sand were mined in Oklahoma during 1992. Sand and gravel was produced in most counties from deposits found in and near rivers and streams. Construction sand and gravel production, the third most valuable commodity, constituted nearly 9.6% of the total nonfuel mineral value produced in the State in 1992.

Construction.—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Reported production of construction sand and gravel was 759,000 short tons (8.3%) above that reported in 1990 and 904,000 short tons (10%) above the 1991 estimate, reflecting increased construction activity. Reported value increased more than $2.5 million (11.3%) above that reported by industry in 1990 and $1.9 million (8.5%) above the estimated 1991 value. Major uses included concrete aggregate, fill, road base and cover, asphaltic concrete, miscellaneous concrete products, and railroad ballast.

Oklahoma construction sand and gravel statistics are compiled by geographical districts, as depicted on the State map. Tables 2 and 3 present end-use data for this commodity in the State and in the five Oklahoma districts. District 2, in the northeastern part of the State, reported the highest production, followed by districts 4, 1, 3, and 5.

The construction sand and gravel industry included 84 companies operating 112 pits in 40 of the State's 77 counties. The five leading counties, ranked in decreasing order of tonnage produced, were Tulsa, Oklahoma, Love, Wagoner, and Canadian. Almost 61% of the State's production was from these counties. Four companies, Gifford-Hill Concrete Co., Coweta Sand Inc., The Dolese Brothers, and Watkins Sand Co., together produced about 38.8% of the State total. Major end uses reported by producers included fill, concrete aggregate, road base and cover, asphaltic concrete, and miscellaneous concrete products. A majority of the material was transported by truck from pits to plants and construction sites.

Industrial.—Four companies, Arkhola Sand and Gravel Inc., Humble Sand Co. Inc., UNIMIN Corp., and U.S. Silica Co., reported production from three mines in Johnston, Muskogee, and Pontotoc Counties and from abandoned

TABLE 3

OKLAHOMA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[1]	W	W	1,034	2,456	453	931
Asphaltic concrete aggregates and other bituminous mixtures	W	W	W	W	28	49
Road base and coverings[2]	81	W	6	W	103	170
Fill	17	40	2,323	3,069	W	W
Snow and ice control	W	W	W	W	—	—
Railroad ballast	—	—	—	—	W	W
Other miscellaneous uses[3]	265	1,081	68	193	38	137
Unspecified:[4]						
Actual	876	2,821	681	1,407	30	55
Estimated	71	374	1,014	2,502	109	321
Total[5]	1,311	4,317	5,126	9,627	761	1,662
Total[6 7]	1,189	4,317	4,650	9,627	690	1,662

	District 4		District 5	
	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[1]	556	1,897	W	W
Asphaltic concrete aggregates and other bituminous mixtures	W	W	—	—
Road base and coverings[2]	235	426	73	258
Fill	W	W	W	W
Snow and ice control	—	—	—	—
Railroad ballast	—	—	—	—
Other miscellaneous uses[3]	281	417	197	666
Unspecified:[4]				
Actual	937	3,509	4	6
Estimated	371	1,256	52	165
Total[5]	2,380	7,504	327	1,095
Total[6 7]	2,159	7,504	297	1,095

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes concrete aggreates (including concrete sand), plaster and gunite sands, and concrete products (blocks, brick, pipe, decorative, etc.).
[2]Includes road and other stabilization (lime).
[3]Includes filtration.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value in thousand metric tons and thousand dollars.

zinc mill sites in Ottawa County. More than 1 million short tons of industrial sand, valued at about $19 million, was produced. This was a decrease of 170,000 short tons (almost 13.7%) from reported 1991 production. Value decreased more than $1.9 million (about 9%) from the reported 1991 value. Most of the industrial sand produced was mined in Johnston and Pontotoc Counties, in the Arbuckle Mountain region of south-central Oklahoma. The sand was mined by surface methods primarily from the Ordovician Oil Creek and McLish Formations, and was used in making container and flat glass, for foundry sand, ceramics, abrasives, and for other chemical and industrial uses. High-purity feldspathic sand was dredged from the Arkansas River, in Muskogee County, and used in the manufacture of glass. Most of the material was transported by truck or rail from pits or dredging operations to plants.

Ball-InCon Glass Packaging Corp. closed its glass plant in Sand Springs, Tulsa County, and another it owns in southern California, primarily because of the excessive cost to upgrade equipment and bring the plants up to industry standards. The company's other plants in 10 States, including one in Okmulgee, Okmulgee County, will assume production from the closed plants. Ball leads the Nation in the production of glass containers for the food industry and is third in the production of commercial glass bottles and jars.

Since 1988, Humble Sand and Gravel

Co. of Picher, Ottawa County, has shipped between 3,000 and 6,000 bags of sand to Dammann, Saudi Arabia, where the sand was used to coat oil pipelines, providing corrosion protection against sulfuric acid in the oil. Flint contained in the sand makes it harder and more suitable for coating purposes than the fine-grained desert sand.

Stone.—Both crushed and dimension stone were produced in Oklahoma during 1992. Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

The utilization of a stone deposit is determined by the quality of the stone, demand, available transportation, and availability of the deposit. For some aggregate uses and for dimension stone, physical characteristics are significant. For some chemical and other specialized uses, chemical composition is important. If specific physical or chemical characteristics are not important, cost of haulage, local demand, and availability are the determining factors.

Crushed.—Crushed stone, the leading commodity produced in Oklahoma in 1992, constituted about 42% of the State's total nonfuel mineral value. Estimated 1992 production of 27.5 million short tons, valued at an estimated $105 million, was an increase of 1.8 million short tons (7.1%) and $9.8 million (10.3%) from reported 1991 totals. In 1991, the most recent year with a full-year industry canvass, 42 companies reported production of crushed stone from 66 quarries in 36 counties. The three leading counties, Johnston, Murray, and Rogers, accounted for 32% of the 1991 production. Five companies, Anchor Stone Co., Arkhola Sand and Gravel Inc., Boorhem-Fields Inc., Dolese Brothers, and Meridian Aggregates Co., together produced almost 56% of the 1991 State total. Stone produced in 1991 included limestone and dolomite (86.6%), sandstone (6%), granite (4.5%), traprock (1.5%), and shell (1.5%). Chat and rhyolite also were produced.

Limestone, one of the most widely available mineral resources of the State, generally accounts for about 60% of the reported tonnage of nonfuel minerals mined. In 1991, crushed limestone and dolomite were produced by 34 companies operating 58 quarries and crushing facilities. Major end uses reported were concrete aggregate, graded road base, screening, railroad ballast, fill, and unpaved road surfacing.

Amis Materials Co., Big Deal Construction Co. Inc., Heiskill Gravel Inc., Rock Producers Inc., and Stigler Stone Co. Inc., operating quarries in Atoka, Muskogee, Seminole, Le Flore, and Haskell Counties, reported production of crushed sandstone in 1991. End uses included fine screenings, concrete aggregate, fill, bituminous aggregate, riprap and jetty stone, graded road base, and railroad ballast.

Granite was mined and crushed in 1991 at three quarries in the southern part of the State by Aggregate Materials, in Greer and Kiowa Counties, and by Meridian Aggregates Co., in Johnston County. Traprock was mined and crushed by Western Rock Products Inc., in Murray County. Crushed granite and traprock were used for railroad ballast, concrete aggregate, fill, road base and surfacing, fine screenings, bituminous aggregate, filter stone, riprap and jetty stone, and a variety of other uses. Shell was recovered from lakes and rivers in Pittsburg County by the Pittsburg County Highway Department and used for graded road base and unpaved road surfacing.

Large mounds of chat, fragments of siliceous rock, limestone, and dolomite waste remaining from lead-zinc milling operations, abound in Ottawa County. Chat was used for railroad ballast, highway construction, fill, and concrete aggregate.

Rhyolite was mined by Western Rock Products Inc. from a quarry in Murray County. The Carlton Rhyolite was the source of the material that was used for construction aggregate, railroad ballast, and riprap.

Muskogee Bridge Co. Inc. obtained a court order allowing the company to temporarily continue operating its limestone quarry in Cherokee County, despite an order to shut down issued by the Oklahoma Department of Mines. Two workers were killed when lightning set off an explosion of dynamite in October. The company was operating the quarry for its own construction use, but without benefit of a mining permit.

Dimension.—Estimated 1992 production and value of dimension stone increased 1,405 short tons and $110,000, respectively, above reported 1991 totals. Five companies reported production of dimension granite and sandstone in 1991, the most recent year with a full-year industry canvass. Primary uses were for building stone and monument stone. Granite was quarried from the Arbuckle Mountains in Johnston County and from the Wichita Mountains in Greer and Kiowa Counties. Sandstone was quarried in Le Flore County.

Dimension stone, primarily marble and granite, was shipped from other States and finished into monuments and miscellaneous shapes for a variety of construction uses.

Tripoli.—Oklahoma ranked second of four States producing tripoli in 1992. Production decreased and value increased from totals reported in 1991. The Oklahoma deposits were mined by American Tripoli Inc., from the Mississippian Boone Formation. The company owns six surface mining operations in Ottawa County. Tripoli, a microcrystalline form of high-purity silica, is used as an abrasive, in buffing and polishing compounds, in concrete, and as a paint filler.

Other Industrial Minerals.—Several other industrial mineral commodities, produced in Oklahoma as byproducts of other industries or shipped into the State, either were sold as recovered or processed into higher value products.

Anhydrous ammonia, most of which was used for fertilizer products, was produced by four companies from plants in the State. Farmland Industries Inc.

operated a nitrogen solutions plant having a capacity of 900,000 short tons per year. Agricultural Minerals Corp. operated a nitrogen fertilizer facility in Verdigris, Rogers County. The plant capacity was 1 million short tons per year. The company produced ammonia, urea, urea-ammonium nitrate solutions, and fertilizers. Oklahoma Nitrogen, a division of Terra International, Inc., produced ammonia from its 450,000-short-ton-per-year-capacity plant in Woodward, Woodward County. Terra began procedures to upgrade the plant to produce methanol, in demand for oxygenated fuels. Wil-Grow Fertilizer Co. produced anhydrous ammonia from its 94,000-short-ton-per-year-capacity plant at Pryor, Mayes County.

Barite was shipped into the Elk City plant of Old Soldiers Minerals Ltd., Beckham County, and ground for use as a weighing agent in oil- and gas-well-drilling fluids.

Carbon dioxide was produced by Applied Energy Services Inc. (AES) at a plant adjacent to its cogeneration facility near Shady Point, Le Flore County. The plant is designed to produce 200 tons per day of liquefied food-grade carbon dioxide. Byproduct carbon dioxide was removed from flue gas from the co-generation plant boilers. The gas was then purified, liquefied, and prepared for shipping to the contractor, Tyson Foods.

A variety of gemstones, minerals, and fossils were collected by amateur collectors and professionals, both for private collections and for commercial sales. The materials were sold as specimens and formed into a variety of decorative items. Freshwater mussel shells were collected from lakes and rivers in eastern Oklahoma to be used for implanting in oysters for pearl cultivation. Most of the shell material collected by American Shell Co., Tennessee Shell Co., and U.S. Shell Co. was exported to Japan. Small quantities of freshwater pearls also were recovered from the mussels. Barite roses, the official State rock, are more abundant in Oklahoma than anywhere else in the world. Other rock and mineral specimens collected included agate, carving-quality alabaster, gem-quality chert, dolomite pyramids, flint, jasper, mica, quartz crystals, selenite crystals, and geodes of barite, claystone, or ironstone containing crystals of aragonite, barite, calcite, quartz, or sand. Fossils included crinoids, ferns, horn coral, oyster shells, petrified wood, and many others.

Oklahoma ranked 24th of 34 States producing or expanding perlite in 1992. Noble Materials expanded perlite for use as fillers at its plant in Oklahoma County.

Sulfuric acid was a byproduct of the Zinc Corp. of America smelter at Bartlesville, in Washington County.

Crude vermiculite was shipped from mines in South Carolina and used in concrete aggregate and soil conditioners.

Volcanic ash deposits occur in a number of counties in the western and central parts of the State. Hope Minerals Co., in Okfuskee County, produced ash primarily for use in concrete mixtures, and as abrasives, absorbents, and insulating compounds.

Metals

A variety of metals were produced or refined in the State. As with industrial commodities, the sluggish economy weakened major markets, resulting in low sales volumes.

Aluminum.—Conoco Inc. developed a reclamation process for fluorinated alumina waste generated at its Ponca City refinery in Kay County. Kaiser Aluminum & Chemical Corp. will use the waste as a high-quality additive in manufacturing aluminum. Conoco expects to reclaim about 260,000 pounds of alumina from this plant each year. Activated alumina is used in the production of high octane gasoline. The alumina draws out unwanted fluorides from propane and butane products. The first shipments of waste were sent to Kaiser's Mead, WA, plant in December.

Cadmium and Zinc.—Zinc Corp. of America was one of four companies in the country that recovered cadmium from lead and zinc smelters. Cadmium was precipitated from leached zinc electrolyte at the company's 60,000-metric-ton-per-year slab zinc smelter in Bartlesville, Washington County. The cadmium was filtered, briquetted, and processed to produce a commercial-grade cadmium ball anode. Primary uses included a variety of industrial applications, including photodetectors and transparent conductors, and cadmium batteries.

Gallium and Germanium.—The Specialty Materials Div. of Eagle-Picher Industries Inc., with an office in Quapaw, Ottawa County, was involved in gallium, germanium, and environmental products. The company also reprocessed scrap.

Gallium was recovered and refined from primary and secondary source materials. Most of the gallium was used to make gallium arsenide, used in light-emitting diodes and high-speed integrated circuits. Eagle-Picher's Quapaw plant was upgraded, allowing the commercial production of 99.999999%-pure material at a capacity of about 2,400 kilograms per year. No other U.S. company produced this grade of material. Demand was down because of cutbacks in defense, the economic recession, and a supply of lower priced foreign material. At yearend, the plant was operating at about 50% capacity.

Primary germanium was recovered from zinc smelter residues. The plant, with a 30,000-kilograms-per-year germanium capacity, produced germanium tetrachloride and germanium dioxide, along with polycrystalline and single-crystal germanium metal. Germanium is a strategic and critical material, used in infrared systems, fiber optics, radiation detectors, semiconductors, and other applications.

Steel.—Sheffield Steel Corp. operated a two-furnace, 400,000-short-ton-capacity minimill in Sand Springs, Tulsa County. The plant produced reinforcing bar and fence posts from scrap. Slag, produced as a byproduct in the steelmaking process at the plant, was sold for aggregate applications to International Mill Service Co., in Sand Springs. Production and

value increased about 4% and 5%, respectively, above 1991 totals.

Uranium.—Uranium oxide, extracted during phosphoric acid manufacture in Florida, was shipped to Sequoyah Fuels Corp. for processing. Sequoyah, owned by San Diego-based General Atomics Inc., operated a uranium processing plant at Gore, Sequoyah County. Uranium hexafluoride, used in producing reactor fuel, was produced from refined ore. The company also produced depleted uranium tetrafluoride.

After reopening in April, the Sequoyah Fuels Corp. uranium processing plant at Gore, Sequoyah County, experienced two more incidents of chemical leaks, resulting in further investigation by the Nuclear Regulatory Commission and increased controversy. The plant was shut down in November. In late December the company received permission to operate on a limited basis to fulfill current contracts for uranium tetrafluoride. The contracts were scheduled to expire during the summer of 1993, at which time uranium tetrafluoride production also was expected to cease. At yearend, controversy arose as to who will pay for the cleanup, anticipated to cost as much as $20 million and to take up to 12 years to complete. Sequoyah was one of four nuclear fuel plants on the Federal "watch list" because of various problems, and one of only two hexafluoride plants in the country.

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[1]State Mineral Officer, U.S. Bureau of Mines, Denver, CO. She has 15 years of mineral-related industry and government experience.

[2]Geologist IV, Oklahoma Geological Survey, Norman, OK.

[3]Oklahoma Employment Security Commission. Labor Market Information Newsletter. V. 2, Issue 12, Dec. 1992.

[4]Work cited in footnote 3.

[5]U.S. Department of Labor, Mine Safety and Health Administration. Mine Injuries and Worktime, Quarterly. Jan. to Dec. 1992.

[6]Minerals Management Service. Mineral Revenues 1992.

[7]Petroleum Information. Resume 1992.

[8]Energy Information Administration. Petroleum Supply Annual, May 1993.

[9]———. Natural Gas Annual, Oct. 1993.

[10]Work cited in footnote 8.

[11]Work cited in footnote 9.

[12]Work cited in footnote 7.

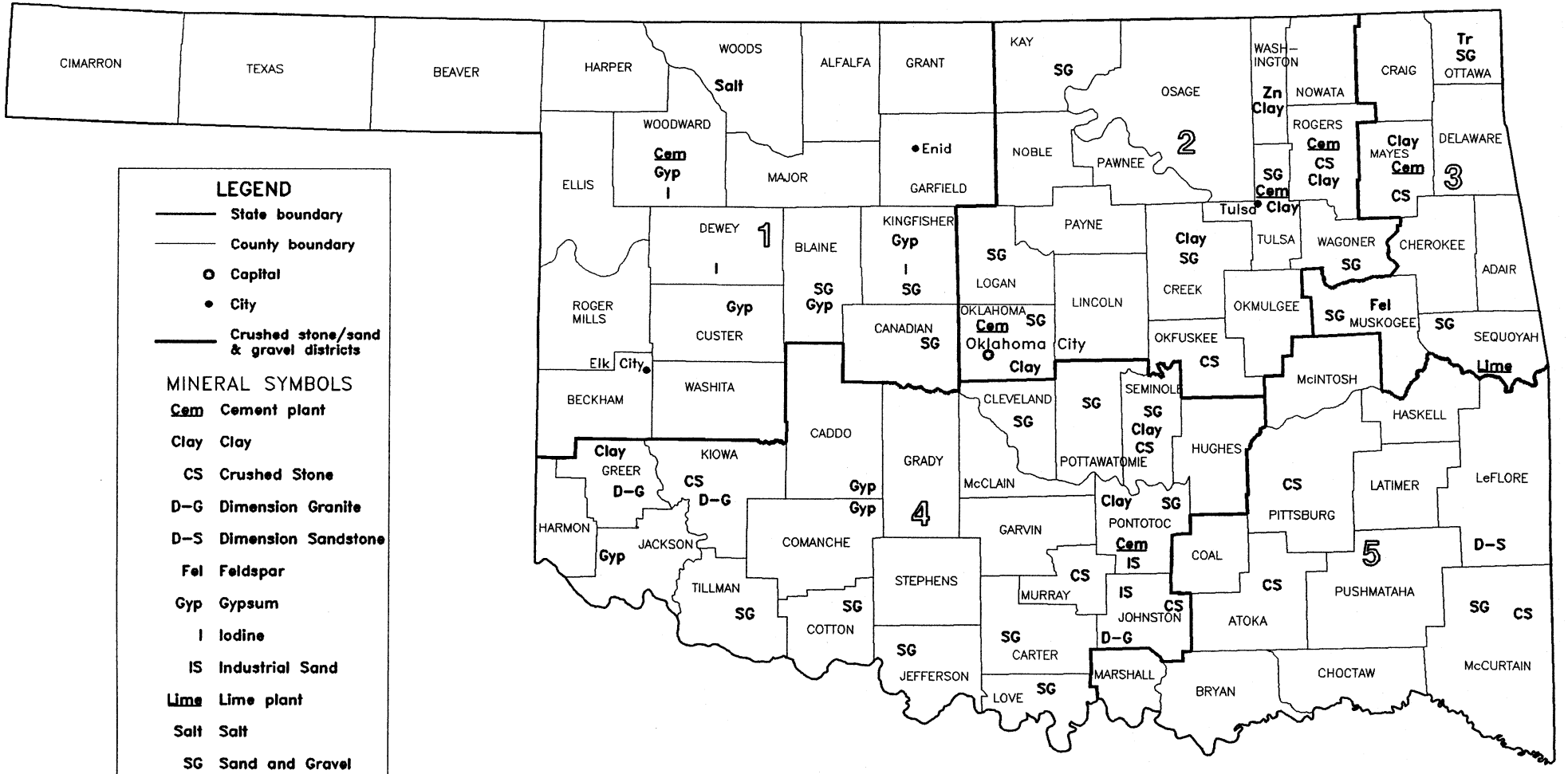
[13]Work cited in footnote 9.

[14]Work cited in footnote 7.

[15]Energy Information Administration. Coal Production 1992, Oct. 1993.

[16]Oklahoma Business Bulletin. Sept. 1992, Dec. 1992, Mar. 1993.

OKLAHOMA



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Cem	Cement plant
Clay	Clay
CS	Crushed Stone
D–G	Dimension Granite
D–S	Dimension Sandstone
Fel	Feldspar
Gyp	Gypsum
I	Iodine
IS	Industrial Sand
Lime	Lime plant
Salt	Salt
SG	Sand and Gravel
Tr	Tripoli
Zn	Zinc

Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Barite:			
Milpark Drilling Fluids	5500 N. Western, Suite 225 Oklahoma City, OK 73118	Plant	Washita.
Old Soldiers Minerals Ltd.	Box 1607 Elk City, OK 73648	do.	Beckham.
Cement:			
Blue Circle Inc., a division of Blue Circle Industries Inc.[1]	2609 N. 145th E. Ave. Tulsa, OK 74116	Quarry and plant	Rogers and Tulsa.
Holnam Inc., Ideal Cement Div., a subsidiary of Holderbank Financiere Glaris, Ltd.[2]	Box 190 Ada, OK 74820	do.	Pontotoc.
Lone Star Industries Inc.[3]	Box 68 Pryor, OK 74362	do.	Mayes, Oklahoma, Woodward.
Clay:			
Acme Brick Co., a division of Justin Industries Inc.	Box 14566 Oklahoma City, OK 73113	Pits and plants	Oklahoma.
Chandler Materials Co., Choctaw Div.	5805 East 15th St. Tulsa, OK 74112	do.	Oklahoma, Rogers, Tulsa.
Commercial Brick Corp.	Box 1382 Wewoka, OK 74801	Pit and plant	Seminole.
Frankoma Pottery Inc.	Box 789 Sapulpa, OK 74066	do.	Creek.
Mangum Brick Co. Inc.	Box 296 Magnum, OK 73554	Pits	Greer.
Washington County	5th and Johnstone Bartlesville, OK 74003	Pit	Washington.
Feldspar:			
Arkhola Sand and Gravel Inc., a division of APAC Arkansas Inc., a subsidiary of Ashland Oil Inc.[4]	Box 1401 Muskogee, OK 74402	Dredge and plant	Muskogee.
Gallium and germanium:			
Eagle-Picher Industries Inc., Specialty Materials Div.	Box 737 Quapaw, OK 74363	Refinery	Ottawa.
Gypsum:			
Harrison Gypsum Co. Inc.	Box 336 Lindsay, OK 73052	Quarry and plant	Caddo.
Heartland Cement Co., Div. of R.C. Cement Co.	Box 407 Watonga, OK 73772	do.	Blaine.
Republic Gypsum Co.	Drawer C Duke, OK 73532	Quarries and plant	Jackson.
Temple-Inland Forest Products Corp.	Box 101 Fletcher, OK 73541	Quarry and plant	Comanche.
United States Gypsum Co., a subsidiary of USG Corp.	Box 100 Southard, OK 73770	do.	Blaine.
Western Plains Material	Box 979 Weatherford, OK 73096	Quarries	Blaine, Custer, Woodward.
Iodine:			
IoChem Corp.	6520 N. Western Ave. Suite 200 Oklahoma City, OK 73116	Oilfield brines and plant	Dewey and Woodward.
North American Brine Resources	5600 N. May, Suite 200 Oklahoma City, OK 73112	do.	Kingfisher and Woodward.
Woodward Iodine Corp., a subsidiary of Asahi Glass Co. Ltd. and Ise Chemical Co.	Box 1245 Woodward, OK 73802	do.	Woodward.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Lime:			
St. Clair Lime Co.	Box 894 Oklahoma City, OK 73101	Underground mine and plant	Sequoyah.
Salt:			
Cargill Inc., Salt Div.	Box 167 Freedom, OK 73842	Solar evaporation	Woods.
Sand and gravel:			
Construction:			
Anchor Stone Co.	8835 S. St. Louis Tulsa, OK 74133	Dredge, pit, plant	Tulsa.
Boorhem-Fields Inc.[5]	Box 206 Hugo, OK 74743	Quarries and plant	Bryan.
Gainesville Sand & Gravel Co.	518 E. Scott Gainesville, OK 76240	Pit and plant	Love.
Haskell Lemon Construction Co. of General Materials Co. Inc.	Box 75608 Oklahoma City, OK 73147	Pits and plant	Cleveland.
The Quapaw Co.[6]	Route 2, Box 1205 Cushing, OK 74023	Quarry	Creek.
Industrial:			
UNIMIN Corp.[7]	Box 159 Roff, OK 74865	Pit and plant	Pontotoc.
U.S. Silica Co.	Box 36, Hwy. 7 North Mill Creek, OK 74856	Pits and plant	Johnston.
Stone:			
Crushed:			
Aggregate Materials	Route 1, Box 220B Snyder, OK 73566	Quarry and plant	Greer and Kiowa.
Amis Materials Co.	Box 417 Atoka, OK 74525	Quarry	Atoka.
Anchor Stone Co. & Tulsa Rock Co., subsidiaries of Anchor Industries Inc.[8]	66th St. N. & 145th E. Ave. Owasso, OK 74055	do.	Rogers.
Big Deal Construction Inc.	Box 302 Warner, OK 74469	do.	Muskogee.
The Dolese Brothers[9]	Box 677 Oklahoma City, OK 73101	Quarries	Atoka, Caddo, Carter, Coal, Comanche, Kiowa, Murray, Pittsburg, Seminole.
Heiskill Gravel Inc.	Box 637 Okemah, OK 74859	Dredge, pits, plants	Okfuskee.
Humble Sand Co.	Box 217 Picher, OK 74360	Open pit and plant	Ottawa.
Meridian Aggregates Co., a subsidiary of Burlington Northern Railroad	Hwy. 1, Box 86 Mill Creek, OK 74856	Quarry	Johnston.
Pittsburg County	Box 268 Haileyville, OK 74546	Plant	Pittsburg.
Pryor Stone Inc.	Box 968 Pryor, OK 74362	Quarry	Mayes.
Rock Producers Inc.	Box 126 Spiro, OK 74959	do.	Le Flore.
S & S Sand	Box 338 Vian, OK 74962	Plant	Sequoyah.
Stigler Stone Co. Inc.	Route 3, Box 90 Stigler, OK 74462	Quarry	Haskell.

See footnotes at end of table.

TABLE 4—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone—Continued:			
Dimension:			
Bodie L. Anderson Quarries Inc.	Box 106 Mill Creek, OK 74856	Quarry	Johnston.
Miller Stone Co.	Route 1 Hackett, AR 72937	do.	Le Flore.
Texas Granite Corp.	202 S. 3d Ave. Cold Springs, OK 56320	Quarries	Greer and Kiowa.
Willis-Oklahoma Red Granite Inc.	900 Quarry Dr., Box 867 Granite, OK 73547	do.	Greer.
Tripoli:			
American Tripoli Inc.	222 Oneida, Box 489 Seneca, MO 64865	Open pits	Ottawa.
Volcanic materials:			
Axtell Mining Corp.	Box 92 Gate, OK 73844	Open pit	Beaver.
Kendon Co.	Route 2, Box 122A Wetumka, OK 74883	do.	Okfuskee.
Western Rock Products Inc.[10]	Box 599 Davis, OK 73030	do.	Dewey and Murray.
Zinc:			
Zinc Corp. of America, a division of Horsehead Industries Inc.[11]	Box 579 Bartlesville, OK 74005	Electrolytic refinery	Washington.

[1]Also clay and crushed stone in Rogers County.
[2]Also clay and crushed stone in Pontotoc County.
[3]Also clay and crushed stone in Mayes County.
[4]Also industrial sand in Muskogee County and crushed stone in Cherokee, Kay, and Tulsa Counties.
[5]Also crushed stone in Choctaw, Johnston, Marshall, and McCurtain Counties.
[6]Also crushed stone in Creek and Pawnee Counties.
[7]Also crushed stone in Pontotoc County.
[8]Also crushed stone in Rogers County.
[9]Also construction sand and gravel in Canadian, Kingfisher, Logan, Oklahoma, and Love Counties.
[10]Also crushed stone in Murray County.
[11]Also sulfuric acid; copper, lead, and silver residues; and cadmium balls.

THE MINERAL INDUSTRY OF OREGON

By Rodney J. Minarik[1]

Nonfuel mineral production value in Oregon in 1992 was $214.2 million, an increase of more than 8% from that of 1991, according to the U.S. Bureau of Mines (USBM). Increases in the production value for portland cement and construction sand and gravel more than offset a decline in the estimated value for crushed stone. Industrial minerals accounted for the bulk of the State's total nonfuel mineral production value. The State ranked 38th in the Nation in that value, unchanged from 1991. Oregon was the Nation's sole producer of emery and nickel in 1992; the State ranked first in the quantity of pumice produced, third in the production of diatomite, and was a significant producer of processed natural zeolite.

TRENDS AND DEVELOPMENTS

Construction materials—portland cement, construction sand and gravel, and crushed stone—continued to be the most valuable minerals produced, accounting for almost 85% of the State's total mineral production value. Metals production reported to the USBM included copper, gold, nickel, silver, and zinc. Highlights for the year included the opening of Glenbrook Nickel Co.'s new port facilities at Coos Bay, where nickel will be imported from New Caledonia for feed at its nickel smelter at Riddle; Newmont Mining Corp.'s acquisition of Atlas Precious Metals Inc.'s Grassy Mountain gold project; and the adoption of Oregon Department of Environmental Quality's (DEQ) rules regarding heap leaching into the House bill 2244 implementation plan.

EMPLOYMENT

According to the Research, Tax and Analysis Section of the Oregon Employment Division, Department of Human Resources, the State's 1992 mining and quarrying employment was

TABLE 1
NONFUEL MINERAL PRODUCTION IN OREGON[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland)	thousand short tons	W	W	e249	e$18,675	W	W
Clays	metric tons	223,452	$1,390	213,356	1,086	2202,530	2$326
Copper[3]	do.	—	—	W	W	152	361
Gemstones		NA	1,683	NA	2,758	NA	2,723
Nickel ore[4]	metric tons	330	NA	5,523	NA	6,671	W
Sand and gravel (construction)	thousand short tons	15,785	60,928	e15,600	e62,800	16,488	69,536
Silver[3]	metric tons	W	W	—	—	(5)	1
Stone (crushed)[6]	do.	e18,000	e86,600	20,608	89,322	e16,800	e74,900
Talc and pyrophyllite	metric tons	105	10	63	67	64	67
Zinc[4]	do.	—	—	751	873	—	—
Combined value of cement (masonry), clays [bentonite (1992)], diatomite, emery, gold (1990, 1992), lime, pumice, silver (1990), stone [crushed dolomite and quartzite (1990), crushed slate (1991-92)], and values indicated by symbol W		XX	53,984	XX	22,347	XX	66,256
Total		XX	204,595	XX	197,928	XX	214,170

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" data.
[3]Recoverable content of ores, etc.
[4]The Riddle nickel smelter uses lateritic ore mined on Nickel Mountain, lateritic ore imported from New Caledonia, and small tonnages of recycled Ni-bearing catalysts. In 1989, the Glenbrook Nickel Co. purchased the idled mining and smelting complex and restarted the operation. Since then, production of ferronickel on a contained Ni basis has been as follows: 1990—3,701 metric tons valued at $32.8 million; 1991—7,065 metric tons valued at $57.6 million; and 1992—8,962 metric tons valued at $62.7 million.
[5]Less than 1/2 unit.
[6]Excludes certain stones; kind and value included with "Combined value" data.

1,500 workers, a decrease from the 1,600 workers reported for 1991. Reflecting the weakness of the State's aluminum reduction industry, employment in the nonferrous metals segment of Oregon's primary metals industry decreased to 4,700 workers from 5,400 in 1991. Blast furnace and iron and steel foundry employment fell to 5,800 in 1992, a decrease of 200 from that of 1991. Weekly wages for primary metals industry workers averaged $536.50 for a 39.8-hour workweek.

ENVIRONMENTAL ISSUES

Implementation of Oregon House bill 2244, sometimes referred to as the chemical process mining or cyanide heap-leaching bill, came closer to reality. The bill was passed by the Oregon Legislature in 1991. In September, the Environmental Quality Commission (EQC) adopted DEQ's regulations regarding heap leaching, including the design of protective liners for heap-leach pads, preventive measures to keep wildlife from coming in contact with hazardous substances, detoxification standards, and monitoring procedures. Regulations by the State's Department of Geology and Mineral Industries (DOGAMI), the Water Resources Department, and the Department of Fish and Wildlife already had been finalized and adopted earlier. The rules passed by the EQC are designed to prevent acids, cyanide, and heavy metals produced by heap leaching from entering the environment. The bill does not apply to those using flotation milling. Both environmentalists and the mining industry agreed that the rules are probably the most restrictive in the Nation. The bill specified that DOGAMI would have the lead coordination role in rewriting the rules and that multiple permits from several State agencies will remain necessary.

EXPLORATION ACTIVITIES

According to DOGAMI, Oregon mineral exploration activity in 1992 was somewhat mixed. On the plus side, exploration and permitting continued at a number of established sites, the number of small-scale operators in eastern Oregon requesting environmental assessments rose, and in southwest Oregon, many smaller operators attempted to patent their projects. On the downside, USDA Forest Service officials reported that exploration by major mining companies in the Wallowa-Whitman, Umatilla, and Malheur National Forests was down, and U.S. Bureau of Land Management (BLM) officials in eastern Oregon districts generally reported little exploration activity overall.

Newmont Mining acquired Atlas Precious Metals Grassy Mountain gold project. The proposed open pit site is about 40 kilometers south of Vale near the Owyhee Reservoir in Malheur County. Reportedly, the Grassy Mountain project has probable reserves of 31,000 kilograms of gold and 76,700 kilograms of silver. Atlas's operating plan had included mining of the oxide ore body with two open pits using heap-leach cyanidation. Mine life was projected to be at least 8 years. The 35-year lease, with options for 3 additional 10-year periods, included both Grassy Mountain and the Musgrove Creek property in Idaho.

In Baker County, Golconda Resources Ltd. drilled and reopened some old tunnels at the Gold Hill Mine. Cracker Creek Gold Mining Co. and Cable Cove Mining Co. continued small-scale exploration efforts at their Bourne and Herculean projects, respectively. At the Herculean project, 30 tons of concentrates was tested for gold and base metals.

In Malheur County, ICAN Mineral Ltd. drilled at the Racey gold property, Western Mining maintained its Freeze property, and in the Dry Creek Buttes area, Battle Mountain Gold kept its Freezout claims. Cyprus Metal Exploration and Development Co. retained interest in the Red Butte and Mahogany projects. The Red Butte project was contingent upon a BLM decision of whether to remove it from a Wilderness Study Area designation. Drilling was done by Carlin Gold in the Stockade area and by Western Epithermal at its Shell Rock Butte property. Malheur Mining continued work on its Kerby-East Ridge property, although a suit was filed against the BLM for its environmental assessment of the project. Earth Search Sciences conducted surface studies and a geochemical evaluation at Shasta Butte.

In Grant County, Formation Capital Corp. reduced the size of its Mammoth project claim block by 50%. The Mammoth property is a copper-gold and gold-silver prospect. After leasing the Copperopolis and Standard prospects, Placer Dome conducted surface surveys late in the year. Noranda drilled its Flag prospect in the Flagstaff Butte area of Harney County. Carlin Gold continued work at Buck Mountain in Harney and Malheur Counties.

In Lake County, Pegasus Gold recommitted itself to the Quartz Mountain prospect. The joint venture of Pegasus Gold and Wavecrest Resources Inc., a subsidiary of Quartz Mountain Gold Corp., maintained the gold property, 53 kilometers west of Lakeview. The property contains the Crone Hill and Quartz Butte deposits and associated underground feeder veins. Work was done under the direction of Pegasus Gold which, according to DOGAMI, noted anxiety about the low grade and refractory nature of the deposit. The heap-leach project would initially concentrate on an oxide ore zone, followed by possible development of a large disseminated sulfide resource.

In western Oregon, Plexus Inc., a subsidiary of Plexus Resources Corp., continued permitting activities on its Bornite copper-gold-silver project, 19 kilometers northeast of Mill City in the North Santiam Mining District, Marion County. The company was seeking permission from USDA Forest Service officials at the Willamette National Forest to develop the underground mine about 80 kilometers east of Salem. The permitting process continued, and a preliminary environmental impact statement (EIS) was distributed for public review. The EIS said the project would have no anticipated, significant, long-term adverse impact on the environment if

Plexus implements Forest Service recommendations on proposed mitigation measures and monitoring plans during mine construction.

In western Coos County, Oregon Resources Corp., a subsidiary of Rare Earth Resources Ltd., continued to acquire necessary permits while evaluating the extent of its resource of onshore black sands in the Seven Devils area. Black sands are alluvial or beach sands concentrated chiefly by wave, current, or surf action and contain valuable minerals, such as chromite, garnet, zircon, and titanium compounds. The project is in the prefeasibility stage, and the identification of possible markets was ongoing.

In Josephine County, Cominco American Resources Inc., after further evaluation, returned its interest in the Turner-Albright copper-zinc-gold prospect, near O'Brien, to Savanna Resources Ltd. Walt Freeman, an independent mining engineer, was in the process of patenting nickel claims in the Rough and Ready Creek drainage of Josephine County; the laterite ore also contained chrome and iron values. Dragon's Gold did project maintenance at the Martha Mine in the Greenback district.

LEGISLATION AND GOVERNMENT PROGRAMS

A study, funded by the USDA Forest Service, was undertaken to determine whether the old Sumpter dredge, sited in a scenic alpine valley in eastern Oregon's Elkhorn Mountains, should become the main attraction for a new State park. A team of engineers, architects, and interpretive consultants examined the 1,130-metric-ton gold mining dredge to assess its structural condition and to determine what improvements would be necessary to transform it into a visitor attraction. If approved, the park also would include the Sumpter Valley Railroad, which hauled gold ore to Baker City from 1890 to 1947.

Significant developments in several areas were achieved at the USBM Albany Research Center (ALRC). For example, scientists at ALRC used liquid emulsion membranes to extract copper from leach solutions and remove metal contaminations from samples of acid mine drainage. The emulsion contains an organic compound that attracts a particular metal and a stripping agent in an aqueous solution. In laboratory tests, scientists used the membranes to remove up to 97% of the copper and 96% of the zinc contained in samples of acid mine drainage. They obtained similar results recovering copper from mineral processing leach solutions. Field tests for the technology are being conducted with a new mobile demonstration unit at a copper mine in San Manuel, AZ.

As part of an interagency agreement between the USBM, the Idaho National Engineering Laboratory (INEL), and the U.S. Department of Energy, a series of tests was completed to study the feasibility of melting low-level, radioactive wastes. More than 18 metric tons of simulated radioactive wastes was melted at ALRC's state-of-the-art water-cooled, fully instrumented, 0.9-metric-ton electric arc vitrification furnace with ancillary feed and offgas systems. The goal of the project was to determine whether the low-level transuranic elements found in the radioactive wastes can be encapsulated safely in the slag produced by the furnace. This would be a long-term solution to leaching problems inherent with the past practice of landfilling these waste residues.

Aircraft engine manufacturers are testing cast titanium aluminide components to increase the operating temperatures of commercial jet engines. Also, titanium aluminides can decrease the weight of an engine compared with engines containing nickel-base alloys. As with most castings, however, a certain amount of repair welding of defects is necessary. Currently, welding wire cannot be obtained for less than $2,200 per kilogram because titanium aluminides are very brittle and are not easily fabricated to welding wire diameters. ALRC scientists have demonstrated a means to reduce significantly the welding wire costs. Small-diameter, very thin-wall niobium tubes are filled with titanium and aluminum powders. The tubes are sealed on the ends and cold pressed to 345,000 kilopascals, partially collapsing the tubes and compressing the powders. The tubes are heated to 700 degrees C. At this point a self-sustaining, high-temperature reaction takes place to transform the elemental powders to titanium aluminides.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Cement.—Cement production in Oregon increased in both tonnage and value from that of 1991. Ash Grove Cement West Inc., the State's sole cement producer, operated a cement plant and limestone quarry near Durkee, Baker County. The plant, equipped with a preheater kiln, is considered state of the art.

Almost all of the cement output was general use and moderate heat Types I and II gray portland cement; a small quantity of masonry cement also was produced. The bulk of the portland cement produced in the State was used by ready-mixed companies; other users included building materials dealers, concrete product manufacturers, government agencies, and highway and other contractors. The Durkee plant was fueled almost exclusively by natural gas. The cement rock (limestone) used in the manufacture of cement was mined from a nearby pit. Virtually all of the production from the Durkee operation leaves the plant in bulk by truck or rail.

Clays.—Total clay production in Oregon increased 4% in quantity and more than 10% in value from that of 1991. Two types of clay were produced in Oregon—bentonite and common clay.

Bentonite production increased more than 2% in quantity and 11% in value from that of 1991. According to the USBM survey, three companies in two counties accounted for Oregon's bentonite production. Evergreen Bentonite Inc. and

Central Oregon Bentonite Co. ranked first and third, respectively, in the State in quantity produced. They produced bentonite from adjoining properties on Camp Creek, 64 kilometers southeast of Prineville, Crook County. Teague Mineral Products Co., south of Adrian, Malheur County, was the State's second largest producer of bentonite clay. Teague's premium-grade sodium bentonite was mined in northern Malheur County. The material was sold for soil sealant at waste disposal sites, ditches, and ponds; for drilling mud; and as sealant for abandoned drill holes.

Common clay, used chiefly in bricks, cement, and ceramic tile, was mined in Baker, Jackson, Klamath, Lane, and Multnomah Counties. Ash Grove Cement was the State's leading producer; other producers reporting included Columbia Brick Works and Klamath Falls Brick and Tile Co.

Diatomite.—Diatomite production in Oregon rose almost 3% in quantity and 9% in value from that of 1991; the State ranked third in quantity and fourth nationally for diatomite production value. Eagle-Picher Industries Inc. mined diatomaceous earth from Miocene lake sediments at a surface operation in the Juntura Basin, along the Malheur-Harney County line. The diatomite was trucked 70 miles to the company's Celatom diatomite processing facility west of Vale, Malheur County. Production was used for filter aids in water and food processing and for pharmaceuticals, and markets included Japan.

Oil-Dri Production Co. operated both an open pit and a diatomite processing facility in Christmas Valley, Lake County. The company shipped worldwide in bags and in bulk. The diatomite was used as an oil absorbent and was sold under several brand names as pet litter.

Emery.—Oregon Emery Co., of Halsey, produced emery from a deposit in eastern Linn County. At a plant south of Albany, the material was crushed and screened to specific particle shapes and size ranges and was primarily used in skid-resistant and hardened surfaces, such as industrial floors, ramps, and traffic ways, and on steel-bridge decking. Oregon was the only State to report emery production in 1992.

Gemstones.—The value of Oregon's gemstone production decreased from that of 1991. Although not actually a gem, the thunderegg, Oregon's State rock, may be the State's most well-known gem material. Thundereggs were collected at many sites throughout the State. Some of the most popular collection sites were the Madras-Prineville area, which includes the counties of Crook, Jefferson, and Wheeler; near Burns, Harney County; near Lakeview, Lake County; and in the Succor Creek area in Malheur County. Gem-quality calcium plagioclase, commonly referred to as sunstone or heliolite, was the largest contributor to the State's gemstone production value. Sunstone, a variety of feldspar, is Oregon's official gemstone. The production of sunstone occurred at three areas in Harney and Lake Counties. Opal also contributed significantly to Oregon's gemstone production. Other notable Oregon gemstones produced included various picture and scenic jaspers, agates, and petrified wood.

Lime.—Lime production increased almost 4% in quantity and nearly 9% in value from that of 1991. Quicklime accounted for the bulk of Oregon's production, almost 86% of the total lime produced in 1992. Ash Grove Cement was the State's largest producer. At Portland, Multnomah County, the company sold both quicklime and all of the State's hydrated lime. Hydrated lime was produced by Ash Grove at a kiln in Portland. High-calcium limestone was barged in from Ash Grove's quarry on Texada Island near Vancouver, British Columbia, Canada, and used as the plant's feedstock. Production was consumed by local steel, chemical, and paper industry markets.

Amalgamated Sugar Co. purchased high-purity crushed limestone from Ash Grove's Durkee pit, Baker County, for use as "sugar rock" feedstock at its plant in Nyssa, Malheur County. Amalgamated Sugar calcined the limestone to produce quicklime for use in the processing of beet sugar.

Perlite.—Expanded perlite production in Oregon increased in both quantity and value from that of 1991. Supreme Perlite Co. manufactured expanded perlite at its plant in Portland. Some of the raw perlite it processed came from the company's mine on Dooley Mountain, Baker County. Other companies reporting production included Armstrong World Industries Inc. and Georgia Pacific Corp. Expanded perlite was used in the production of cryogenic, horticultural, masonry, and construction products.

Pumice.—Oregon pumice production ranked first nationally for tonnage produced. Production increased more than 6% in quantity and almost one-third in value from that of 1991. In the Bend area, Deschutes County, Cascade Pumice Co. and Central Oregon Pumice Co. produced pumice from surface mines and operated crushing and screening plants. Cascade Pumice, the State's largest producer, mined pumice from two open pits and operated a quarry that produced red volcanic cinders. Central Oregon Pumice also produced pumice from two open pits and quarried red volcanic cinders from two additional sites. Both companies served markets in northern California, Oregon, Washington, and British Columbia by truck and railroad. The processed pumice was sold for a variety of uses, including lightweight concrete aggregate, building and decorative block, landscaping, road construction and maintenance, roofing, horticulture, and in the manufacture of stone-washed jeans.

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains

TABLE 2

OREGON: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	4,410	$17,820	$4.04
Plaster and gunite sands	70	572	8.17
Concrete products (blocks, brick, pipe, decorative, etc.)	174	619	3.56
Asphaltic concrete aggregates and other bituminous mixtures	3,150	15,917	5.05
Road base and coverings[1]	3,993	16,002	4.01
Fill	625	1,723	2.76
Snow and ice control	112	544	4.86
Railroad ballast	W	W	4.64
Other miscellaneous uses[2]	16	87	5.44
Unspecified:[3]			
Actual	1,074	4,446	4.14
Estimated	2,863	11,806	4.12
Total	[4]16,488	69,536	4.22
Total[5 6]	14,958	69,536	4.65

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

estimates for 1991 and actual data for 1990 and 1992.

Construction sand and gravel production for Oregon increased almost 6% in quantity from that estimated in 1991 and more than 4% from that surveyed in 1990. Production value increased almost 11% from that estimated in 1991 and 14% from that surveyed in 1990. Oregon construction sand and gravel statistics are compiled by geographical districts, as depicted on the State map. District 1, representing the northwest part of the State, accounted for more than 78% of the surveyed output. Production was reported from 29 of Oregon's 30 counties, with Clackamas, Colombia, Lane, Marion, and Multnomah among the leading producers.

Major uses included concrete aggregates, including concrete sand (27%); road base and coverings (24%); and asphaltic concrete aggregates and other bituminous mixtures (19%). Table 3 presents end-use data for construction sand and gravel in the four Oregon districts. The bulk of the construction sand and gravel was transported by truck; lesser quantities were moved by waterways and other methods.

Industrial.—Silica sand was produced by CooSand Corp. from dune sands mined on the north shore of Coos Bay, Coos County. The sand was shipped by rail to a plant in the Portland area, where the bulk of it was processed to meet specifications for container glass manufactured by Owens-Illinois in Portland. The rest was used for sandblasting sand and railroad traction sand.

Stone.—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains actual data for 1991 and estimates for 1990 and 1992.

Oregon crushed stone production decreased in both quantity and value from that reported in 1991. Reflecting the predominantly volcanic nature of the State's geology, the bulk of Oregon's crushed stone was traprock (basalt). Other types included granite, limestone, sandstone, and volcanic cinder and scoria. Klamath, Lane, Multnomah, Washington, and Yamhill Counties were among the leading crushed stone producers. The uses for crushed stone in Oregon during the year included graded road base, unpaved road surfacing, bituminous aggregate, and crusher run or fill.

Talc (Soapstone).—Steatite of Southern Oregon Inc. produced high-grade variegated-colored soapstone from deposits on Elliott Creek Ridge in the Klamath Mountains at the southern edge of Jackson County. The principal product was asbestos-free sculpture stone in a variety of colors, which was marketed worldwide for art carving and other specialty uses.

Zeolite.—Teague Mineral mined clinoptilolite from deposits in the Succor Creek Formation in Malheur County. Although a number of Oregon zeolite deposits have been documented, Teague Mineral was the only company known to commercially mine a natural zeolite product in Oregon in 1992. Along with ore from deposits in southwest Idaho, the mine output was processed at the company's mill near Adrian and sold for ammonia absorbent in aquarium systems, animal feed supplement, anticaking agents, fungicide carriers, odor control, and wastewater treatment. The company marketed its products both domestically and internationally.

Metals

Aluminum.—Oregon's primary aluminum production decreased in quantity and value from that of 1991. Aluminum essentially maintained its price at $0.58 per pound after falling from

TABLE 3

OREGON:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	3,455	14,333	689	2,254	W	W	W	W
Plaster and gunite sands	45	408	W	W	—	—	W	W
Concrete products (blocks, brick, etc.)	124	459	W	W	—	—	W	W
Asphaltic concrete aggregates and other bituminous mixtures	2,524	13,131	476	2,134	W	W	W	W
Road base and coverings[2]	2,929	11,932	569	2,119	25	129	470	1,821
Fill	357	1,040	190	537	W	W	W	W
Snow and ice control	W	W	W	W	—	—	—	—
Railroad ballast	W	W	—	—	—	—	—	—
Other miscellaneous uses	71	366	125	525	46	178	454	1,917
Unspecified:[3]								
Actual	1,037	4,298	4	18	—	—	—	—
Estimated	2,352	9,063	—	—	—	—	511	2,743
Total[4]	12,895	55,030	2,054	7,588	70	307	1,435	6,481
Total[5 6]	11,698	55,030	1,863	7,588	64	307	1,302	6,481

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Excludes 33,176 short tons valued at $129,718, not reported by county.
[2]Includes road and other stabilization (cement).
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

$1.10 per pound in 1988 to $0.74 per pound in 1990.

Reynolds Metals Co.'s smelter at Troutdale remained temporarily closed. It was closed in December 1991, reportedly as a result of economic conditions. The plant has a rated ingot capacity of 121,000 metric tons per year. Only the casthouse, that portion of the plant that turns metal cast into ingot, remained open. Reynolds had imported alumina from Australia and Jamaica to be processed at the Multnomah County facility.

Northwest Aluminum Co. maintained production at its tolling smelter near The Dalles in Wasco County. The company operated the 82,000-metric-ton-per-year plant at near capacity under a lease-purchase agreement signed in 1986 with Martin Marietta Corp. The alumina used at the smelter was obtained from Australia.

Columbium, Hafnium, Tantalum, Titanium, and Zirconium.—Teledyne Wah Change Albany (TWCA), a major producer of columbium, produced high-quality columbium materials for use in columbium-bearing alloys for jet engines, aerospace applications, chemical processing equipment, and superconductor applications at its plant in Albany, Linn County. Products produced included columbium pentoxide, high-purity ferrocolumbium, nickel columbium, and columbium metal. With the addition of a new furnace, TWCA expects to increase its electron beam melting capacity for columbium by 360,000 pounds to 1.3 million pounds annually, about 38%. The new furnace will be used primarily to melt and purify columbium, but also will be used to melt columbium-base alloys, vanadium, titanium, zirconium, and hafnium. The upgrade, which expands on the company's four existing electron beam furnaces, was expected to take 4 years to complete.

TWCA was one of only two domestic producers of zirconium metal sponge and ingot. Zirconium, a strong metal transparent to radiation, was used principally in nuclear reactors, in superalloys for the aerospace and defense industries, and in flash bulbs. A byproduct of zirconium production, TWCA produced hafnium metal as sponge and crystal bar. Major markets for hafnium metal included nuclear reactor control rods, ceramics, refractories, aerospace alloys, and optical fibers. Tantalum produced by TWCA continued to be used primarily for aerospace engine components.

Oregon Metallurgical Corp. (OREMET) was one of only three U.S. companies that produced titanium sponge. With 10 reduction furnaces, OREMETS's titanium plant at Albany, Linn County, had a rated capacity of 6,800 metric tons per year. An on-site magnesium plant

was used to support titanium sponge output. OREMET signed a multiyear contract to supply titanium sponge to RMI Titanium Co. Although the size of the contract was not revealed, it was reported that OREMET had to increase its production rate to fulfill the terms of the agreement. This was the first full year of operation for OREMET's new vacuum-creep flattener, a plate rolling system for titanium. The flattener produces a high-quality plate demanded by the aerospace and fabrication industries. The finished plate is shipped directly to large customers or to distributors for further processing and resale to smaller end users. Also, in a joint venture with Oregon Steel Mills Inc., Oregon Steel Mills converted OREMET's titanium slab into plate. In the past, OREMET employed several steel rolling mills in Pennsylvania for its plate conversion, but under terms of the joint venture, most of the work will be done at Oregon Steel's Portland plant. The agreement benefited OREMET by reducing transportation costs and cutting lead times..

Both OREMET and TWCA produced titanium ingot at their Oregon plants; TWCA's ingot was used in-house.

Copper and Zinc.—Formosa Exploration Inc., a subsidiary of Formosa Resources Corp. of British Columbia, mined copper and zinc ore from its Silver Peak underground mine; a minor amount of gold also was produced. The Koroku-type massive sulfide deposit is sited on a ridge about 16 kilometers south of Riddle in Douglas County. Several thousand metric tons of ore was stockpiled. Concentrates produced at the company's 360-metric-ton-per-day mill were trucked to Vancouver, WA, then shipped to Japan for further processing. Formosa received financial funding and technical support from the Metal Mining Agency of Japan (MMAJ) as part of a program to expand company reserves.

Gold.—Oregon's gold production came mainly from small placer mines in southwestern and northeastern parts of the State. The Bonnanza Mine, a placer operation on Pine Creek near Halfway, Baker County, was the State's largest gold producer. The mine was closed in July, then reclamation work and exploration extending into nearby properties was done.

DOGAMI reported small placer activities on Sucker Creek, Josephine Creek, and in the Galice area in Josephine County; on Deer Creek, Elk Creek, Pine Creek, and in the Rye Valley in Baker County; in the Morman Basin near the Baker County-Malheur County line; in the Greenhorn area in Baker and Grant Counties; and on Big Creek in Grant County.

Nickel.—The joint venture of Glenbrook Nickel Co., a wholly owned subsidiary of Cominco Resources International Ltd. and Cominco American Inc., operated the Nation's only nickel smelter near Riddle, Douglas County. A highlight of the year was the opening of Glenbrook Nickel's new port facilities at Coos Bay. The facilities are capable of off-loading, crushing, and drying both wet and dry nickel ore from New Caledonia. The ore was trucked to the company's smelter at Riddle. Although imported ore was used as smelter feed during 1992, ore from Glenbrook Nickel's adjacent Nickel Mountain Mine provided the bulk of the feed. According to Cominco Ltd.'s 1992 annual report, the smelter produced 8,962 metric tons of nickel in contained ferronickel. Applying the average London Metal Exchange (LME) cash price for 1992, the value of the ferronickel was estimated at $62.7 million. In November, the company announced that because of the downturn in worldwide markets, it would temporarily close its facilities for at least 5 weeks at yearend.

Glenbrook Nickel's subsidiary, Green Diamond Abrasive Co., manufactured products from slag left over after the nickel is removed from the ore. The abrasives plant, just north of Riddle, was purchased from the Reed Minerals Co. in 1991. The slag, an abrasive, with sharp granules ranging in size from BB pellets to fine sand, is screened and sized and used primarily in sandblasting; other uses include roofing granules and backing sand for shingles.

Silicon Metal and Ferrosilicon.—Silicon metal was produced by Dow Corning Corp. at its facility in Springfield, Lane County. The product was used exclusively for the company's silicon-base chemical operations in Michigan and Kentucky. Using a single 17.5-megawatt electric furnace, the Springfield plant is capable of producing about 9,000 metric tons of silicon metal annually. The plant's electric power was supplied by Bonneville Power Administration, and all the raw materials reportedly are obtained domestically.

Steel.—Cascade Steel Rolling Mills Inc., operators of a minimill in McMinnville, Yamhill County, completed the first full year of operation of its new melt shop. Construction of the plant, capable of producing more than 540,000 metric tons annually, was completed in 1991 by Danieli S.p.A., an Italian equipment manufacturer. The increased billet production was expected to correct a raw steel shortfall at the McMinnville plant. This allows the company to make outside billet sales and could lead to a new rolling mill capable of producing wire rod, which has not been produced in the West for about a decade. Cascade is owned by Schmitzer Steel Products, a private, family-controlled company.

Oregon Steel Mills Inc., an employee-owned business, produced steel slab and plate at a plant in Portland. The Portland-based steelplate and pipe producer used the plant's production to supply slab to its plate mill in Fontana, CA, and plate to its pipe mill in Napa, CA. The company awarded a contract to design and build a new hot plate leveler to achieve a higher standard of flatness. The leveler will allow the company to ship 85% to 99% of its heat-treated production at one of the steel industry's highest flatness specifications. Also, the equipment was designed to accomplish the task in one pass. The demand for flatness is a result of the welding precision necessary by fabricators and

manufacturers. A new tank-type ladle degasser, designed to treat 77 metric tons of carbon and low-alloy grades of steel, also was put out for contract. Currently, Oregon Steel's largest single pipe order calls for the company to supply more than 1,045 kilometers of 0.9-meter and 1.1-meter double-submerged arc-weld line pipe for use on the Pacific Gas Transmission-Pacific Gas & Electric Pipeline expansion project.

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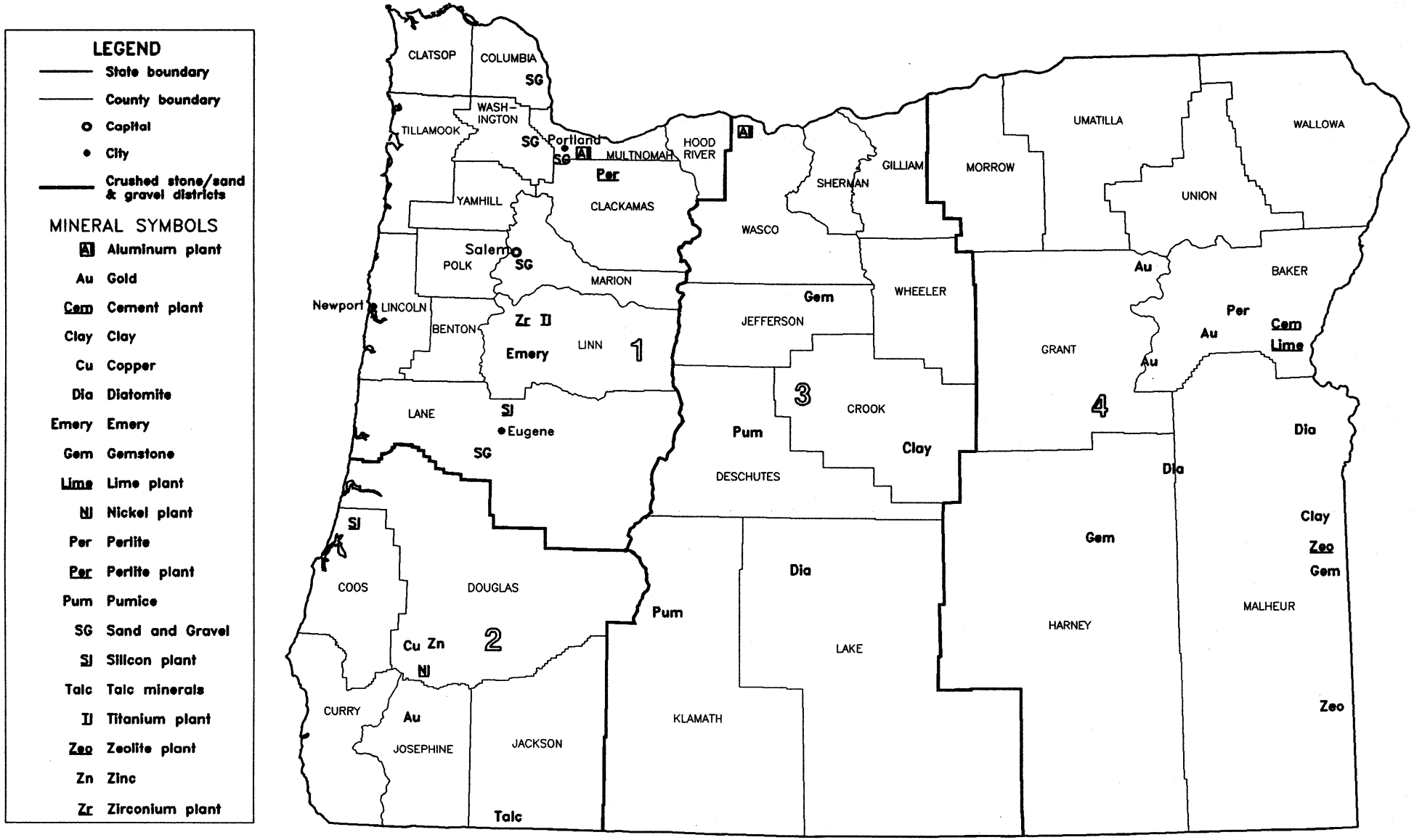
[1]State Mineral Officer, U.S. Bureau of Mines, Spokane, WA. He has 18 years of mineral-related experience in industry and government and has covered the mineral activities in Oregon since 1989. Assistance in preparation of the chapter was given by W. A. Lyons, editorial assistant.

OREGON



Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Aluminum:			
Northwest Aluminum Co.	3313 West 2d St. The Dalles, OR 97058	Smelter	Wasco.
Cement:			
Ash Grove Cement West Inc.	6720 SW Macadam Ave. Suite 300 Portland, OR 97219	Plants and quarries	Baker.
Copper:			
Formosa Exploration Inc.[1]	Box 108 Riddle, OR 97469	Underground mine	Douglas.
Diatomite:			
Eagle-Picher Industries Inc.	Graham Blvd. Vale, OR 97918	Surface mine and plant	Harney and Malheur.
Oil-Dri Production Co.	Box 191 Christmas Valley, OR 97638	do.	Lake.
Emery:			
Oregon Emery Co.	3505 SW Pine St. Albany, OR 97321	do.	Linn.
Gold:			
Bonnanza Mining Inc.	Box 873 Halfway, OR 97834	Placer mine	Baker.
Lime:			
Amalgamated Sugar Co.	Box 1766 Nyssa, OR 97913	Plant	Malheur.
Ash Grove Cement West Inc.	6720 SW Macadam Ave. Suite 300 Portland, OR 97219	do.	Multnomah.
Nickel:			
Glenbrook Nickel Co.	Box 85 Riddle, OR 97469	Smelter	Douglas.
Perlite (expanded):			
Supreme Perlite Co.	4600 North Suttle Rd. Portland, OR 97217	Plant	Multnomah.
Pumice:			
Cascade Pumice Co.	Box 1087 Bend, OR 97701	Pit	Deschutes.
Central Oregon Pumice Co.	5 NW Greenwood Ave. Bend, OR 97701	Pit	Do.
Sand and gravel (construction):			
Delta Sand & Gravel Co.	999 Division Ave. Eugene, OR 97404	Pit	Lane.
Lone Star Northwest Aggregates	3510 SW Bond St. Portland, OR 97201	Pits	Columbia and Washington.
Morse Brothers Inc.	Box 7 Lebanon, OR 97355	do.	Benton, Linn, Marion.
Ross Island Sand & Gravel Co.	4315 SE McLoughlin Blvd. Portland, OR 97202	Pit	Multnomah.
Talc (soapstone):			
Steatite of Southern Oregon Inc.	2891 Elk Lane Grants Pass, OR 97527	Surface mine and mill	Jackson.
Titanium:			
Oregon Metallurgical Corp.	Box 580 Albany, OR 97321	Smelter	Linn.

See footnotes at end of table.

TABLE 4—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Zeolite:			
Teague Mineral Products Co.[2]	1925 Hwy 201 South Adrian, OR 97901	Surface mine and plant	Malheur.
Zirconium:			
Teledyne Wah Chang Albany Corp.[3]	Box 460 Albany, OR 97321	Plant	Linn.

[1]Also zinc.
[2]Also bentonite.
[3]Also columbium, hafnium, tantalum, titanium, and vanadium.

THE MINERAL INDUSTRY OF PENNSYLVANIA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Pennsylvania Bureau of Topographic and Geologic Survey, Department of Environmental Resources, for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.,[1] and Samuel Berkheiser[2]

The value of nonfuel mineral production in Pennsylvania increased slightly in 1992 to about $879 million. Despite the small gain, demand for minerals remained well below the levels that existed from 1987 through 1990. During that period, the State's production of nonfuel minerals exceeded $1 billion in value each year. The decline in the construction industry was the main economic driver that impacted the production of minerals in Pennsylvania.

Output of coal and steel in 1992 also remained about the same as that in 1991. Production of these commodities has remained stagnant for the past 2 years, indicative of conditions in the State's manufacturing sector.

Although the mining and minerals-related industries in Pennsylvania remained flat, in terms of production, similar conditions existed for the most part nationwide. The State ranked 12th in the value of nonfuel mineral production, accounting for nearly 3% of the U.S. total. Pennsylvania also retained its position as the Nation's third leading producer of steel and fourth in coal.

TRENDS AND DEVELOPMENTS

Pennsylvania's mineral wealth has historically served its population in providing employment and economic opportunity through development of these resources. Before the rise in importance of the national and global marketplace, Pennsylvania's coal, steel, and cement industries were cornerstones to the State's economy. During the 1970's and 1980's, these industries were affected as large surface coal mining operations opened in the Western United States, continuous steel casting technology emerged internationally, and cementmaking technology and transport benefited overseas producers.

In 1969, with enactment of the National Environmental Policy Act

TABLE 1
NONFUEL MINERAL PRODUCTION IN PENNSYLVANIA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	303	$22,594	e253	e$18,975	326	$21,924
Portland	do.	5,621	286,185	e4,881	e248,931	5,529	258,887
Clays	metric tons	[2]840,646	[2]2,900	[2]701,399	[2]2,890	649,257	3,455
Gemstones		NA	5	NA	5	NA	1
Lime	thousand short tons	1,626	92,557	1,695	95,328	1,660	94,543
Peat	do	18	730	10	207	16	250
Sand and gravel (construction)	do.	r20,795	r97,068	e18,300	e87,800	19,334	94,643
Stone:							
Crushed[3]	do.	e95,800	e502,700	70,334	362,306	71,600	380,200
Dimension	short tons	r e46,788	r e10,894	r41,983	r10,459	41,728	10,822
Combined value of clays [fire (1990), kaolin (1990-91)], mica [scrap (1990-91)], sand and gravel (industrial), stone [crushed granite (1990), crushed limestone, dolomite, and quartzite (1991-92)], and tripoli		XX	15,125	XX	17,482	XX	14,655
Total		XX	r1,030,758	XX	r844,383	XX	879,380

eEstimated. rRevised. NA Not available.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain clays; kind and value included with "Combined value" figure.

[3]Excludes certain stones; kind and value included with "Combined value" figure.

TABLE 2
PENNSYLVANIA: LIME SOLD OR USED BY PRODUCERS, BY USE

Use	1991		1992	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Agriculture	12,862	$867	10,283	$744
Acid water neutilization	155,276	8,430	72,713	3,985
Paper and pulp	29,589	1,414	27,379	1,273
Steel, sic oxygen	460,658	21,821	381,245	19,209
Steel, electric	284,682	13,972	196,569	9,553
Sewage treatment	76,557	4,376	58,642	3,285
Water purification	47,866	2,893	40,356	2,470
Other[1]	627,205	41,556	872,581	54,024
Total	1,694,695	95,329	1,659,768	94,543

[1]Includes alkalies, aluminum bauxite, glass, incinerator gas scrubber, industrial solid waste, ladle desulfurization, oil-well drilling, ore concentration, other chemical and industrial, other metallurgy, precipitated calcium carbonate, petroleum refining, refractory, soil stabilization, sugar refining, sulfur removal, tanning, and wire drawing.

(NEPA), a realization began to emerge that environmental protection was a component of national policy. During the past 20 years, the United States has invested about $1 trillion in environmental protection, according to the U.S. General Accounting Office.

For Pennsylvania, the change in markets, technology, and costs associated with environmental protection have resulted in diminished production and employment in the mining industry. As a result, the influence of these industries on the State's overall economy has lessened.

EMPLOYMENT

In 1992, employment in mining, construction, and primary metals all declined compared with 1991 levels. Workers in mining dropped by 1,000 to 24,000; construction employees fell from about 204,000 to 192,000; and primary metals jobs declined from 83,000 to 75,400.[3]

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Industrial minerals were produced in Pennsylvania at about 414 operations, according to data reported to the U.S. Bureau of Mines and listed in table 1. Crushed stone was produced at 187 quarries, sand and gravel at 160 pits, common clay and shale at 25 pits, dimension stone at 13 quarries, lime at 9 plants, cement at 10 plants, peat at 7 bogs, and industrial sand, kaolin, and tripoli at 1 operation each. Production from these operations accounted for the State's mineral production value of $879 million in 1992.

In addition, the following mineral commodities were processed in Pennsylvania: iron oxide materials, expanded perlite, iron and steel slag, sulfur (recovered), and exfoliated vermiculite. The combined value of these commodities as reported to the U.S. Bureau of Mines was about $50 million.

Compared with 1991 data, three more operations reported in 1992. A breakdown shows six more sand and gravel pits, one closed lime plant, one less clay pit, and a halt in mica production. In processed commodities, no data were reported for synthetic graphite.

Cement.—Output of portland cement increased in 1992 after 3 consecutive years of decline. Nationally, the State ranked third in output, trailing only California and Texas. Combined, these three States accounted for about 29% of U.S. production.

A continuing environmental issue for cement-producing States is the burning of waste materials as an alternative to fossil fuels. In 1992, Keystone Cement Co.'s permit to burn hazardous waste was suspended by the State's Department of Environmental Resources (DER). Quantities of waste in excess of the permit amount were burned. A citizens group was formed to halt any further burning of waste at the plant. Keystone, under strict monitoring by the DER, was allowed to resume burning the waste after about 6 weeks. The citizens group then filed a petition with the State's Environmental Hearing Board seeking a permanent halt to the burning. The case remained pending at yearend.

LaFarge Corp. at Cementon conducted a test burn using scrap tires in December 1991. The company obtained permission from the State DER to burn an estimated 1.2 million tires annually beginning in March 1993. According to the company, the waste tires would provide about 30% of the plant's fuel requirement. Equipping the plant to burn tires cost about $1 million.

Lime.—Nationally, Pennsylvania continued to rank third in output of lime, accounting for about 9% of the U.S. total. In 1992, the State's smallest lime producer, Honey Creek Lime Co., was not in operation. For the year, nine plants were in operation.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Pennsylvania sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 4 presents end-use statistics for Pennsylvania's four districts.

Output of construction sand and gravel in Pennsylvania in 1992 was about 5% higher than that in 1991. The gain was attributed to increased production in District 3. District 3, which includes Pittsburgh, was the only district in which

TABLE 3
PENNSYLVANIA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quanitity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	5,380	$29,891	$5.56
Plaster and gunite sands	163	1,249	7.66
Concrete products (blocks, brick, pipe, decorative, etc.)	433	2,219	5.12
Asphaltic concrete aggregates and other bituminous mixtures	2,472	13,075	5.29
Road base and coverings[1]	4,492	16,529	3.68
Fill	557	1,891	3.39
Snow and ice control	222	1,082	4.87
Other miscellaneous uses[2]	417	1,990	4.77
Unspecified:[3]			
Actual	2,916	16,046	5.50
Estimated	2,282	10,670	4.68
Total	19,334	[4]94,643	4.90
Total[5 6]	17,540	94,643	5.40

[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

output increased. Airport and highway construction in that area resulted in the increased demand.

Sand and gravel was produced in 38 of the State's 67 counties with District 3 accounting for about 37% of the production. Armstrong, Lawrence, Beaver, Erie, Mercer, and Crawford were the leading producing counties. Statewide, 113 companies operated 160 pits.

Stone.—Crushed stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—Pennsylvania was again one of the top States in crushed stone production despite a 25% drop in output since 1990. Lower production in 1991 and 1992 occurred as the result of weaker demand from the construction industry, particularly in roadbuilding.

The environment and land use issues continued as major concerns of the crushed stone industry. At a public hearing in Swiftwater on the expansion of a quarry operation, Monroe County residents identified noise, dust, and potential groundwater problems as environmental issues. Other items identified at the hearing were: fly-rock from blasting, delineation of wetlands, access through quarry property to a historic cemetery in the area, setbacks from property and wetlands, ground water sampling, bonding requirements, reclamation procedures, and design of sediment basins. The company, which operated the quarry since 1987, sought to expand a sandstone quarry on an additional 179 acres from a 14-acre site. The expansion remained pending at yearend.

In 1991, Miller & Son Paving Inc. received permits from the State DER to open a quarry and concrete plant on a 150-acre site near Gardenville, Bucks County. However, in 1992, Plumstead Township officials denied the company permission to open the quarry. This quarry controversy started in 1988 and has resulted in 44 hearings. Miller & Son has appealed the decision to Bucks County Court. A ruling was not expected until 1993.

An attempt at addressing one of the quarry issues in Pennsylvania was a joint study on blasting by the U.S. Bureau of Mines, Pennsylvania Department of Environmental Resources, and Villanova University that began during the year. The objective of the work was to determine how the impact of blasting changes, based on geology and weather conditions, as well as the effect on local residents. The study conducted at a dolomite quarry in Montgomery County was expected to provide information that could be applied to similar sites in Pennsylvania and nationwide.

Dimension.—Pennsylvania's dimension stone industry produced sandstone granite, quartzite, and slate at 13 quarries. Nationally, the State ranked seventh in total production but was among the top States in slate production.

Metals

No metals were mined in Pennsylvania. Metals discussed in this section were processed from materials received from both foreign and domestic sources. Production and value data for these metals are not included in table 1.

Steel production declined from 9.4 million short tons in 1991 to about 9.1 million short tons in 1992, according to data published in the Pennsylvania Business Survey by The Pennsylvania State University. Output was the lowest in more than 20 years.

Despite the low production, one major new mill startup began. U.S. Steel Group of USX Corp. completed construction and began operating a continuous caster at its Mon Valley Works in September. The $250 million caster has the capacity to produce 2.6 million short tons of steel per year.

Bethlehem Steel Corp., in November,

TABLE 4

PENNSYLVANIA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	1,062	4,874	926	5,142	1,898	10,716	1,495	9,161
Plaster and gunite sands	3	W	19	166	3	W	139	1,058
Concrete products (blocks, brick, etc.)	286	1,347	W	W	W	W	W	W
Asphaltic concrete aggregates and other bituminous mixtures	287	1,310	431	2,210	1,434	6,843	320	2,712
Road base and coverings[1]	1,498	6,768	140	601	1,904	6,637	950	2,522
Fill	182	447	78	327	220	753	76	364
Snow and ice control	123	540	W	113	64	338	W	91
Other miscellaneous uses[2]	202	862	145	590	136	748	116	687
Unspecified:[3]								
Actual	307	1,001	1,072	6,290	1,079	6,083	458	2,672
Estimated	810	3,225	1,041	5,477	431	1,968	—	—
Total[4]	4,760	20,374	3,853	20,917	7,170	34,086	3,552	19,266
Total[5 6]	4,318	20,374	3,495	20,917	6,504	34,086	3,222	19,266

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

signed a letter of intent to sell its Bar, Rod, and Wire Div. operations in Bethlehem to the Ispat Group of India. The operations have a capacity to produce 1.2 million tons of steel per year. The facility, which employed 2,200 workers, was shut down in September. However, early in 1993, the deal was canceled and the operations remained closed.

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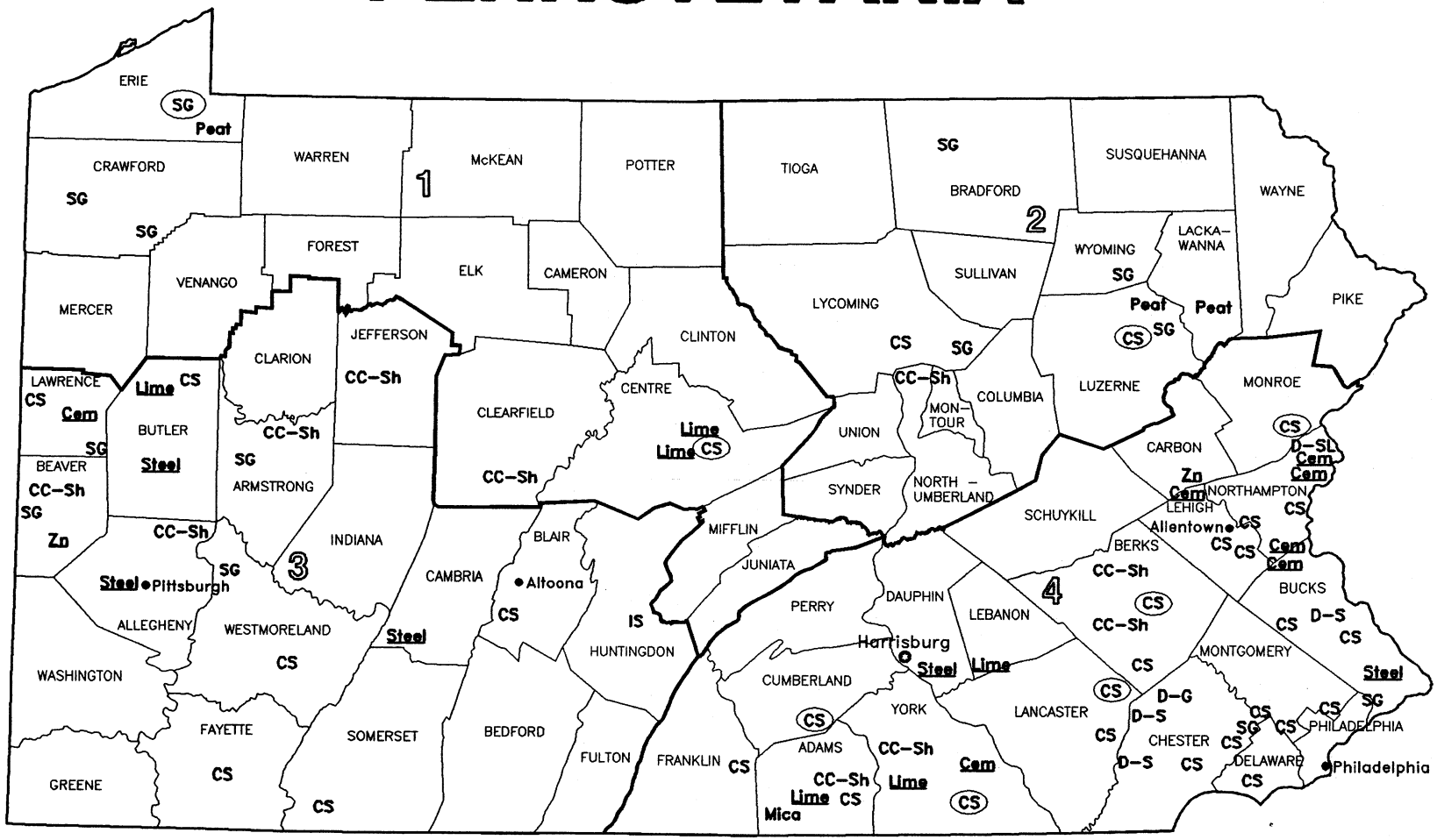
[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related industry and government experience and has covered the mineral activities in Pennsylvania for 10 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.
[2]Economic geologist, Pennsylvania Bureau of Topographic and Geologic Survey, Department of Environmental Resources, Harrisburg, PA.
[3]Pennsylvania Business Survey. College of Business Administration, The Pennsylvania State University, University Park, PA, Feb. 1992, p. 4.

PENNSYLVANIA



Principal Mineral-Producing Localities

LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

CC-Sh	Common Clay & Shale	IS	Industrial Sand	Steel	Iron and Steel plant
Cem	Cement plant	Lime	Lime plant	Zn	Zinc plant
CS	Crushed Stone	Mica	Mica		Concentration of mineral operations
D-G	Dimension Granite	Peat	Peat		
D-S	Dimension Sandstone	SG	Sand and Gravel		
D-SL	Dimension Slate				

TABLE 5
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Allentown Portland Cement Co. Inc.	Box 199 Blandon, PA 19510	Plant and quarry	Berks.
Essroc Materials Inc.	Drawer 32 Nazareth, PA 18064	Plant and quarries	Lehigh and Northampton.
LaFarge Corp.[1]	5160 Main St. Whitehall, PA 18052	Plant	Lehigh.
Hercules Cement Co.	Center St. Stockertown, PA 18083	Plant and quarry	Northampton.
Lone Star Industries Inc.	Box 818 Nazareth, PA 18064	Plant	Do.
Clays and shale:			
Common:			
Glen-Gery Corp.	Box 1542 Reading, PA 19603	Pits and plants	Adams, Berks, Jefferson, York.
Harmar Brick Inc.	Rich Hill Rd. Cheswick, PA 15024	Pit	Allegheny.
McAvoy Vitrified Brick Co.	Rural Delivery 2, Box 309 Phoenixville, PA 19460	Pit	Chester.
Watsontown Brick Co.	Box 68 Watsontown, PA 17777	Pit	Northumberland.
Kaolin:			
Narvon Products Corp.	900 East 8th Ave., Suite 200 King of Prussia, PA 19406	Pit and plant	Lancaster.
Lime:			
J. E. Baker Co.	Box 1189, 320 North Baker Rd. York, PA 17404	Plant and quarry	York.
Bellefonte Lime Co. Inc.	Box 448, North Thomas St. Bellefonte, PA 16823	Plant and quarries	Centre.
Wimpey Minerals PA Inc.[2]	Box 468 Hanover, PA 17331	do.	Adams and Lebanon.
Centre Lime & Stone Co. Inc.	Box 130 Pleasant Gap, PA 16823	Plant and quarry	Centre.
Mercer Lime & Stone Co.	3090 USX Tower Pittsburgh, PA 15219	Plant	Butler.
Peat:			
Lake Benton Soil Products Inc.	2607 Milwaukee Rd. Clarks Summit, PA 18411	Bog	Lackawanna.
Sand and gravel:			
Construction:			
Davison Sand & Gravel Co.	400 Industrial Blvd. New Kensington, PA 15068	Dredge and pits	Armstrong and Westmoreland.
Dravo Corp	4800 Grand Ave. Pittsburgh, PA 15225	Dredge, pit, plant	Allegheny and Beaver.
Glacial Sand & Gravel Co. Inc.	Box 1022 Kittanning, PA 16201	Dredge and plant	Armstrong.
Warner Co.	699 Bristol Pike Morrisville, PA 19067	do.	Bucks.
Wyoming Sand & Stone Co.	Rural Delivery 2, Box 26 Tunkhannock, PA 18657	Pits and plant	Bradford and Wyoming.
Industrial:			
U.S. Silica Co.	Box 187 Berkeley Springs, WV 25411	Quarries and plant	Huntingdon.

See footnotes at end of the table.

TABLE 5—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity
Stone:		
Crushed:		
Commercial Stone Corp.	2200 Springfield Pike Connellsville, PA 15425	Quarries and plant	Fayette and Westmoreland.
Eastern Industries Inc.[1]	4401 Camp Meeting Rd. Center Valley, PA 18034	do.	Berks, Carbon, Dauphin, Lancaster, Lehigh, Mifflin, Northampton, Northumberland, Susquehanna, Tioga, Union.
Eureka Stone Quarry Inc.	Box 249 Chalfont, PA 18914	do.	Bucks, Lackawanna, Monroe, Pike, Wayne.
Glasgow Inc.	Box 1089 Glenside, PA 19038	do.	Chester and Montgomery.
Hanson PLC[1]	Box 231 Easton, PA 18044	do.	Centre, Chester, Clinton, Columbia, Delaware, Lycoming, Monroe, Montour, Tioga, Wayne, York.
Medusa Cement Co.	2001 Portland Park Wampum, PA 16157	do.	Butler, Lawrence, York.
New Enterprise Stone & Lime Co. Inc.[1]	Rural Delivery 3 New Enterprise, PA 16664	do.	Adams, Bedford, Blair, Clearfield, Cumberland, Franklin, Huntingdon, Lancaster, Somerset.
Penns Supply Inc.	Box 3331 Harrisburg, PA 17105	do.	Cumberland, Dauphin, Perry.
Dimension:		
A. Dally & Sons Inc.	Box 27, Railroad Ave. Pen Argyl, PA 18072	Quarries and mills	Northampton.
Delaware Quarries	Route 22 Lumberville, PA 18933	Quarry and plant	Bucks.
Pennsylvania Granite Corp.	Box 510 St. Peters, PA 19470	Quarries and mill	Chester.
Welsh Mountain Building Stone Inc.	227 Isabella St. Norristown, PA 19401	Quarry	Do.
Mark C. Wise Inc.	Box 208 Bowmansville, PA 17507	do.	Do.

[1]Also sand and gravel.
[2]Also stone.

THE MINERAL INDUSTRIES OF PUERTO RICO, NORTHERN MARIANAS, ISLAND POSSESSIONS, AND TRUST TERRITORY

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Department of Natural Resources, Commonwealth of Puerto Rico, for collecting information on all nonfuel minerals.

By Steve W. Sikich[1] and Ramón M. Alonso[2]

THE COMMONWEALTH OF PUERTO RICO

Statistics released by the U.S. Bureau of Mines (USBM), Department of the Interior, indicated that the value of nonfuel mineral commodities produced in Puerto Rico was $123.9 million in 1992. The 1992 figure cannot be compared with the 1991 value because the values of crushed stone, which accounts for approximately 30% of the Commonwealth's mineral output, and industrial sand and gravel were not included in the 1992 value. Even with these mineral commodities being excluded, Puerto Rico's mineral value was greater than that of 10 mainland States.

Cement sales, arguably the Commonwealth's most reliable indicator of the health of its construction industry, increased 3.5% in quantity and 8.2% in value over those of 1991, but was still less than the record high set in 1990. Reconstruction that year following the devastation caused by Hurricane Hugo provided the impetus for the record output. The increase in 1992 reflected a broader upturn in the island's economy and an end to its recession.

Production data were reported for only two other mineral commodities. Clays, the lowest valued of five mineral commodities for which production data are reported, increased 48.5% in value, from $355,000 to $527,000. Lime, the island's third most valuable mineral commodity, decreased 16.3%, from $4.4 million in 1991 to $3.7 million in 1992.

Trends and Developments

The pro-statehood New Progressive Party won impressive victories in November's election, winning more than two-thirds of the seats in both the Commonwealth Senate and House in addition to the Governor's office. The victory prompted the newly elected Governor to press for a political status referendum in 1993.

TABLE 1

NONFUEL MINERAL PRODUCTION[1] IN THE COMMONWEALTH OF PUERTO RICO AND ISLANDS ADMINISTERED BY THE UNITED STATES

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
PUERTO RICO							
Cement (portland)	thousand short tons	1,486	$122,027	e1,382	e$110,560	1,431	$119,643
Clays	metric tons	W	W	145,483	355	W	527
Lime	thousand short tons	29	3,483	30	4,440	30	3,717
Sand and gravel (industrial)	do.	55	825	55	825	W	W
Stone (crushed)	do.	NA	NA	8,828	49,839	—	—
Total		XX	[2]126,335	XX	166,019	XX	[2]123,887
ADMINISTERED ISLANDS							
American Samoa: Stone (crushed)	thousand short tons	—	—	69	756	—	—
Guam: Stone (crushed)	do.	—	—	2,201	18,038	—	—
Total		XX	—	XX	18,794	XX	—

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; not included in "Total." XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Total does not include value of item withheld.

The Commonwealth Government accelerated its election year public works spending to nearly $2 billion in an effort to speed up the island's slow economic recovery. One of the principal projects was the 2-mile-long San Jose Lagoon Teodoro Moscoso Bridge, a $150 million project that began in July. A second project involved the reconstruction of 13 public housing projects at an estimated cost of $122 million. This was the first phase of a modernization program that will invest almost $300 million in Federal funds into 40 of the island's oldest and most dilapidated public housing projects within the next few years. In announcing the $2 billion worth of projects at a nationally televised press conference in late May, the island's Governor noted that the spending was much more than election year spending in that it represented a government effort to break down the bureaucratic barriers that impeded economic development and had delayed the individual projects for several years.

Other projects expected to boost the Commonwealth's mineral economy, especially crushed stone and cement, were proposed in 1992. One was a $1 billion rail-based mass transportation system linking San Juan, Baymon, Guaynabo, Caguas, and Carolina. The first phase of the urban train system is scheduled to begin construction in 1995 and will cost an estimated $600 million. All six phases are scheduled to be completed by the year 2004. Initial funding for phase 1 will be provided by $65 million in Highway Trust Funds under the Federal Transit Act approved by Congress in 1991. The $65 million had been allocated to Puerto Rico for the past 10 years, but were frozen because Puerto Rico was not ready to begin the project. The remainder of the cost will be borne by Commonwealth agencies and by the private sector.

Construction on the San Jose Lagoon Bridge began in July. The bridge will have four 12-foot-wide lanes and a total length of 2.1 miles. The platform of the bridge will consist of prebuilt concrete slabs supported by steel pilings and concrete headers. A related $200 million highway construction project, extending from the bridge to Loiza, is in the planning stage and is expected to begin construction in 1993. The Federal Highway Administration gave Puerto Rico its innovative Highway Finance Award at the 1992 annual meeting of the American Association of State Highway and Transportation Officials because of the innovative agreement between the private and public sectors for the construction of the Teodoro Moscoso Bridge. The project was the first major public-private partnership in the United States or its territories.

In September, a mainland-based engineering consultant firm, Alcocer & Co., proposed a $1.3 billion islandwide high-speed passenger and freight rail system linking the island's four major ports. The system would begin in Ceiba on the northeast coast and end in Mayaguez on the west coast, with stops in San Juan, Caguas, Salinas, Ponce, and Yauco. The project would be funded primarily by the private sector with the Commonwealth providing the right-of-way. It also was anticipated that possibly some federally legislated funding will be utilized along with Government-guaranteed bonds. The project would take 6 years to complete.

Despite the public works spending, the Commonwealth's economy faced severe challenges from uncertainty over the future of section 936 tax benefits. Section 936 of the U.S. Internal Revenue Code allows U.S. mainland firms to repatriate profits generated by their Puerto Rican subsidiaries to the mainland 100% free from Federal taxes. For years it, along with local tax legislation, has been one of the pillars of the Commonwealth's economic development strategy. In recent years, however, a growing number of U.S. legislators have been pushing for a repeal of section 936 or a reduction in its tax benefits. Section 936 was not changed by Congress in 1992, but major changes that significantly restrict 936 benefits are expected in 1993.

The Puerto Rico Economic Development Administration (Fomento), the island's promotor of manufacturing jobs, also faces a major challenge over the issue of so-called runaway plants from the States to Puerto Rico. Section 936 companies establishing or expanding operations in Puerto Rico are under increasing pressure from labor unions on the mainland who claim these companies are exporting jobs to the island at the expense of workers on the mainland. In the area of investment promotions, Fomento has been facing increasing competition from countries offering similar incentive packages. In more labor-intensive industries, Puerto Rico is expected to continue losing investment and jobs to low-wage countries such as Costa Rica, the Dominican Republic, Honduras, and Mexico.

Another external factor affecting manufacturing investment in Puerto Rico is the North American Free Trade Agreement (NAFTA) recently negotiated between the United States, Canada, and Mexico. Although NAFTA had not been ratified as of yearend, there were indications that it is already diverting investment in new plants and expansion of existing plants away from Puerto Rico toward Mexico. The average manufacturing wage in Mexico remains near $1 per hour, compared with about $6.50 in Puerto Rico. Mexico also shares a 2,000-mile border with the United States, and the countries' proximity greatly reduces transportation costs for raw materials and finished products.

Puerto Rico's continued dependence upon imported oil to produce 99% of the electricity consumed by more than 1 million industrial, commercial, residential, and institutional customers also has served as a detriment to the Commonwealth's economic growth. Proponents of alternate energy sources have argued that bureaucratic regulations and well-intended but often misinformed and misguided attempts to protect the environment have hampered attempts to develop clean coal technology as a cheaper and more environmentally sound source of energy. The basic infrastructure for generating and distributing electricity was developed more than 35 years ago. The last powerplant, Aguirre in Salinas, was built

in 1972.

In 1992, the Puerto Rico Electric Power Authority (PREPA) unveiled a 5-year, $1.4 billion capital expenditure program to upgrade the island's five major powerplants, to better its distribution system, and to develop critical reserve capacity needed to prevent power outages that result from breakdowns and scheduled maintenance. PREPA also plans to build an $80 million, 200-megawatt oil-burning powerplant in Arecibo by 1994.

Several companies dependent upon the minerals industry were involved in new operations or plant expansions. Included were Owens Illinois, San Juan Cement Co., Puerto Rican Cement Co., Du Pont Electronics Materials Inc., Coral Can Co., Bayamon Steel Processors, Servimetal Inc., Crossland Boiler Sales & Service Inc., Empasas Tito Castro, and Marmoles Vassco Inc. Details are included in the Review by Nonfuel Mineral Commodities section.

Arochem Corp. filed for chapter 7 bankruptcy liquidation in August. The company closed its 80,000-barrel-per-day refinery at Peñuelas in December 1991 after Federal Bureau of Investigation and Internal Revenue Service officials began investigating allegations that top company executives illegally channeled large amounts of money from the firm. In December 1992, the company's chief executive officer was convicted of 21 counts of conspiracy, bank fraud, wire fraud, and money laundering. At yearend, Arochem's principal creditors were attempting to recoup their losses by finding a buyer for the closed refinery. Prior to the Federal investigations, Arochem had announced plans to build, in a joint venture with Texaco Corp. and General Electric Corp., a multimillion dollar electrical power and steam generating (cogeneration) plant at the Peñuelas site.

Employment

Preliminary data reported[3] by the Mine Safety and Health Administration (MSHA) showed an average of 1,676 people directly employed by Puerto Rico's mining industry in 1991. This represents a 1.9% decrease from the 1,708 reported for 1991. Of the total number, 1,071 were employed in surface mines and 605 were employed in mills and preparation facilities. One fatality, at a mill and preparation facility, occurred in Puerto Rico's mining industry in 1992.

Environmental Issues

Included in legislation passed in 1992 that indirectly affects the minerals industry was law 70, the Recycling law. This act establishes the mechanism and guidelines that will enable both the public and the private sectors to reach the goal of recycling one-third of the total volume of solid waste generated on the island. Exports of recyclable materials increased to 130,300 metric tons or 143,640 short tons, more than double the 56,900 metric tons (62,737 short tons) exported in 1987. Major commodities exported were aluminum, iron and steel, paper and cardboard, and plastic.

Construction of a recycling facility to recover metal from discarded automobile carcasses was scheduled for September in the Guaynabo/Carolina area. The facility, designed with a capacity to shred 120,000 automobile bodies annually, is a joint venture between a Puerto Rican firm, Westech Corp., and two Florida firms, Montenay Power Corp. and NAMCO International Corp. Shredded metal will be separated into ferrous and nonferrous material, 95% of which would be exported to steel mills and other clients on the mainland. Future plans call for the establishment of a scrap tire processing, recovery, and pulverizing plant at the site.

Reconstruction of P.R. Highway 191 through the El Yunque rain forest, which is administered by the U.S. Forest Service, continued to be delayed. A $3.5 million contract awarded to Redondo Construction Co. by the Federal Highway Administration in 1991 was challenged by environmentalists who filed a lawsuit that alleged the project violated the U.S. National Environmental Policy Act, which requires that an environmental impact statement (EIS) be filed for projects that have the potential to significantly affect the environment. In April 1992, a U.S. District Court Judge ruled that the EIS filed 10 years ago was no longer valid and ordered that a new EIS be prepared. Highway 191 was closed in October 1970 when it was blocked by landslides triggered by a tropical storm.

Repairs to the Carraizo Dam, which overflowed during Hurricane Hugo, began in late summer. The overflow damaged the electric motors powering the pumps that provide water to much of Puerto Rico. As a result, 70% of the island was left without water service. The repairs, which will take 2 years to complete, include the installation of a new tainter gate system and renovation of the bascule gates. The gates control the volume of water that is discharged from the dam and, if working properly, should have prevented the overflowing during Hurricane Hugo.

Plans by North Carolina-based Cogentrix to build a $540 million coal-burning energy plant in Mayaguez remained on hold at yearend pending the issuance of more than 30 permits and approvals needed from both Commonwealth and Federal governments. Cogentrix' plans, first announced in 1989, were to have the first 300-megawatt unit operational by March 1993. Opposition by local residents, environmental groups, and the municipal and newly elected Commonwealth governments have cast doubt upon the project being built.

Exploration Activities

In June, a 3-day meeting was conducted jointly by the Puerto Rico Department of Natural Resources, the University of Puerto Rico at Mayaguez, and the U.S. Geological Survey (USGS) to outline the results of a multiyear study of the island's known and undiscovered mineral resources. Meeting officials noted that the scientific data obtained from the study should aid the public and private sectors in long-range land use and economic planning in Puerto Rico and provide a better understanding of the

Commonwealth's mineral potential.

The study indicated that at least 11 different types of metallic mineral deposits, including copper, gold, iron, lead, manganese, molybdenum, silver, zinc, and other minerals, occur in the island in addition to the industrial minerals (cement, clay, sand and gravel, and stone) currently being produced. There are 13 known deposits of the metallic minerals and more than 125 other known occurrences of subeconomic concentrations of the minerals. The assessment, which was the first to consider both onshore and offshore mineral deposits, was begun in 1990 as part of the USGS National Mineral Resource Assessment Program.

USGS geologists who conducted the study first identified and delineated areas that may contain particular deposit types and then estimated the number of possible undiscovered deposits. Finally, they estimated the amount of minerals in the undiscovered deposits based on grade and tonnage models of previously discovered deposits of similar types. In the Puerto Rican study, USGS estimated that there is a 50% chance of three or more undiscovered porphyry copper-gold deposits similar to the three deposits that have already been discovered in Tanama and Rio Vivi.

In the past, attempts to develop potential mineral deposits have been frustrated by lack of investment, poor infrastructure, uncertainty over the island's status, the difficulty in negotiating mineral leases, and inadequate waste disposal.

However, during October, the Department of Natural Resources granted two exclusive exploration permits to Southern Gold Resources (USA) Inc. and Newmont Overseas Exploration Ltd. Their areas are the known copper porphyry-gold deposits at Cala Abajo and Tanama, respectively. Cominco American Resources Inc. still has a 40-square-kilometer exclusive exploration permit in the Cerro Avispa-Jájome area of Cayey.

Legislation and Government Programs

Numerous changes in regulations for the use, vigilance, conservation, and administration of territorial waters were submitted by the Department of Natural Resources and approved in December. Under the new regulations, the definition of maritime zone public domain was expanded from rivers, beaches, and other waterfront property influenced by waves and tides to include "zones of deposits of loose materials, such as sand, gravel, etc., with or without vegetation formed by action of sea, wind, or other natural or artificial causes." The new regulations will not only increase the number of sand and gravel operations required to pay royalties to the Commonwealth, but also will regulate future and existing commercial developments on areas covered by the new regulations.

The Overseas Private Investment Corp. (OPIC) extended until 1995 the period during which it will guarantee section 936 loans in the Caribbean region. OPIC also doubled the amount it is willing to commit under the guarantees from $100 million to $200 million and reduced the amount that the Puerto Rican government was required to guarantee from $1 for every $1 to $1 for every $3 for 1992 and 1993. In 1994, the ratio falls to $1 for every $2 and, in 1995, reverts to $1 for every $1. OPIC announced a 1-year phaseout of the program in 1991, but, according to OPIC officials, reconsidered the decision to give the Commonwealth government's guarantee program "time to fully mature."

The Government of Guyana signed a Tax Information Exchange Agreement with the United States making Guyana eligible to receive funding under section 936. In 1992, there was approximately $9 billion in 936 funds deposited in Puerto Rico's financial institutions. This money represents profits of the Commonwealth's subsidiaries of mainland firms operating under section 936 of the U.S. Internal Revenue Code. A Congressional mandate requires that a minimum of $1 million annually be loaned for projects in Caribbean Basin Initiative eligible countries. Guyana is a vast, largely undeveloped country in the northeastern part of South America that is rich in mineral resources such as bauxite and gold. The nation's economy is largely dependent upon mining, agriculture, and forestry.

Fomento celebrated its 50th anniversary in 1992. Originally, Fomento was the Spanish acronym for the Puerto Rico Development Co. (Pridco), a public company created by the Puerto Rico Legislature to promote the island's industrial development in 1942. Among the first companies established under Pridco were the Puerto Rican Cement Co. and the Owens-Illinois glass manufacturing facility, both based upon mineral resources.

In 1950, the original Fomento's operations were reorganized with the creation of a government agency, the Puerto Rico Economic Development Administration, which retained the name Fomento. Fomento's success since it was founded in 1942 can be measured in a number of ways. In 1946, there were 24 manufacturing plants in operation in Puerto.[4] In 1992, there were 1,433 Fomento factories employing 141,433 workers.[5] In 1940, average Puerto Ricans had an annual income of $120, a lifespan of 46 years, and 3 years of education. By 1990, these numbers increased to more than $6,500, 74 years, and 12 1/2 years (for manufacturing workers), respectively. Puerto Rico's gross national product per capita, as measured in 1990 dollars, increased from $1,500 in 1945 to almost $6,500 in 1990.

At yearend 1992, Fomento's promotions related to the minerals industry included 2 construction materials projects with the potential of creating 70 new jobs and a total investment of $10 million. It also was promoting the Cabot Corp. Inc.'s proposed natural gas processing facility that would employ 150 workers.

Review by Nonfuel Mineral Commodities

Industrial Minerals.—Industrial minerals accounted for all of Puerto Rico's mineral production. The Commonwealth ranked ahead of 12 States in the value of industrial minerals produced in 1992.

Cement.—Portland cement, once again, was the most valuable mineral commodity produced in 1992, accounting for 96.6% of the reported total mineral value. Production was 1.43 million sthort tons, 3.5% more than the 1.38 million short tons produced in 1991. Cement production in 1992 was 3.7% less than the record high set in 1990.

Portland cement was produced by two companies in Puerto Rico; neither manufactured masonry cement. Puerto Rican Cement Co., the Commonwealth's largest cement producer, reported sales of $80 million and a 60% share of Puerto Rico's cement market in 1992. Its $60 million conversion to a dry-process kiln system became fully operational in 1992.

The San Juan Cement Co. inaugurated its new dry-process production facility in August. The project was started in August 1988 with an original completion date of October 1990. However, a series of delays caused by mechanical and electrical contractors delayed the start of clinker production until 1991, and full production of more than 700,000 short tons per year was not achieved until 1992. The new system achieved stricter quality control and increased energy efficiency in the quarry, grinding, and pyroprocessing systems.

Clays.—The quantity of clay produced was withheld in 1992. However, its reported value increased 48.5% to $527,000 in 1992 after falling 39.8% to $355 million in 1991. All of the reported clay production in Puerto Rico was common clay used in the manufacture of portland cement.

Lime.—Puerto Rico's reported lime production remained at 30,000 short tons, although its attendant value decreased 16.3% from $4.44 million in 1991 to $3.72 million. The Commonwealth ranked ahead of 4 of the 33 States that produced lime in 1992. Puerto Rican Cement Co., the island's only lime producer, manufactured hydrated lime and a minor amount, less than 0.1% of the total produced, of quicklime. Principal markets were in water purification and construction applications.

Sand and Gravel.—Construction.—Because of very poor response to its canvass forms, the USBM no longer compiles production data for construction sand and gravel mined in Puerto Rico.

MSHA inspected 54 construction sand and gravel operations employing 529 workers. Of the 54 operations, 6 were listed as working on an intermittent schedule and 3 were seasonal. Three additional operations were listed as permanently closed.

Empasas Tito Castro opened a new sand and gravel pit in 1992. The company, a leading supplier of quarried materials, asphalt, and concrete, celebrated its 42d anniversary in 1992. Aggregates were mined from three crushed stone quarries and two sand and gravel pits.

Industrial.—Industrial sand and gravel production data were withheld in 1992. Owens-Illinois of Puerto Rico (O-I) was the Commonwealth's only industrial sand producer. O-I announced, in December, plans to expand its Puerto Rican Operations by investing $10 million in new production facilities, machinery, and equipment. The company operates a glass container production facility at Vega Alta using locally mined industrial sand. It also manufactures plastic containers for the pharmaceutical market at Las Piedras. O-I plans to manufacture 8-ounce glass bottles in the original Coca-Cola contour for B&C Bottlers Corp. of Cayey. B&C, the Puerto Rican bottler and distributor of Coca-Cola products, plans to reintroduce the registered brand 8-ounce bottle on the island.

Stone.—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—Crushed stone remained Puerto Rico's second most valuable mineral commodity, although the industry was not surveyed in 1992 and production data were not available.

MSHA inspected 61 crushed stone operations employing 880 workers. Of the 61 operations, 3 were listed as working on an intermittent schedule. Six additional operations were listed as permanently closed. The quarries were comprised of 37 limestone, 1 traprock, 1 sandstone, and 22 in which the rock type was not identified.

Hormigonera Mayaguezana Inc. celebrated its 40th anniversary in 1992. The company, which started with a single aggregate quarry in Cabo Rojo in 1951, had grown to be the eighth largest supplier of construction materials in 1992. In addition to its aggregate operations managed by a sister company, Gravero Mayaguezano Inc., Hormigonera operated 12 premixed concrete plants with annual sales of more than $27.5 million and more than 200 employees.

Dimension.—Dimension stone production was not surveyed by the USBM in 1991. MSHA inspected two dimension stone quarries that operated full time in 1992, marble quarries operated by Empresas Tito Castro Inc. and by Marmoles Vassco Inc. Both quarries are in Ponce County.

Marmoles Vassco produced a variety of marbles at its Juana Diaz quarry northeast of Ponce. A new quarry to produce black marble was also in the siting stage. Installation of new equipment that increased the capacity of its finishing plant just north of Ponce to 120,000 square feet of tile per month and allowed new products to be produced became fully operational in 1992. Specialty products produced included thin (5/8-inch) bush-hammered tile, window sills, thresholds and risers, and tabletops and countertops. The company also exported rough blocks to Italy.

Other Industrial Minerals.—Two additional industrial minerals were recovered in Puerto Rico. Salt, evaporated from seawater, was produced by two companies in southwestern Mayaguez. Salt also was imported through the Port of San Juan. Elemental sulfur was recovered as a byproduct of oil refining by the Sun Oil Co. Inc. at Yabucoa. The USBM withheld

production data on sulfur.

Metals.—Metals have not been mined in Puerto Rico since the Juncos iron mine closed in 1953, and prospects for resuming metal mining in the foreseeable future are unlikely. However, as noted in the Exploration section, metal occurrences are common on the island and the possibility of future development of an economic metal deposit should not be completely discounted.

Among Puerto Rico's major exports are metal products manufactured from material imported from the United States and foreign countries and from recycled scrap. Aluminum was extruded to manufacture contours in the form of tubes, channels, and angles by Alruss Extrusion and Finishing Corp. and Aluminum Extrusion Corp. (Alumex). Alumex produced 50% of its own ingots from a recycling plant in Canovanas.

Although no steel is manufactured in Puerto Rico, more than 20 companies sell or install steel imported mainly from the United States. In late 1992, Bayamon Steel Producers began production of galvanized steel at its Bayamon plant. Completion of the $20 million expansion project allows Bayamon to coat steel imported from the mainland using the hot-dip zinc galvanizing process, the first operation of its kind in the Caribbean area. The new line has the capacity to process approximately 110,000 short tons of steel per year. Bayamon initially plans to produce about 90,000 short tons per year to satisfy the local market of 40,000 to 50,000 short tons per year with the remainder being exported principally to the southeastern United States and to other Caribbean countries.

Coral Can Inc. inaugurated its state-of-the-art manufacturing operations in Bayamon in October. The operation produces metal cans used in food processing, including tomato sauce, fruit juice, and vegetables. Crossland Boiler Sales & Service Inc., the largest company specializing in the fabrication, maintenance, and repair of industrial boilers, heat exchangers, and other pressure vessels in the Caribbean, was nearing completion of a $2.5 million expansion of its manufacturing and office facilities in Caguas. The company employed more than 400 contract workers in St. Croix, Virgin Islands, where it is a major contractor in the $1 billion expansion of the Hess Oil refinery.

In August, Servimetal Inc. announced plans to expand its steel manufacturing facility in Caguas. The $1.5 million expansion planned for 1993 will nearly double Servimetal's capacity to produce flat steel, stainless steel, and aluminum sheets, rolls, and coils from imported cold-rolled, hot-rolled, pickled, oiled, and electrogalvanized steel and aluminum. Standard Press Steel Inc., a subsidiary of Standard Press Technologies Inc., Newton, PA, phased out its Puerto Rican manufacturing operations. The phaseout, part of a reorganization of the company's overall operations, idled more than 100 workers at Anasco. Company officials cited declining sales and rising transportation and energy costs as principal reasons for closing the Puerto Rico plant, which was established in 1976.

A variety of precious metals also were imported, primarily for use by Puerto Rico's electronics industry. Du Pont Electronics Materials Inc. completed its $33.7 million expansion of its thick paste film and related intermediates plant in Manati. Thick paste films are made of precious metals such as gold, silver, and platinum; nonprecious metals; ceramics; and glass. They form crucial components in electronic integrated circuits, resistors, and conductors used in the production of products ranging from computers and home appliances to automotive components and military equipment.

THE COMMONWEALTH OF THE NORTHERN MARIANAS

The Commonwealth of the Northern Mariana Islands (CNMI) consists of 14 islands. The chain of islands extends approximately 625 kilometers (389 miles) from the southernmost island of Rota to the northernmost islands of Farallon de Pajoros (Uracas). Only four of the chain's islands, which have a total dry land area of 457 square kilometers (176.5 square miles), are inhabited; these are Saipan, Rota, Tinian, and Anatahan. Total resident population of the islands, based upon the 1990 census, was 23,200 plus an estimated 20,150 nonresident workers. Approximately 90% of the people, 38,900, live on the largest island, Saipan, which has an area of 120 square kilometers (46.5 square miles).

Historically, the islands became part of the Spanish empire in the mid-17th century. In 1898, Spain sold the islands to Germany, which lost them in 1921 when the League of Nations confirmed Japan as administrator. After World War II, the islands became part of the Trust Territories of the Pacific administered by the United States. In 1978, the Northern Marianas became self-governing; in 1986, they became a Commonwealth, and U.S. citizenship was conferred on residents meeting necessary qualifications.

Geologically, the CNMI are mountainous "high islands" composed of limestone in the southern part of the chain and volcanics in the northern part where there are several active volcanos. The only mineral-related industries on the islands are cement building-block manufacturing facilities and a limited amount of metal fabrication. The value of imported construction materials was estimated at $60 million in 1992.

CARIBBEAN ISLAND POSSESSIONS

The Caribbean Island Possessions consist of the U.S. Virgin Islands, which includes 3 major islands and more than 50 smaller islands, and 7 islands lying off the Central American coast. The major islands are St. Croix, St. John, and St. Thomas. Mineral production was reported from St. Croix and St. Thomas in 1992.

Review by Nonfuel Mineral Commodities

The only mineral commodity mined in the Virgin Islands in 1991 was crushed stone. One other industrial mineral, elemental sulfur, was recovered as a

byproduct of oil refining; a metal, alumina, was refined from imported bauxite.

Industrial Minerals.—**Stone.**—The Virgin Island's crushed stone industry was not surveyed in 1992. Only two companies, Devcon International Corp. on St. Croix and St. Thomas and St. Croix Stone and Sand Inc. on St. Croix, reported production to the USBM in 1991. MSHA records indicate that a third company, No. 1 Contracting Corp., operated a traprock quarry at Sara Hill in St. Thomas. MSHA also inspected two stone-crushing operations on the islands. V. I. Cement and Building Products Inc. operated the Springfield crusher on St. Thomas. The mobile crusher operated by Inter Island Inc. of Puerto Rico in 1991 was permanently closed in 1992.

Devcon, based in Deerfield Beach, FL, operated the Brookman Quarry about 7 miles west of Charlotte Amalie on St. Thomas. Production capacity from the quarry is listed at 150,000 short tons per year. Devcon also imported cement from Columbia and fine sand from Barbuda, a small island about 200 miles east of St. Thomas. The sand supplements manufactured sand produced from the crushed stone and is used in the manufacture of concrete blocks.

Caribbean Material Supply Co. Inc., a wholly owned Devcon subsidiary, operated the Springfield Quarry near Groveplace on St. Croix. Plant capacity was 150 short tons per hour, about the same as that of the St. Thomas plant. St. Croix Stone and Sand Co. operated the Robes Hill Quarry near Frederiksted. Plant capacity was about 125 short tons per hour. No. 1 Contracting Corp. operated the Sara Hill Quarry on St. Thomas.

Other Minerals.—The Virgin Islands Aluminum Corp. (VIALCO), a subsidiary of the Swiss-based aluminum trading company Clarendon Ltd., operated a 700,000-short-tons-per-year alumina refinery on St. Croix. Bauxite, the basic raw material used in manufacturing the alumina, was imported from the recently opened bauxite deposits on the Berbice River in Guyana. VIALCO reportedly entered an agreement with Alusuisse-Lonza Services (ALS), Switzerland, under which ALS will provide VIALCO with proprietary alumina precipitation technology for its St. Croix alumina plant.[6] The technology was expected to improve and maintain VIALCO's quality control while providing the basis for increasing the plant's production capacity.

PACIFIC ISLAND POSSESSIONS

The Pacific Island Possessions consist of 12 islands or island chains that were acquired by the United States between 1839 and 1967. The major islands are American Samoa, Guam, and Johnston. The only mineral production on the islands that was reported to the USBM was crushed stone for local construction. Crushed stone production was reported from American Samoa and Guam in 1991, but the industry was not canvassed in 1992. A new minerals-related industry was announced by the Governor of American Samoa in May. Construction of a new factory to manufacture cans on the island was scheduled to begin by the end of the year by a local corporation that plans to invest $20 million in the project.

The U.S. Army Corps of Engineers continued recovering radioactive particles from 100,000 cubic yards of soil contaminated by nuclear testing on Johnston Atoll. Contaminated soil is processed to recover the plutonium, and the clean soil is returned for landfill. The project is expected to be completed by late 1993 or early 1994.

Johnston Atoll was annexed by the United States under the Guano Act and mined briefly for phosphate in the late 1800's. In 1923, the atoll's two natural islands, Johnston and Sand, were designated a National Wildlife Refuge. In 1936, the U.S. Navy took control of the island and began reef-blasting, dredging, and building landfills to construct a refueling base for aircraft and submarines during World War II. In the 1950's and early 1960's, Johnston Atoll was a launch facility for U.S. atmospheric nuclear testing in the Pacific.

Since the early 1970's, chemical munitions were brought to the island for storage and hundreds of barrels of Agent Orange were shipped from Vietnam. An incinerator to destroy the chemical weapons was completed in 1989, but has been used only to process the contaminated soil. The destruction of the chemical weapons remained on hold in 1992 pending agreement on an environmentally safe procedure for accomplishing the task.

TRUST TERRITORY OF THE PACIFIC ISLANDS

The Trust Territory of the Pacific Islands was created in 1947 when the United Nations created 11 trusteeships for territories captured from Japan and other Axis Powers. The only territory remaining in the Trust, the Republic of Palau, applied for "free association" status with the United States in 1983, but a compact has not yet been ratified. Under terms of free association, the United States would provide economic aid and be responsible for Palau's defense in return for being allowed to maintain military bases on the island. The major obstacle in ratifying the compact has been a nuclear-free clause in Palau's Constitution, which the United States deems incompatible with its defense and security interests. Mineral production was not reported from Palau in 1992.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 34 years of industry and government experience and has covered the mineral activities in Puerto Rico since 1989. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

[2]Director, Puerto Rico Geological Survey.

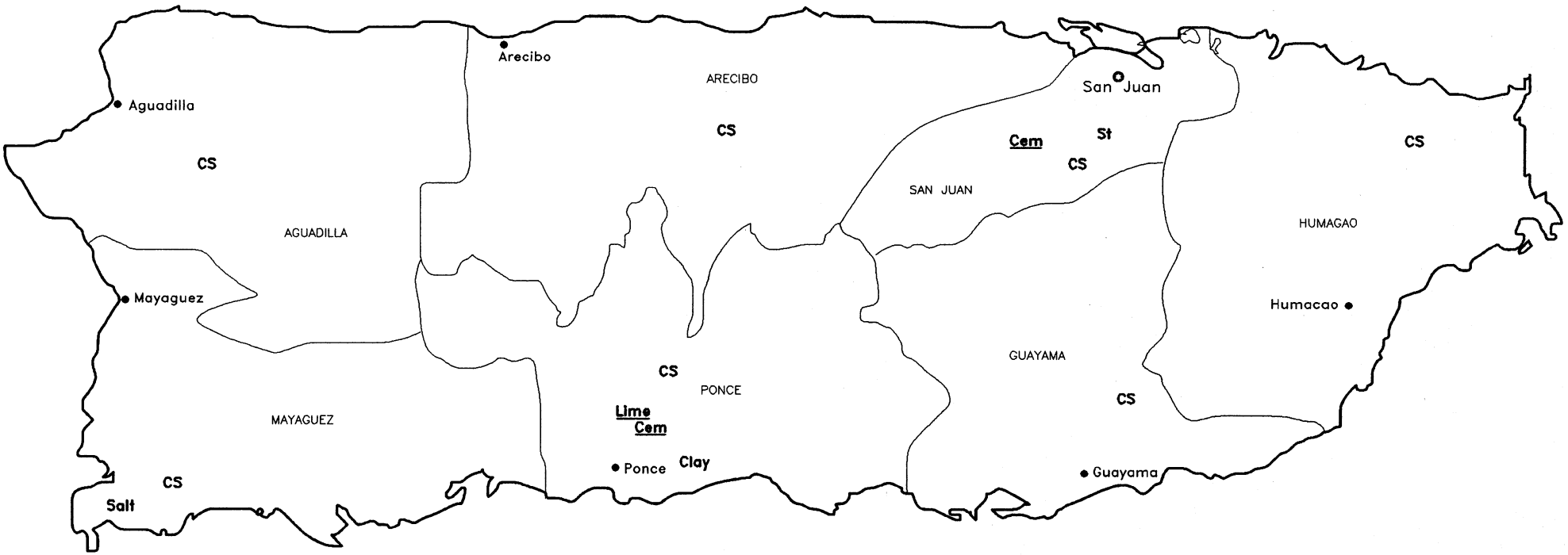
[3]U.S. Department of Labor. Mine Injuries and Work Time, Quarterly. Jan.-Dec. 1992, p. 14.

[4]Caribbean Business (San Juan, Puerto Rico). Late Fomento Founder Moscoso Remembered. V. 20, No. 26, June 25, 1992, p. 10.

[5]Casiano, M. A., Jr. (ed.). 1993 Caribbean Business to Business Guide. Casiano Communications Inc. 1993, p. 83.

[6]Mining engineering (Englewood, CO). Industrial Minerals 1992. V. 45, No. 6, June 1993, p. 564.

PUERTO RICO



LEGEND	
State boundary	
District boundary	
Capital	
City	

MINERAL SYMBOLS	
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
Lime	Lime plant
Salt	Salt
St	Stone

Principal Mineral–Producing Localities

TABLE 2
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
	PUERTO RICO		
Cement:			
Puerto Rican Cement Co. Inc.[1]	Box 1349 Ponce, PR 00733	Plant	Ponce.
San Juan Cement Co.[2]	GPO 2888 San Juan, PR 00936	do.	San Juan.
Sand (industrial):			
Owens-Illinois of Puerto Rico	Box 387 Vega Alta, PR 00762	Pit and plant	Arecibo.
Stone:			
Crushed:			
Productora De Agregados Inc.	Box 1052 Sabana Seca, PR 00749	Quarry	Do.
Empresas Ortiz Brunet	Box 1839 Guaynabo, PR 00657	do.	San Juan.
Terressa Aggregates Inc.	24 Building 35 #17-Sta Rosa Bayamon, PR 00620	do.	Mayaguez and San Juan.
Cantera Carrizo Inc.	Box 2588 San Juan, PR 00936	do.	San Juan.
Dimension:			
Marmoles Vassco Inc.	Box 8238 Ponce, PR 00732	do.	Aquadilla and Ponce.
Empresas Tito Castro Inc.[3]	Box 589 Ponce, PR 00731	do.	Ponce.
Sulfur:			
Puerto Rico Sun Oil Co.	Box 476 Yabucoa, PR 00767	Plant	Humacao.
	VIRGIN ISLANDS		
Alumina:			
Virgin Islands Alumina Inc.	Box 1525 Kingshill St. Croix, VI 00851	Plant	St. Croix.
Stone (crushed):			
Devcon International Corp.	Box 7368 St. Thomas, VI 00801	Quarry	St. Thomas.
St. Croix Stone & Sand Inc.	Box 732 Frederiksted St. Croix, VI 00841	do.	St. Croix.
	GUAM		
Sulfur:			
Amerada Hess Corp.	1 Hess Plaza Woodbridge, NJ 07095	Plant	St. Croix.
Stone (crushed):			
Mitsubishi Cement Corp. (Hawaii Rock Products)	Box H Agana, GU 96910	Quarry	Guam.
Perez Brothers Inc.	Box F Agana, GU 96910	do.	Do.

[1]Also lime, clay, and crushed stone.
[2]Also clay.
[3]Also crushed stone and construction sand and gravel.

THE MINERAL INDUSTRY OF RHODE ISLAND

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Rhode Island Department of Environmental Management for collecting information on all nonfuel minerals.

By Donald K. Harrison[1]

The value of nonfuel mineral production in 1992 was $21.5 million, an $8.2 million increase over that of 1991. The primary reason for the gain was the increase in production of construction sand and gravel over 1991 estimates. Estimated output and value of crushed stone, the State's second leading mineral commodity in terms of value, also increased in 1992. Additionally, industrial sand was mined by two companies in the State and mineral-related commodities were received and shipped out of the port of Providence. Some of the commodities received at the port included caustic materials, cement, petroleum products, and steel. The primary commodity shipped out was iron and steel scrap.

TRENDS AND DEVELOPMENTS

In 1992, the average annual value of total construction contracts was down 9% from that of 1991. The 1992 value was also 54% lower than the peak building year of 1989. The 9% drop in 1992 was not as drastic as that in the past couple of years. The largest drop in the value of construction contracts occurred in 1990 when the value plummeted 60% from that of 1989. On a positive note, however, two categories of construction were up in 1992. The value of housing starts, which had continued to decline since 1988, was up 7%. The value of nonresidential construction also rose by 8%. These gains, however, were offset by decreases in nonbuilding contracts, which fell by 50%. Overall, however, there appear to be some signs of recovery in construction activity in Rhode Island as well as in the other New England States. Because construction activity is highly dependent on the availability of construction aggregates, the modest recovery should help to stabilize this industry.

EMPLOYMENT

In 1992, the average number of workers employed in the mineral extractive industries in Rhode Island was 122, the same as that reported in 1991.[2] Of this total, 93 workers were employed at sand and gravel operations, 16 at stone operations, and 13 at mineral-related mills and preparation plants in the State.[3] In the mineral-dependent construction industry, employment was down nearly 13%.

LEGISLATION AND GOVERNMENT PROGRAMS

The Rhode Island State Planning Council, a division of the Department of Administration, is the primary agency that provides policy guidance and coordinates activities regarding the physical, economic, and social development in the State. The Division of Planning comprises the Office of Strategic Planning, the Office of Systems Planning, and the Office of Municipal Affairs. During 1992, several bills that directly affected the activities of the State Planning Council and Division of Planning were signed into law. Public Law Chapter 133, Article 21, amended the powers and duties of the Coastal Resources Management Council (CRMC). CRMC's planning and management programs now must be developed around basic standards and criteria that whenever possible should be

TABLE 1
NONFUEL MINERAL PRODUCTION IN RHODE ISLAND[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$2	NA	$1	NA	$1
Sand and gravel (construction)	thousand short tons	1,969	9,042	e1,300	e6,000	2,455	11,964
Stone (crushed)	do.	[2] e1,600	e8,800	1,187	7,262	e1,500	e9,500
Total[3]		XX	17,844	XX	13,263	XX	21,465

eEstimated. NA Not available. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes crushed traprock.

[3]Partial total, excludes values that must be concealed to avoid disclosing company proprietary data.

consistent with the State guide plan. Article 3 of Chapter 133 extensively revised the policies for solid waste management and the functions of the Solid Waste Management Corp. Some of the new policies included allowing tipping fees to be charged at solid waste processing facilities only if designed to recycle at least 70% of the municipal solid waste stream. Article 3 also states that the use of landfills is to be minimized and that incineration is prohibited. At least two solid waste processing facilities, with capabilities of 1,000 tons per day each, will be built in the State.

Chapter 385, the "Land Development and Subdivision Review Enabling Act of 1992," is the third and final major proposal of the Land Use Commission. It gives cities and towns authority to review those kinds of land development projects specified in the local zoning ordinance and requires that they adopt standards for and approve division of land into parcels or lots. It ties into both the Comprehensive Planning and Land Use Regulation Act of 1988 and the Zoning Enabling Act of 1991.

In addition to responding to requests for geological information from agencies, companies, towns, and individuals, the State Geologist's office participated in a joint proposal with the Connecticut Geological Survey, funded by the Minerals Management Service. This project, which is in the 10th year of an offshore sand and gravel study, was headed by the University of Rhode Island's Graduate School of Oceanography.

The State Geologist, together with the other New England State Geologists, began a study administered through the New England Governors' Conference to assess the availability of sand and gravel in the region. This supply study is the second phase of a total resource assessment; the first phase, which involved a demand projection, was published in January. Work on the State surficial (glacial) geology map was delayed owing to staff shortages but was expected to resume in fiscal year 1993.

Residents living within about one-half mile of the contaminated Western Sand & Gravel Superfund site were informed by the State Department of Environmental Management that their households would be hooked up to new underground wells. Between 1953 and 1975, an active sand and gravel pit was operated at the site. Liquid chemical and septic wastes were dumped into the open pits between 1975 and 1979, where they soaked into the soil and contaminated the ground water. The Environmental Protection Agency (EPA) has been involved in cleaning up the site since 1980 and is continuing to monitor the levels of contaminants in the affected ground water. The EPA determined that 78 corporations were liable for the dumping in the 20-acre parcel.

The Portsmouth Town Council was informed by a private consultant that abandoned coal mines along the west shore of town do not reach under the site of a proposed oil-fired powerplant at Arnold's Point. The presence of the old coal mines in the Arnold Point area had been of concern to council members and local residents, who feared that the land could subside under the weight of the plant and its 400,000-gallon oil storage tank and 200,000-gallon water tank. The council, sitting as a Board of License Commissioners, is considering Aquidneck Power Limited Partnership's proposal to build an 85-megawatt power facility on 32 acres. The council also was asked by the State Facilities Siting Board to determine whether the developer's proposal to build the oil storage tank and to store and process oil on the site is allowable under the town's zoning ordinances. The Siting Board will have final say on the matter. The topic of mine subsidence was investigated because between 1808 and 1913 numerous coal companies mined coal in the area, called the Narragansett Basin.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Construction sand and gravel was the State's leading mineral commodity in terms of value, accounting for 56% of the value of all minerals produced in the State. The output of nearly 2.5 million short tons was the highest since 1984 when about the same amount was produced. In 1992, a total of 14 companies mined construction sand and gravel from 19 pits in 3 of the State's 5 counties. Leading counties, in order of output, were Kent, Providence, and Washington. Construction sand and gravel was used for concrete aggregate, asphaltic concrete aggregates, road base and coverings, and fill.

Controversy continued in the towns of Coventry and South Kingston regarding soil erosion and sediment control ordinances. In 1991, the Coventry town council approved an amendment to the town's 1990 soil erosion and sediment control ordinance that required sand and gravel operators to submit plans to the town for controlling erosion and settlement within a given period. Several companies have not complied with the ordinance, and legal action was taken against them by the town. In the town of South Kingston, a proposed soil erosion and sediment control ordinance was being debated between the town council and developers and gravel companies who believe that the proposed ordinance is unfair and overregulatory because of the very nature of their businesses.

Industrial.—Two companies, both in Providence County, mined industrial sand in the State. Holliston Sand Co. Inc. operated a pit and plant near Slatersville and the Taggart Sand Products Corp. operated a pit and plant near Lincoln. Most of the sand was used for filtration, molding and core, and blasting.

Stone.—**Crushed.**—Crushed stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years

TABLE 2

RHODE ISLAND: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	913	$4,884	$5.35
Plaster and gunite sands	23	40	1.74
Asphaltic concrete aggregates and other bituminous mixtures	349	2,049	5.87
Road base and coverings	360	1,165	3.24
Fill	148	310	2.09
Snow and ice control	W	W	5.58
Railroad ballast	W	W	15.00
Other miscellaneous uses	24	155	6.46
Unspecified:[1]			
Actual	33	437	13.24
Estimated	606	2,925	4.83
Total[2]	2,455	11,964	4.87
Total[3 4]	2,227	11,964	5.37

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[2]Data may not add to totals shown because of independent rounding.
[3]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[4]Total quantity and total value in thousand metric tons and thousand dollars.

only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Estimated crushed stone production in 1992 totaled 1.5 million short tons valued at $9.5 million. In 1991, the last year the Bureau surveyed the industry, six companies operated six quarries in three of the State's five counties. Leading counties, in order of output, were Providence, Washington, and Newport. Limestone was the predominate stone quarried; granite and traprock also were produced. Most of the stone was used for bituminous aggregate, road base, and concrete aggregate.

A dispute, which began in 1990, between a quarry operator and neighbors fighting to limit the quarrying operations in Cumberland continued throughout 1992. Neighbors for a Better Environment (NBE) have been seeking to halt the quarrying operations of Lynch & Sons Inc. from encroaching closer to their properties and have been urging the town council to enact an ordinance restricting noise and air pollution at the quarry site. About 30 NBE member residents have contended that the quarry has illegally expanded from its original parcel where it held grandfathered rights on agriculturally zoned land where quarrying is not permitted. Lawyers for the quarry contend that the entire lot should be considered an industrial zone because the quarry predates the agricultural designation on the town's zoning map, which was adopted in 1952. In a decision handed down by the Superior Court and upheld by the State Supreme Court in July, the Zoning Board was directed to rehear the case. No decision by the board was rendered by yearend.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related experience and has covered the mineral activities in Rhode Island for the past 8 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]"Average number of workers" is a summary of the average number of workers at individual mining establishments during periods (not necessarily continuous) of active operations.

[3]U.S. Department of Labor, Mine Safety and Health Administration. Mine Injuries and Worktime Quarterly, Jan.-Dec. 1992, 32 pp.

RHODE ISLAND

Principal Mineral-Producing Localities

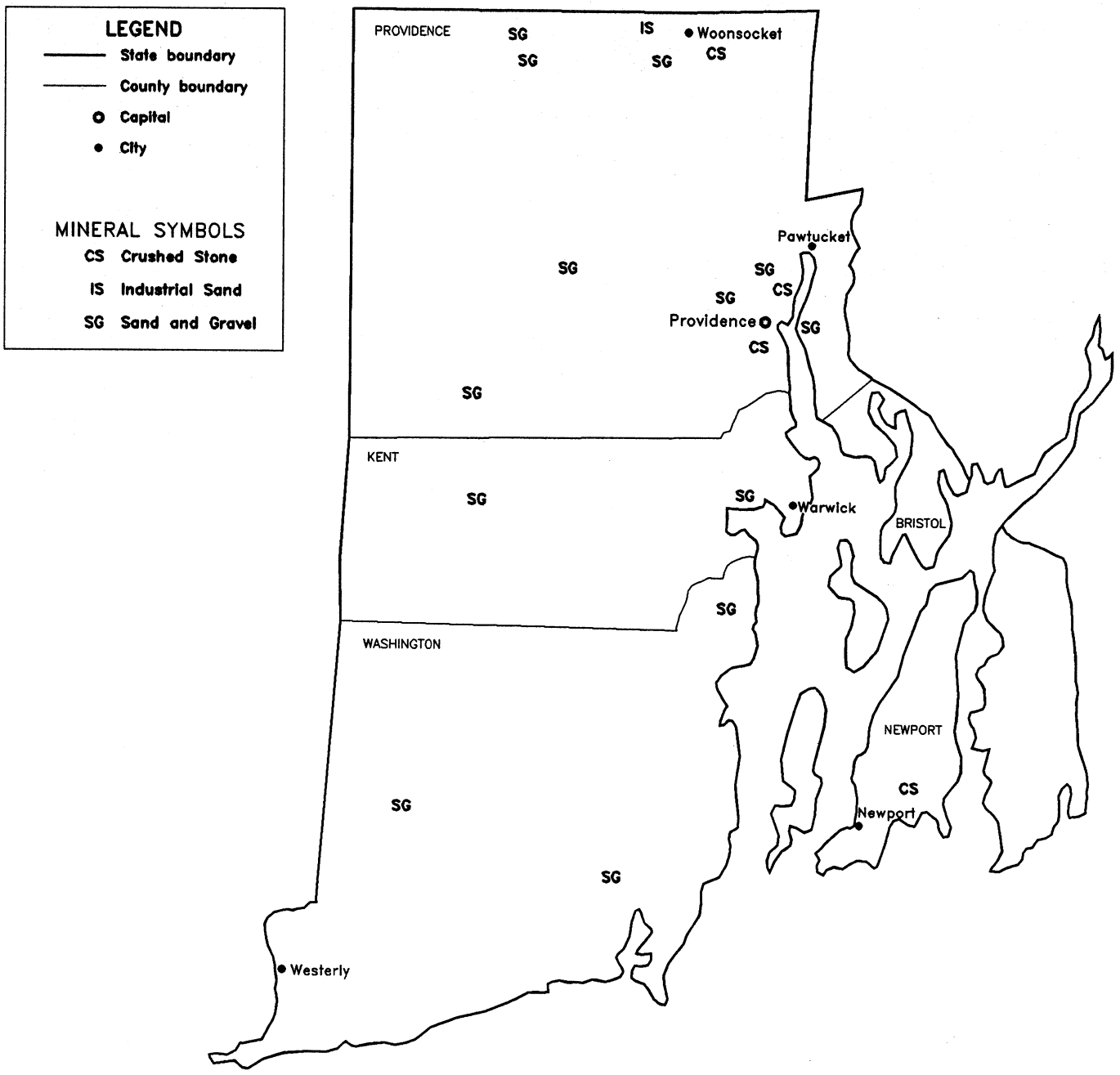

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Construction:			
A. Cardi Construction Co. Inc.	Box 267 Coventry, RI 02816	Pits	Kent.
Material Sand & Stone Corp.	618 Greenville Rd. Woonsocket, RI 02895	Pit	Providence.
Richmond Sand & Gravel Inc.	Box 389 Wyoming, RI 02898	Pit	Washington.
River Sand & Gravel Co. Inc.	400 French Town Rd. East Greenwich, RI 02818	Pit	Kent.
South County Sand & Gravel Co.	Box 3725 Peace Dale, RI 02883	Pit	Washington.
Industrial:			
Holliston Sand Co. Inc.	Box 97, 303 Lowland St. Holliston, MA 01746	Pit and plant	Providence.
Taggart Sand Products Corp.	Moshassuck Valley Industrial Highway Lincoln, RI 02865	do.	Do.
Stone (1991):			
Cherenzia Excavation Inc.	41 Ledward Ave. Westerly, RI 02891	Quarry	Washington.
The Conklin Limestone Co. Inc.	RFD 1 Lincoln, RI 02865	do.	Providence.
J. H. Lynch & Sons Inc.[1]	825 Mendon Rd. Cumberland, RI 02864	do.	Do.
Peckham Brothers Co. Inc.	Box 193 Newport, RI 02840	do.	Newport.
Tilcon Corp.	875 Phoenix Ave. Cranston, RI 02920	do.	Providence.
Todesca Forte Inc.	14 Whipple St. Berkley, RI 02864	do.	Do.

[1]Also sand and gravel.

THE MINERAL INDUSTRY OF SOUTH CAROLINA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the South Carolina Geological Survey for collecting information on all nonfuel minerals.

By Steve W. Sikich[1]

The value of nonfuel mineral commodities mined in South Carolina in 1992 increased 2% to $346.9 million. Although this increase was modest, it was significant when compared with the 24.4% decrease that occurred the previous year. The turnabout was significant in that it indicated the State's mineral industry was rebounding from the recession that had impacted South Carolina and the Nation for the past several years. Because of the interdependency between the State's overall economy and its mineral economy, the turnabout suggested the general recession in the State had ended.

As a result of the increase, South Carolina's national ranking in the value of minerals produced improved from 32d in 1991 to 30th in 1992. The State accounted for slightly more than 1% of all the minerals produced in the United States.

For the eighth consecutive year, South Carolina led the Nation in vermiculite production, ranked second in kaolin output, and remained the only gold-producing State in the Eastern United States.

TRENDS AND DEVELOPMENTS

Although South Carolina's mineral economy increased in 1992, it was still almost 23% less than the record high of $450 million set in 1990. Cement continued to be the leading mineral commodity produced in the State, although its value decreased 6.3% from $99.7 million in 1991 to $93.4 million in 1992. Crushed stone, the leading commodity in 1990, remained almost constant, decreasing less than 1% in value from $84.3 million in 1991 to $83.8 million in 1992. Gold values were published for the first time. South Carolina, with a value of $74.8 million, ranked seventh out of 13 gold-producing States.

The Brewer Gold Mine in Lancaster County terminated mining operations in November. Processing of mined ore was expected to continue at least through mid-

TABLE 1
NONFUEL MINERAL PRODUCTION IN SOUTH CAROLINA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland)	thousand short tons	2,464	$109,644	e2,215	e$99,675	2,296	$93,385
Clays	metric tons	2,062,824	44,486	1,709,205	25,662	1,608,338	27,694
Gemstones		NA	10	NA	10	NA	641
Gold[2]	kilograms	W	W	W	W	6,747	74,832
Sand and gravel:							
Construction	thousand short tons	r8,664	r24,998	e6,600	e18,900	6,896	19,923
Industrial	do.	844	15,972	822	16,348	849	17,316
Stone:							
Crushed[3]	do.	e26,200	e135,400	18,216	84,260	17,600	83,800
Dimension	short tons	r e8,929	r e 848	8,829	854	W	W
Combined value of cement (masonry), gold (1990-91), manganiferous ore, mica (scrap), peat, silver, stone [crushed shell (1990), crushed dolomite (1991-92)], vermiculite, and values indicated by symbol W		XX	r118,475	XX	r94,364	XX	29,305
Total		XX	r449,833	XX	r34,073	XX	346,896

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Recoverable content of ores, etc.
[3]Excludes certain stones; kind and value included with "Combined value" figure.

1993. Although mining operations at the Haile Gold Mine in Lancaster County ended in 1991, gold continued to be processed at the site throughout 1992. The mine closings left South Carolina with only two operations actually mining gold at yearend, Kennecott's Ridgeway Mine in Fairfield County and Consolidated Nevada Goldfields Corp.'s Barite Hill Mine in McCormick County. In May, Amax Gold Inc. announced that it exercised its option to purchase a 62.5% interest in the Haile Gold Mine near Kershaw.

Clay, the State's fourth leading mineral commodity, which dropped more than 42% in value in 1991 from 1990's record high, showed a modest 8% increase in 1992.

Completion of the final phase of construction of the Wando Terminal at the Port of Charleston began in 1992. The project is expected to take 3 years and cost $82 million.

The Radsand Red Quarry, a dimension granite operation in Kershaw County, was acquired by Swanson Granite Co. of Concord, NH.

Showa Denko Carbon Inc. completed an $11 million expansion at its Ridgeway, Dorchester County, graphite plant.

Bavarian Motor Works, better known as BMW, began construction of a $625 million automobile production facility in Greer. Construction is expected to take 4 years, with the first phase of the facility beginning production in 1994 and full production beginning in 1996. In addition to using large amounts of industrial minerals and metals in the manufacturing process, a significant amount of construction aggregates, cement, and other minerals will be needed for building, parking lot, and access road construction.

In August, RSR Corp., Dallas, TX, announced plans to build a secondary lead smelter in either North Carolina or South Carolina. Although a decision on the final site was expected within 2 weeks, RSR had not made an announcement of the final selection by yearend. The proposed smelter would employ 150 permanent workers and process more than 6 million automotive and industrial batteries, each containing an average of 20 pounds of lead. The project will cost an estimated $60 million and is anticipated to take 3 to 5 years for permitting and construction.

EMPLOYMENT

Preliminary data reported by the Mine Safety and Health Administration showed an average of 2,000 people directly employed by South Carolina's mining industry in 1992. This represents a 3.3% decrease from the 2,268 reported for 1991. Of the total number, 895 were employed in surface mines and 1,105 were employed in mills and preparation facilities. More than 4 million employee hours were worked in the South Carolina mineral industry in 1992 without a fatal accident.

Nevada Goldfields' Barite Hill Gold Mine was honored as the South Carolina Employment Commission's top 1992 job creator for the McCormick/Abbeville area. The award is given annually by the State's governor to South Carolina's top 100 job creators. Nevada Goldfields not only provided jobs for more than 40 area residents but also trained many of them in specific skills related to the mining operation.

ENVIRONMENTAL ISSUES

In June, the U.S. Supreme Court announced its decision in *Lucas v. South Carolina Coastal Commission*. In the decision, the Court ruled that South Carolina may have to compensate a property owner who was denied the economic use of his property. This could have a significant effect on mineral-producing companies, not only in South Carolina but also nationally, that have been denied the right to develop or expand their operations because of zoning ordinances or environmental laws. Editorially, the American Mining Congress stated: "The decision will force government to work harder to justify land use and environmental regulations that deprive property owners of the right to develop and use their land. Especially important for mining, the case is directly relevant to the current fierce debates on wetlands regulation, Endangered Species Act reauthorization, and Mining Law reform. All involve placing severe limits on access to and use of private and public lands to protect certain physical attributes of land or to preserve certain species."[2] Coalitions of mining and timber companies, developers, farmers, and other rural landowners have organized movements to support changes in environmental regulations and to file lawsuits similar to the one above.

Stoller Chemical Co. closed its fertilizer plant near Charleston in February amid allegations that fertilizer it exported to Bangladesh and Australia contained toxic cadmium and lead waste. The hazardous material was contained in byproduct dust, which was sold to Stoller by Gaston Copper Recycling Corp. of Columbia. Gaston's parent firm, Southwire Co. of Carrollton, GA, contended[3] that because the material was not waste and was not sent to Stoller for disposal, it was not subject to special handling required by the Resource Conservation and Recovery Act (RCRA). In June, a grand jury indicted Gaston, Southwire, Stoller, Hy-Tex Marketing Inc. of Beaufort, SC, and three company officials for allegedly exporting hazardous waste illegally. Specifically, the companies were charged with conspiracy to violate the RCRA by entering into an agreement to transport hazardous waste without a manifest, treat hazardous waste without a permit, and export the waste without consent of the importing countries. At yearend, the Stoller plant remained closed, Stoller had declared bankruptcy, and the case was still pending trial.

The South Carolina Waterfowl Association (SCWA), an environmental group that has taken a cooperative stance in its dealings with business, has three major programs that guide its corporate sponsorships as follows:

1. Management and enhancement of corporate wetlands,
2. The Adopt-A-Habitat program,
3. Reclamation of mining sites.

Holnam Inc., a Holly Hill cement manufacturer, became an SCWA

corporate sponsor in 1992. The company owns 2,640 acres, 800 of which is wetlands located in Four Hole Swamp near the Frances Beidler State Forest. Traditionally, the swamp, which contains some of the oldest living stands of bald cypress and tupelo in the world, has been a prolific wood duck breeding area. However, extensive logging west of the Holnam tract and Hurricane Hugo reduced nesting habitat to a critically low level. Late in 1992, Holnam and SCWA began installing nesting boxes on the 800-acre tract. Thirty-five boxes had been installed by yearend.

Vulcan Materials Corp.'s 99-year-old Liberty Quarry in Pickens County was selected as the 1992 quarry of the year by the National Stone Association. Two hundred acres set aside by Vulcan at its 400-acre quarry in Pickens County was certified in October as a national wildlife habitat by Wildlife Habitat Enhancement Council, a national conservation organization headquartered in Silver Spring, MD. Enhancements at the quarry included 4 hawk perches set on trees at heights up to 70 feet above ground level, 35 bird houses, 40 martin houses, and 5 wood duck boxes. Other enhancements include the creation of wetlands, food plots, and squirrel boxes.

The Intermountain Field Operations Center, U.S. Bureau of Mines, conducted an assessment of potential mineral deposits that could be affected by construction of the proposed bypass around Anderson. Mineral resources occurring in the 75,000-acre corridor investigated included corundum, crushed stone, gemstones, heavy-mineral sands, pegmatite minerals, and sand.

EXPLORATION ACTIVITIES

Gold exploration in South Carolina was reduced significantly from previous years because of the economic recession and the low price of gold. Renewed prospecting was reported at the Wilson Chapel Road tract in York County.

Geochemical data collected by the U.S. Department of Energy's National Uranium Resources Evaluation Program and the U.S. Geological Survey's National Mineral Resources Assessment Program led to the discovery of three geochemical anomalies that outline placer deposits in the Eastern United States. These anomalies are located (1) at the North Carolina-South Carolina State line region along the Fall Zone, (2) in coastal South Carolina, and (3) at the base of the Fall Zone near the South Carolina-Georgia State line.

Piedmont Mining Co. announced in late November that drilling, engineering, and environmental studies at the Haile property were continuing. Three drill rigs were operating and were expected to continue drilling into 1993. A $4 to $6 million budget for 1993 operations was under review by Piedmont and Amax Gold. The budget calls for two core drills and a reverse-circulation drill to continue operating throughout 1993. Results of 1992 exploration efforts are detailed in the Metals section.

In its report for fiscal 1992, Consolidated Nevada Goldfields Corp. announced that exploration projects, which are continuing at the Barite Hill Gold Mine, resulted in replaced reserves equal to 20% of the year's production. Proven and probable reserves as of June 30, 1992, were placed at 127,700 ounces.

Blythe & McCarter (B&Mc), a local company, indicated that it planned to continue pursuing a permit for a potential gold property near Hickory Grove, York County. A Texas exploration company that had been evaluating the property for B&Mc had abandoned the project shortly before a scheduled public hearing on the permit application on February 13. As of yearend, the property had not been permitted.

LEGISLATION AND GOVERNMENT PROGRAMS

Three bills affecting the mining industry were enacted by the State legislature in 1992. H.R. 4571 provided that the State must assess the economic impact of proposed environmental regulations. H.R. 3907 provided that charges by the Department of Health and Environmental Control for environmental permits must conform with the appropriations bill. H.R. 1287 approved changes in mining regulations requested by the SC Land Resources Division.

The SC General Assembly overruled a SC Department of Highways and Public Transportation (DH&PT) decision to purchase only crushed stone for asphalt road-paving material by passing an ordinance requiring DH&PT to purchase rounded gravels where available. The DH&PT decision had delayed more than $6 million worth of paving projects in 12 counties. The legislative ruling affected mainly eastern South Carolina where the only aggregate available is from sedimentary or rounded sand and gravel deposits.

The Mining and Reclamation Program of the SC Land Resources and Conservation Commission reported that 270 mining companies held 487 mining permits covering 69,746 acres as of December 31, 1992. Although there were 10 more companies and 2,107 more acres permitted than in 1991, there was 1 less active mining operation in 1992. There were also 23 county governments permitted to operate borrow pits. Of the acres permitted, only 20,537 were actually affected by mining, an increase of 1,108 acres from the previous year. To ensure the completion of reclamation after mining, the commission had a total of $12,356,532 on file at yearend, $618,675 more than at the end of 1991. A total of 6,558 acres has been reclaimed and released by the commission. Mined lands were reclaimed as grassland, pastureland, ponds and lakes, woodlands, wildlife habitat, recreational areas, and commercial development.

Norman K. Olson, who has coauthored this report since he became State Geologist in 1969, retired in August after 23 years of service with the South Carolina Geological Survey (SCGS). As of yearend, his replacement had not been named. In his final report to the Association of American State Geologists, Mr. Olson noted that the primary mission of the SCGS is to provide scientific baseline data for environmental studies, facility siting, and mineral resource development through field investigations,

and publication of geologic maps and reports.

In recent years, the SCGS has been active in working to improve earth science education in South Carolina and was instrumental in founding the SC Earth Science Resources Coalition (SCESRC) in 1988. SCESRC includes the Mining Association of South Carolina (MASC), numerous individual mining companies, several other State agencies, the SC Earth Science Teachers Association, and the National Science Foundation. Members were active in the Southeastern Regional Meeting of the National Science Teachers Association held in Charlotte, NC, in December. South Carolina joined forces with a similar group from North Carolina along with the U.S. Bureau of Mines, the U.S. Geological Survey, and the National Stone Association to distribute an estimated 100,000 pieces of literature and 12 tons of minerals (roughly 50,000 individual samples of 17 different minerals) to 10,000 teachers. MASC also distributed approximately 16,000 copies of the South Carolina Mineral Book to elementary school students and teachers.

Paleontologists and students from the University of South Carolina, Columbia, and Winthrop University, Rock Hill, collected several thousand land-animal fossils from the limestone being quarried by Giant Cement Co. near Harleyville. The fossils, which are millions of years younger than the limestone being quarried, were apparently trapped in caverns that developed in the limestone during periods of flooding. Animals either hibernating in the caverns or driven into them by rising flood waters were covered with sand and sealed in a layer of clay. Included in the find were the remains of mastodons, mammoths, horses, camels, wolves, snakes, frogs, and fish. In all, 34 species of mammal, 8 species of turtle, and a number of birds and snake species were identified. The fossils were scheduled for display at the South Carolina State Museum in Columbia.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Ten industrial minerals were mined in South Carolina in 1992. Four additional industrial mineral commodities (cement, synthetic graphite, iodine, and exfoliated vermiculite) were produced from raw materials mined within the State, shipped from other States, or imported. The 10 mined minerals and cement accounted for all of the mineral production listed in table 1 and for more than 80% of the total value of minerals sold in the State in 1992.

Cement.—Portland cement retained its number one position as the most valuable mineral produced in South Carolina after regaining it from crushed stone in 1991. Cement production increased 3.7% from an estimated 2.2 million short tons in 1991 to 2.3 million short tons in 1992. However, its value decreased 6.3% from $99.7 million in 1991 to $93.3 million. Portland cement represented 26.9% of the value of South Carolina's total mineral production, down from 29% the previous year. Nationally, South Carolina retained its 12th-place ranking in both the quantity and value among the 38 States producing portland cement. In the production of masonry cement, it dropped from second to fifth in quantity and from fourth to sixth in value.

Portland cement was manufactured by Giant Cement Co. and Blue Circle Industries, PLC, both near Harleyville, Dorchester County, and by Holnam Inc. near Holly Hill, Orangeburg County. Giant and Holnam also manufactured masonry cement.

Clays.—Clay production fell for the second consecutive year after reaching a record high in 1990. Although production decreased by 5.9%, the value of clay produced gained 7.9% after a drastic 42.3% fall during the previous year. The quantity of clay mined decreased from 1.7 million metric tons in 1991 to 1.6 million metric tons in 1992, while the attendant value rose from $25.6 million to $27.7 million. Nationally, South Carolina ranked eighth in the quantity and ninth in the value of clay produced. Only two types of clay, common clay (used primarily in the manufacture of brick) and kaolin, were produced in 1992.

Common Clay and/or Shale.—Surprisingly, the value of common clay produced increased by 41.4% from $2.2 million in 1991 to $3.1 million in 1992, although the quantity mined decreased by 6%. The quantity decreased from 1.15 million metric tons in 1991 to 1.08 million metric tons in 1992. The unit value of common clay rebounded to $2.90 per ton in 1992 after dropping from $2.50 per ton in 1990 to $1.93 per ton in 1991. South Carolina was the 8th leading State in common clay production but ranked only 15th in its attendant value.

Common clay production was reported by 13 companies with 27 pits in 15 of South Carolina's 46 counties. This represents a decrease of one company and an increase of two pits from the common clay operations reported in 1990. Common clay was used, in order of decreasing volume, in common brick, cement manufacture, face brick, and miscellaneous floor and wall tile.

Major producers in 1992 were Richtex Corp., Lexington and Richland Counties; Dundee Cement Co., Orangeburg County; Blue Circle Cement Co. Inc., Dorchester County; Palmetto Brick Co., Marlboro and Kershaw Counties; Boral Bricks Inc., Edgefield and Lancaster Counties; and Southern Brick Co., Greenwood and Saluda Counties.

Kaolin.—South Carolina continued to rank second nationally in the value of kaolin produced and regained its second-place ranking in the quantity produced after dropping to third in 1991. Kaolin was valued at $24.5 million, 4.7% more than the 1991 value. Production dropped to 523,000 metric tons, 5.8% less than was produced in 1992.

Processed kaolin was produced by five companies from seven pits in Aiken

TABLE 2
SOUTH CAROLINA: KAOLIN SOLD OR USED BY PRODUCERS, BY KIND

(Thousand metric tons and thousand dollars)

Kind	1991		1992	
	Quantity	Value	Quantity	Value
Air-float	352	21,765	370	23,728
Unprocessed	203	1,672	154	819
Total	555	23,437	524	24,547

TABLE 3
SOUTH CAROLINA: KAOLIN SOLD OR USED BY PRODUCERS, BY KIND AND USE

(Thousand metric tons)

Kind and use	1991	1992
Air-float:		
Adhesives	W	W
Animal feed and pet waste absorbent	W	W
Ceramics[1]	3	3
Fertilizers, pesticides and related products	8	8
Fiberglass	W	W
Paint	W	W
Paper coating and filling	4	4
Plastics	W	W
Rubber	167	165
Refractories[2]	W	W
Other uses[3]	r141	160
Exports[4]	29	30
Total	r352	370
Unprocessed: Face brick and other uses	203	154
Grand total	555	524

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes crockery and earthenware, electrical porcelain, fine china and dinnerware, floor and wall tile, pottery, and roofing granules.
[2]Includes refractory calcines and grogs; firebrick, blocks and shapes; refractory mortar and cement; and high-alumina refractories.
[3]Includes animal oil, catalysts (oil refining), chemical manufacturing, ink, medical, sewer pipe, and unknown uses.
[4]Includes ceramics, adhesives, paper filling, pesticides and related products, and rubber.

County. Producing companies were Dixie Clay Co., a subsidiary of R. T. Vanderbilt Co.; J. M. Huber Corp.; Kentucky-Tennessee Clay Co., a subsidiary of Hecla Mining Co.; National Kaolin Co., a subsidiary of W. R. Grace & Co.; and Southeastern Clay Co. Almost 71% of the quantity and over 96% of the value of kaolin produced in Aiken County were air floated. Major end uses for air-floated kaolin were in rubber, which increased 5.1% over 1991's production, and fiberglass, which increased 16.1% in 1992 after decreasing 40.7% the previous year. Data on kaolin used as an oil refinery catalyst and as paper filler, the next most common uses, were withheld. Other uses of kaolin are included in table 3.

Unprocessed kaolin, used primarily in the production of bricks, was reported by Carolina Ceramics Inc., Richland County; Dixie and National, Aiken County; and Richtex Corp., Lexington and Richland Counties. Tables 2 and 3 summarize kaolin used in South Carolina by kind and end use, respectively, for the years 1991 and 1992.

In July, J. M. Huber Corp. applied for a permit to mine kaolin from a 31-acre pit site on a 2,500-acre tract south of Leesburg, Lexington County. Public hearings were held in December, and the application was pending at yearend.

Gemstones.—The value of gemstones produced in South Carolina increased from $10 million in 1991 to $641 million in 1992. The increase resulted primarily from the inclusion of freshwater pearls and shell in the gemstone data. In previous years, mussel producers declined to break down pearl and shell production on a State by State basis. South Carolina ranked 23d nationally, with all 50 States reporting gemstone production in 1992.

Mica.—South Carolina continued to rank fourth nationally in the value of crude mica produced. Production for 1992 increased slightly over that of 1990. The material mined is a fine-grained, white micaceous mineral assemblage that mineralogically would be classified more correctly as sericite. It is marketed as "mineralite." The ore is dry processed and used mainly as a filler in paint, with additional applications in joint compounds, electronic plastics, rubber, and foundry facings. Plant capacity is rated at 25,000 to 30,000 tons per year. Piedmont Mining Co. operated the property, adjacent to the Haile Gold Mine near Kershaw, Lancaster County, through its wholly owned subsidiary, Mineral Mining Co. Inc. In early August, Piedmont announced that it had sold the assets related to its sericite mica mining operation to MMC Inc. of Kershaw Inc. Assets included a 561-acre tract, bagged inventory, mining and processing equipment, and vehicles. The sale price was $909,250.[4]

Spartan Minerals Corp., a subsidiary of FMC, Lithium Division, was one of the Nation's largest producers of ground mica in 1992. The company processed mica and a feldspar-silicate concentrate

TABLE 4
SOUTH CAROLINA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,943	$12,711	$3.22
Plaster and gunite sands	W	W	6.00
Concrete products (blocks, bricks, pipe, decorative, etc.)	337	923	2.74
Asphaltic concrete aggregates and other bituminous mixtures	602	2,052	3.41
Road base and coverings[1]	186	494	2.66
Fill	897	1,346	1.50
Other miscellaneous uses[2]	64	170	2.66
Unspecified:[3]			
Actual	553	1,344	2.43
Estimated	314	883	2.81
Total	6,896	19,923	2.89
Total[4 5]	6,256	19,923	3.18

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

obtained from FMC's lithium operations near Bessemer City, NC, for use by glass and whiteware manufacturers.

Peat.—American Peat and Organics Co. remained South Carolina's only peat producer. The peat is mined for potting soil and soil-conditioning additives from Snuggedy Swamp near the Edisto River in Colleton County. Of 20 producing States, South Carolina ranked 13th in the amount of peat mined in 1992 but only 19th in its attendant value.

Sand and Gravel.—Construction.—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

South Carolina construction sand and gravel statistics are compiled by geographic districts as depicted on the State map. These data are summarized by major-use category in table 4 and by district and use in table 5.

Construction sand and gravel production increased by 4.5% from an estimated 6.6 million short tons in 1991 to 6.9 million short tons in 1992. The attendant value increased 5.4% from $18.9 million to $19.9 million. Nationally, South Carolina ranked 40th and 43d, respectively, in the quantity and value of construction sand and gravel mined in 1992.

Construction sand and gravel production was reported from 53 pits operated by 43 companies in 21 of South Carolina's 46 counties. The five largest companies in order of quantity produced were Brewer Sand Co. Inc. with an operation in Chesterfield County; Becker Minerals Inc. with operations in Colleton, Marlboro, and Sumter Counties; Palmetto Sand Co. Inc. with two operations in Dorchester County; and two companies with one operation each, B & T Sand Co. in Lexington County and Pageland Sand Co. Inc. in Chesterfield County. The leading counties were Chesterfield, Lexington, Sumter, Dorchester, and Aiken.

Most of the sand and gravel produced was shipped by truck, 57.3%, and railroad, 7.0%. Transportation for 16.6% was not specified, and the remaining 19.1% was not transported. Major uses for construction sand and gravel were concrete aggregate, fill, asphaltic concrete, concrete products, and road base or cover.

B & T Sand Co. received a permit in March from the SC Land Resources Commission to mine construction sand and gravel in the Red Bank area of Lexington County.

Industrial.—Although its production increased, South Carolina dropped from 11th to 12th nationally in the quantity and from 10th to 11th in the attendant value of industrial sand and gravel produced in 1992. Industrial sand was produced in 38 States and Puerto Rico. The volume mined in South Carolina increased by 3.3% to 849,000 short tons, and the value increased 5.9% to $17.3 million. The unit value of industrial sand processed in the State increased from $19.88 to $20.40 per ton and continued to be the highest in the Nation, averaging almost 30% more than the national average of $15.75.

Five companies produced industrial sand and gravel in 1992. Listed in order of declining production, the companies were U.S. Silica Co., Whibco Inc., Unimin Corp., Foster Dixiana Corp., and Columbia Silica Sand Co. U.S. Silica Co. mined from three pits in Lexington County. The other producers had one industrial sand and gravel operation each: Whibco Inc. near Leesburg, Kershaw County; Unimin Corp. in Kershaw County; and both Columbia Silica Sand Co. and Foster Dixiana Corp. in Lexington County.

U.S. Silica, located along SC 302 near the Columbia Metropolitan Airport, was the largest producer of ground silica in the United States and possibly the world, according to the company's plant manager.[5] The ground silica is used widely in the manufacture of fiberglass and similar products. U.S. Silica's

TABLE 5

SOUTH CAROLINA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	150	652	1,486	4,807	2,307	7,252
Plaster and gunite sands	—	—	W	W	—	—
Concrete products (blocks, bricks, etc.)	W	W	229	532	W	W
Asphaltic concrete aggregates and other bituminous mixtures	W	W	W	W	399	724
Road base coverings[1]	W	W	77	149	W	W
Fill	W	49	W	296	670	1,001
Snow and ice control	—	—	—	—	—	—
Railroad ballast	—	—	—	—	—	—
Other miscellaneous uses[2]	183	627	362	1,053	167	553
Unspecified:[3]						
Actual	—	—	308	684	245	660
Estimated	74	206	26	68	215	610
Total[4]	406	1,533	2,488	7,589	4,002	10,800
Total[5 6]	368	1,533	2,257	7,589	3,631	10,800

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

principal customers include Owens Corning and Pittsburgh Plate Glass Co.

Over the past several years, Foster Dixiana Corp., which also has a plant in the Columbia area, has switched from about 75% construction sand and gravel to about 85% industrial sand and gravel. New retail products include sand for the toy markets, golf courses, swimming pool filtration, and abrasives.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—For the second consecutive year, crushed stone ranked second in the value of minerals produced in South Carolina. Nationally, the State's ranking in tonnage produced improved from 24th in 1991 to 22d in 1992, while its attendant value remained at 24th. Production of crushed stone dropped 3.4% from 18.2 million tons in 1991 to 17.6 million tons in 1992. The tonnage produced in 1992 was 33% less than the record high of 26.2 million tons produced in 1990, the last year that crushed stone was the leading mineral commodity produced in South Carolina. The value of crushed stone decreased only 0.5% from $84.3 million in 1991 to $83.8 in 1992, but was 38% less than the record high of $135.4 million set in 1990.

The decline in South Carolina's estimated crushed stone production indicated that the anticipated impact of the new long-term Federal Aid Highway bill failed to materialize. The decrease in crushed stone production also mirrored a decrease in South Carolina's construction industry that, according to a survey by the F. W. Dodge Div. of McGraw-Hill, lost 6% in the value of construction contracts in 1992.

Fifty-two crushed stone quarries, 34 granite and 18 limestone (including marble and coquina), were permitted by the State of South Carolina on December 31, 1992. This represents a decrease of 3 operations, all limestone quarries, from the 55 quarries that were permitted 1 year earlier.

Dimension.—Data on dimension stone were withheld in 1992. However, the trend of declining production that began in 1984 continued in 1992. Nationally, South Carolina ranked 24th in the quantity and 25th in the value of dimension stone, which was produced in 34 States and Puerto Rico. In 1991, the comparative ranking was 25th in both categories.

Granite, the only rock type quarried, was produced by three companies, Matthews International Corp. with quarries in Kershaw and Lancaster Counties and North Carolina Granite Co. and Georgia Stone Industries, each with a quarry in Kershaw County. The granite was sold as rough blocks, rough monumental stone, cut veneer stone, and sawed stone blocks.

A granite dimension stone quarry in Kershaw County was included in the properties acquired by Swanson Granite Co. of Concord, NH, when it purchased Coggins Granite Inc. of Elberton, GA, in February. Swanson, operator of the Rock of Ages Quarry in Barre, VT, is one of the Nation's leading dimension stone producers.

Vermiculite.—South Carolina, one of three States in which vermiculite was mined, continued to lead the Nation in both the quantity and value produced. Reported vermiculite production increased by almost 17% in 1992. The increase was due in part to the closing of the W. R. Grace & Co. operations in Libby, MT, in 1991.

Vermiculite was mined by three companies in Laurens County as follows: W. R. Grace & Co., near Enoree; Patterson Vermiculite Co., at Lanford; and Carolina Vermiculite Div. of Virginia Vermiculite Ltd., southeast of Woodruff. A mine operated by Enoree Minerals Corp. in Spartanburg County was inactive during the year.

Laurens County officials announced in October that royalty revenue paid by W. R. Grace & Co. for vermiculite mined from the Laurens County Park would exceed original estimates of $50,000. Mining is expected to be completed by spring 1993. In addition to paying the royalty money, Grace is grading land at the park for tennis courts and two more ballfields.

Grace's mining superintendent was named South Carolina's Miner of the Year by the Mining Association of South Carolina at its annual meeting held in late April. This marked the second time in 3 years that a Grace employee has received the award. The award was given for outstanding contributions to mining in South Carolina in fields such as reclamation, resource conservation, mining operations, public service, and community involvement.

South Carolina continued to rank second in both the quantity and the value of exfoliated vermiculite produced. Eighteen States produced exfoliated vermiculite in 1992. The quantity sold or used increased by 37%, while the attendant value was more than 40% higher than that of the previous year. Exfoliated vermiculite was produced by W. R. Grace, Patterson Vermiculite Co., and Palmetto Co. primarily for use in agriculture, insulation, and aggregate applications.

Other Industrial Minerals.—Two other industrial minerals mined in South Carolina in 1992 did not have sufficient value to warrant inclusion in the preceding section.

A minor amount of manganiferous schist was mined by the Ashe Division of the Boral Brick Co. from the Roberts Mine in Cherokee County for use as a brick colorant. The quantity of manganese ore mined increased considerably over that produced in 1991 but was still well below 1990 production. South Carolina was the only State in which the manganese colorant was produced in 1992. Sericite schist was mined for use in manufacturing brick by Industrial Minerals Inc. in Cherokee County and by Boral Brick Co., Boren Brick Co., and Carolina Ceramics in Kershaw County. Production data for this material are included in the clay statistics.

Several other industrial minerals were processed or used in South Carolina from materials shipped from out of State. Industrial Minerals Inc. in Kings Creek near Blacksburg, Cherokee County, continued to import the calcium borate minerals ulexite and colemanite from Turkey through the Port of Charleston. The minerals, which contain approximately 40% boron oxide, are ground for sale to fiberglass manufacturers.

South Carolina led the Nation in the value of synthetic graphite produced in 1992. Amoco Performance Products Inc. produced synthetic graphite that was processed into low-modulus cloth and fiber and high-modulus fibers in Greenville. Another Greenville company, National Electrical Carbon Co., manufactured carbon and graphite brushes, seals, bearings, and insulators. Both operations originally were owned by Union Carbide Corp. High-modulus carbon fibers also were produced by BASF Corp., Structural Materials Div., in Rock Hill, York County.

Showa Denco Carbon Inc. (SDKC), a subsidiary of Tokyo-based Showa Denco K.K., manufactured graphite carbon electrodes used in high-temperature electric arc furnaces in Ridgeville, Dorchester County. SDKC completed an $11 million expansion at the plant. The plant produces solid graphite electrodes for electric arc furnaces. Each electrode weighs from 1,100 to 2,000 pounds and is capable of conducting up to 100,000 amperes of electricity into the furnaces to produce temperatures ranging from 13,000° C to 14,000° C. Graphite is the only material capable of withstanding thermal and mechanical stresses developed at ultrahigh temperatures. More than 900,000 tons of graphite electrodes is consumed worldwide each year.

Westvaco Corp., Chemical Div., manufactured organic iodine compounds at North Charleston. Kaolin from Florida and ball clay from Tennessee and Kentucky were used by the Kohler Manufacturing Co. to produce sanitaryware at its Spartanburg plant. The plant also produced porcelain, fiberglass, and acrylic plumbing fixtures. International Mill Service processed steel slag for aggregate from Georgetown Steel Corp.'s minimill in Georgetown. Slag from Owen Electric Steel's minimill at Cayce was processed by Alexander Mill Services. Slag from MacAlloy Corp.'s ferroalloy plant in North Charleston was used for aggregate, refractory material, and roofing shingle applications. Nationally, South Carolina ranked 25th and 28th, respectively, in the quantity and value of iron and steel slag produced in 1992.

Metals

The only metals of commercial value mined in South Carolina were gold and byproduct silver, which was recovered during the gold refining process. Only two of the four companies producing gold in 1992 had active mining operations at

yearend. However, all four continued cyanide leaching operations to recover the gold from the ore. Although not mined in South Carolina, several other metals were shipped into the State for processing into higher value products. Included in these were aluminum, copper, nickel and titanium alloys, and steel.

Gold and Silver.—The U.S. Bureau of Mines published production data for gold mined in South Carolina for the first time in 1992. South Carolina retained its ranking as the seventh leading of 13 gold-producing States. Gold production increased significantly in both quantity and value over that produced in 1991. Published reports listed 1992 gold production from the Ridgeway Gold mine at 161,000 ounces[6] and from the Barite Hill Gold Mine at 15,731 ounces for the calendar year ending July 31, 1992.[7]

Amax Gold Inc. announced in May that it purchased a 62.5% interest in the Haile Gold Mine near Kershaw by exercising its option with Piedmont Mining Corp. Under terms of the agreement, Amax paid Piedmont $1.75 million plus 1 million shares of Amax Gold restricted common stock. Through a drilling program begun in 1991, Amax identified more than 10 million ounces of gold with an average grade of 0.061 ounces per ton and a cutoff grade of 0.025 ounces per ton on the 3,675-acre property. Amax and Piedmont will form a joint venture under which a subsidiary of Amax will be the operator. Preliminary studies indicated that the mine has the potential to produce approximately 100,000 ounces of gold annually with production costs in the $200-per-ounce range and a stripping ratio of 5.8:1.

Mining operations at the Brewer Gold Mine at Jefferson were suspended in early November. The processing of mined ore was expected to continue at least through mid-1993. Brewer's parent company, Westmont Mining Co., a subsidiary of Costain America, indicated that a decision to permanently close the mine depended on the price paid for gold and mining costs, as well as the results of exploration that will continue on adjoining properties. Ore remaining probably will not be mined unless economic conditions improve. Brewer planned to reduce its work force by 50 to 60 people, leaving about 35 employees to continue processing ore and perform land reclamation work. The Brewer Gold Mine has produced approximately 40,000 ounces of gold each year since it opened in 1988.

Before the mine's closing, the Lancaster County Planning Commission denied a request by Brewer Mining Co. to mine gold from a site near Buford. Brewer indicated that it planned to extract 18,000 ounces of gold valued at $2.7 million from the site over a 2-year period. Ore would have been processed at Brewer's existing heap-leach facility in adjacent Chesterfield County.

A new exhibit entitled "Finding Gold: The History of Gold Mining in the Southern Piedmont" opened August 30 at the McKissick Museum at the University of South Carolina. The exhibit examines the history and processes of gold mining in the Carolinas and Georgia and features outstanding gold specimens from Harvard University's prestigious mineralogical museum. Some of the more successful mines in the region are spotlighted and show how gold was mined, processed, cast, and minted. The exhibit was scheduled to continue through January 1993. Recovery of silver was reported by three of the four companies mining gold.

Other Metals.—Although gold and silver were the only metals with commercial value mined in South Carolina, significant amounts of copper (1.5% locally) have been reported to occur in the gold ore at the Brewer mine. Recovery of the copper has not been economically feasible.

Nationally, South Carolina ranked ninth of 14 States in both the quantity and the value of primary aluminum produced in 1992. Primary aluminum was produced by Alumax Inc., a wholly owned subsidiary of Amax Inc., at its Mount Holly, Berkeley County, plant. The plant processed alumina, imported from Australia through the Port of Charleston, into primary aluminum. The operation is jointly owned by Amax Inc., with a 73% ownership share and a 23% product share, and Clarendon Ltd., with a 27% ownership share and a 77% product share. The smelter has a nominal production capacity of 181,000 metric tons using two 180-cell potlines with an expansion capability of two additional potlines.

Blasius Group Inc., operating under chapter 11 bankruptcy protection, continued processing recyclable aluminum for scrap dealers at its Spartanburg plant. The scrap was processed in a 30-foot by 90-foot rotary kiln.

Other companies processing aluminum in South Carolina included Alcoa Fujikura Ltd. and Kaiser Aluminum & Chemical Corp. Aluminum used in the manufacture of automotive components and electrical products is processed by Alcoa Fujikura Ltd. at Spartanburg. Kaiser, a Maxxam Inc. subsidiary, produced aluminum forgings in Greenwood. The Stolle Corp., another Alcoa subsidiary, processed aluminum into building products at Gaffney, Cherokee County.

Southwire Co. in April laid off 90 of approximately 500 workers employed at its Gaston Copper Recycling Corp. plant in Gaston. Company officials attributed the reduction in its nonunion work force to "the bad conditions in the copper scrap market compounded by the recession." Gaston processes copper scrap to produce copper wire rod, much of which is exported through the Port of Charleston.

In October, Nucor Corp., Charlotte, NC, announced plans to install a metallurgical/ladle furnace facility with delivery scheduled for the second quarter of 1993. The facility will use a 27.5 million electron volt transformer to process 100-ton heats of steel. Molten steel will be stirred by injecting argon gas. Heidtman Steel Products Inc., Toledo, OH, began construction of a flat-rolled steel processing plant in Sumter in June.

Georgetown Industries Inc., Georgetown, purchased the Florida Wire & Cable Co. division of Ivaco Inc., Montreal, Canada. Georgetown also

announced that it plans to reacquire a majority interest in Georgetown Steel Corp. from Unimetal, a subsidiary of French steel giant Usinor Sacilor SA. Georgetown will buy a 30% stake from Unimetal, which will give it an 80% stake in its subsidiary. The Georgetown minimill produces steel rods. Stafford Rail Products Inc., a subsidiary of Florida Steel Corp., is a major producer of rail track spikes at its Lancaster plant.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 34 years of industry and government experience and has covered the mineral activities in South Carolina since 1989. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

[2]AMC Journal. A Line In The Sand. V. 78, No. 8, Aug. 1992, p. 19.

[3]American Metal Market (New York, NY). Gaston, Southwire Indicted. V. 150, No. 116, June 16, 1992.

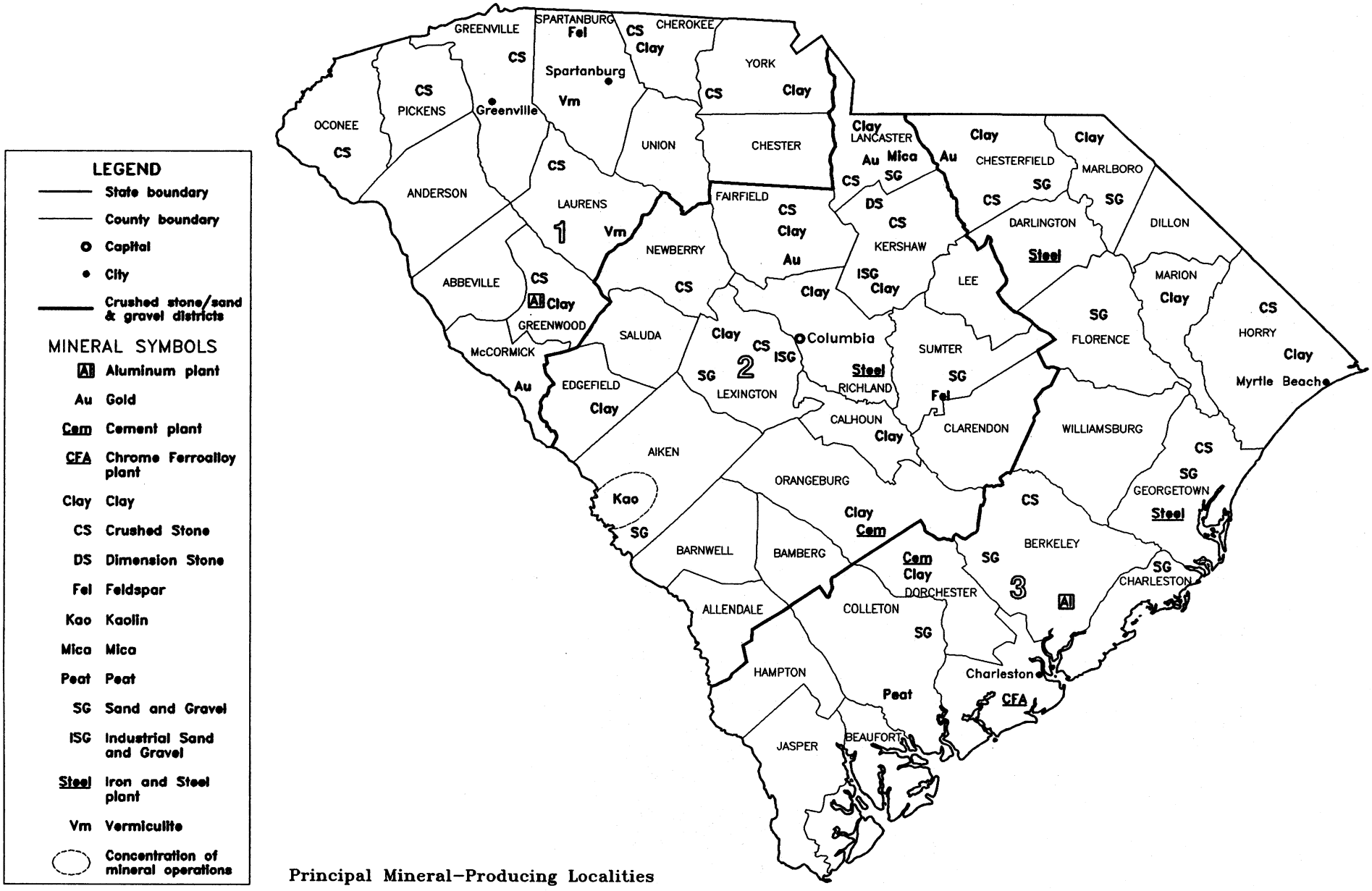
[4]Business Journal (Charlotte, NC). Piedmont Sells Assets. Aug. 10, 1992.

[5]The State (Columbia, SC). Sand Dollars. Dec. 17, 1992.

[6]Sharp, E. Newsletter ILGGM. Feb. 3, 1993.

[7]Messenger (McCormick, SC). Barite Hill Mine Reveals Production Yields. Aug. 6, 1992.

SOUTH CAROLINA



Principal Mineral–Producing Localities

TABLE 6
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Aluminum (smelters)			
Alumax Inc.	Box 1000 Goose Creek, SC 29445	Plant	Berkeley.
Kaiser Aluminum & Chemical Corp.	1508 Hwy. 246 S. Greenwood, SC 29646	do.	Greenwood.
Cement:			
Blue Circle Industries, PLC[1]	Box 326 Harleyville, SC 29448	do.	Dorchester.
Giant Cement Co.[1]	Box 218 Harleyville, SC 29448	do.	Do.
Holnam Inc.[1]	Box 698 Holly Hill, SC 29059	do.	Orangeburg.
Clays:			
Common clay and shale:			
Palmetto Brick Co.	Box 430 Cheraw, SC 29520	Pits and plant.	Kershaw and Marlboro.
Richtex Corp.[2]	Box 3307 Columbia, SC 29230	do.	Lexington and Richland.
Southern Brick Co.	Box 208 Ninety Six, SC 29666	do.	Greenwood and Saluda.
Kaolin:			
J.M. Huber Corp.	Box 306 Langley, SC 29834	do.	Aiken.
Kentucky-Tennessee Clay Co.	Route 7, Box 965 Aiken, SC 29801	do.	Do.
National Kaolin Products Co., a subsidiary of W.R. Grace & Co.	Box 2768 Aiken, SC 29802	do.	Do.
Southeastern Clay Co.	Box 1055 Aiken, SC 29801	do.	Do
Feldspar:			
Spartan Minerals Corp., a subsidiary of FMC, Lithium Div.	Box 520 Pacolet, SC 29372	do.	Spartanburg.
Gold:			
Brewer Gold Co., a subsidiary of Westmont Mining Co.	Route 2, Box 57 Jefferson, SC 29718	Mine and plant	Chesterfield.
Kennecott Ridgeway Mining Co.	Route 2, Box 106 Ridgeway, SC 29130	do.	Fairfield.
Nevada Goldfields Inc.	Box 1530 McCormick, SC 29835	do.	McCormick.
Piedmont Mining Co. Inc.	Box 505 Kershaw, SC 29067	do.	Lancaster.
Mica (sericite):			
MMC. Inc. of Kershaw Inc.	Box 458 Kershaw, SC 29067	do.	Do.
Sand and gravel:			
Augusta Sand & Gravel Co.	Box 472 Clearwater, SC 29822	Pits and plants	Aiken.
Brewer Sand Co. Inc.	Box 267, Route 2 Lancaster, SC 29720	do.	Chesterfield and Lancaster.
Foster Dixiana Sand Co.	Box 5447 Columbia, SC 29250	do.	Lexington.

See footnotes at end of table.

TABLE 6—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone:			
Crushed:			
Martin Marietta Aggregates	Box 30013 Raleigh, NC 27612	Quarries and plant	Berkeley, Georgetown, Horry, Lexington, Richland, York.
Southern Aggregates Co.	Box 191 Jamestown, SC 29453	do.	Berkeley, Horry, Orangeburg.
Tarmac America Inc.	Box 5185 Columbia, SC 29250	do.	Fairfield, Greenwood, Richland.
Vulcan Materials Co.	Box 8834 Greenville, SC 29605	do.	Cherokee, Greenville, Laurens, Pickens, Spartanburg.
Dimension:			
Georgia Stone Industries, Div. of New England Stone Co.	Box 898 Elberton, GA 30635	do.	Kershaw.
Matthews International Corp.	Box 606 Kershaw, SC 29067	do.	Kershaw and Lancaster.
North Carolina Granite Co.	Box 151 Raleigh, NC 27612	do.	Kershaw.
Vermiculite:			
Carolina Vermiculite Div. of Virginia Vermiculite Ltd.	Box 98 Woodruff, SC 29388	Mines and plant	Do.
W.R. Grace & Co.	Route 1 Enoree, SC 29335	do.	Laurens.
Patterson Vermiculite Co.	do.	do.	Do.

[1]Also common clay and crushed stone.
[2]Also kaolin.

THE MINERAL INDUSTRY OF SOUTH DAKOTA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the South Dakota Geological Survey for collecting information on all nonfuel minerals.

By Eileen K. Peterson[1] and Richard H. Hammond[2]

South Dakota mineral producers reported a 1992 value of production for nonfuel minerals of $300 million, an increase of about 4% from the 1991 level of $290 million but still below the record-high level of $319 million reported in 1990.

Both gold production and value increased in 1992 from 1991 levels, 14% and 8%, respectively. Modest increases in value were also noted for cement, feldspar, gypsum, and sand and gravel. Values decreased for clay, lime, mica, silver, and crushed and dimension stone.

Nonfuel mineral production came from 63 of the State's 67 counties. Lawrence County was again the leading county in terms of value for nonfuel mineral production, contributing nearly 70% of the State's total.

The State ranked 34th nationwide in total value of nonfuel mineral production, accounting for about 1% of the Nation's total. South Dakota ranked fourth in gold production, behind Nevada, California, and Utah, and in the top five nationally in production of mica and iron ore.

Gold accounted for approximately $7 out of every $10 of the State's total nonfuel mineral value. In terms of value, leading nonmetallic commodities were portland cement, sand and gravel, and stone. Construction commodities contributed about 24% of the State's total nonfuel mineral production value (see table 1).

TRENDS AND DEVELOPMENTS

Most of South Dakota's industrial minerals production is used in construction. Production of aggregate (crushed stone and construction sand and gravel) in the State decreased more than 6% from 1991 levels.

The decrease in aggregate production could be attributed to a stagnant construction industry, both building and highway construction. Sand and gravel production was not impacted to the extent that crushed stone production was during 1992.

According to U.S. Department of Commerce figures, 2,296 new residential units, valued at $200.6 million, were permitted for construction in 1992. The number of units permitted was down more than 8% but the value was up more than 20% from 1991 figures. Permitted nonresidential construction was valued at $78 million, down more than $24 million from 1991.

State mineral extraction taxes for State fiscal year 1992 (July 1991 through June 1992) generated $4.374 million in revenue for the State treasury. That figure represents a decrease of nearly $1 million from the previous fiscal year. Lower revenues can be attributed to lower gold production and lower gold prices during the State's 1992 fiscal year and, in part, to a severance tax break given to Homestake Mining Co. Gold and silver severance taxes in South

TABLE 1
NONFUEL MINERAL PRODUCTION IN SOUTH DAKOTA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$110	NA	W	NA	$967
Gold[2]	kilograms	17,870	221,157	16,371	$191,217	18,681	207,195
Sand and gravel (construction)	thousand short tons	r9,676	r23,513	e8,700	e20,800	8,279	22,187
Silver[2]	metric tons	10	1,566	7	944	6	802
Stone (crushed)	thousand short tons	e4,800	e16,800	4,824	19,657	e4,500	e18,900
Combined value of cement, clays (common), feldspar, gypsum (crusde), iron ore (usable), lime, mica (scrap), stone (dimension), and values indicated by symbol W		XX	r55,897	XX	57,304	XX	50,619
Total		XX	r319,043	XX	289,922	XX	300,670

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Recoverable content of ores, etc.

Dakota, the highest in the country, are based on a twofold system: companies are taxed on gross production and on profits. Because of continued low gold prices, all gold mining operations in the State were trying to cut production costs to show a profit for the year. If gold prices remain below $350 per troy ounce (tr oz), it will drive some producers currently operating at, or above, the price of gold out of business. Low gold prices have undoubtedly contributed to decisions by some companies to postpone planned expansions.

The gold mining industry in South Dakota faced much uncertainty in 1992. Because of falling gold prices, increasing production costs, and approval of a November ballot issue that could limit mine expansions, most companies were forced to reevaluate future mining plans and operation methods. It can be expected that the number of operators will decline over the next few years.

Two of the four surface heap-leach mines are in fact nearing closure. One completed mining reserves in 1992 and did not identify additional reserves during exploration drilling in the mine area. The other is scheduled to complete mining of permitted oxide reserves in 1993. Although some additional resources have been found, the company has not yet filed for a mine permit with the State. Both mines will continue leaching operations for about 1 year from cessation of mining. The drop in employment, State and local taxes, and severance taxes will be felt throughout the State. Mineral severance taxes have been a significant source of revenue for South Dakota.

A first of its kind stop work order was issued against a large-scale gold mine operator in the Black Hills. The South Dakota Department of Environment & Natural Resources (DENR) issued the order in response to mine permit violations related to acid mine drainage. Issuance of the stop work order has opened the possibility of similar action against other operators. The discovery of acid mine drainage also resulted in closer State DENR examination of waste rock piles at other gold mines in the Black Hills.

Environmental groups, and some citizens in the State, continue to be concerned about environmental problems associated with the large-scale heap-leach gold mines that have been developed in the Black Hills since 1983. The discovery of acid mine drainage problems at a gold mine refueled concerns and will undoubtedly result in additional calls for more regulations as well as stricter control and enforcement of existing regulations on all mining companies.

EMPLOYMENT

South Dakota Department of Labor's 1992 annual report on earnings covered by unemployment insurance indicated the 1992 average mining employment figure of 2,695 was up 6.9% from the 1991 revised average of 2,520 employees. Employment in the mineral resources dependent construction industry also increased slightly in 1992 to 12,488, up from 11,878 in 1991. Employment in oil and gas extraction fell 25% from 1991 figures to 75 people employed in 1992.

The State report also showed that the mining industry in South Dakota continued to have the highest average annual earnings of any industry group in the State in 1992. Average mining earnings were $34,136, up 4% from the $32,810 reported in 1991. Metal mining had the highest average wage at $37,803, oil and gas earnings averaged $30,881, and other mining averaged $25,876. The 1992 average annual wage in the State was $18,016, about 52% of the average for the mining sector.

According to U.S. Department of Labor Mine Safety and Health Administration (MSHA) figures, no fatalities were reported in 1992 in South Dakota's mining and milling operations. During the almost 4.5 million employee-hours worked at mines and milling facilities, a reported 98 injuries occurred to workers resulting in lost workdays, down nearly 20% from that of 1991 when 125 such injuries were recorded. An additional 116 injuries occurred with no workdays lost, down about 22% from 148 such injuries recorded in 1991. Fatalities and injuries were down significantly in the Homestake Mine after the 1991 minewide cleanup and safety evaluation following four deaths in unrelated incidents in the mine during 1991. Reported injuries in the mine fell by 76% from 1991 to 1992.

ENVIRONMENTAL ISSUES

Required environmental controls in place at the State's large-scale surface gold mines allows mining to occur, and at the same time, maintains legislated environmental protection. One surface heap-leach mine completed mining operations in 1992 and after completing leaching operations sometime in 1993, will complete reclamation of the mine site. This will be the first of the heap-leach mines to undertake final site reclamation and will be examined closely, both by the State and by environmental groups, for compliance with State regulations as well as any closure and reclamation problems. Any problems identified during mine closure could result in additional regulations for the three surface heap-leach mines still operating in the State.

During 1992, two Notices of Violation were issued by the South Dakota DENR for mine permit violations related to acid mine drainage problems. Although no fine was assessed, the State DENR ordered the offending mine operator (LAC Minerals Inc.) to immediately stop new mining and waste rock dumping at the mine.

In January 1992, the State DENR identified sulfide waste rock in a valley-fill waste repository at LAC Minerals Inc.'s Richmond Hill heap-leach gold mine as a source of acid mine drainage. The reactive rock was a sulfide-bearing altered amphibolite containing marcasite and pyrite. A rapid rate of acid generation was manifested in elevated rock temperatures atop the waste dump where fumaroles formed and temperatures of 82° C (180° F) were recorded. The DENR ordered LAC Minerals to submit an acid mine drainage mitigation plan to address a long-term plan for how the operator would control the drainage. The

DENR halted all new mining operations in the mine and issued two Notices of Violation. Settlement of the enforcement action was pending at yearend.

Acid mine drainage was an unexpected problem at the mines operating in oxide ore deposits. Identification of the problem at Richmond Hill has, therefore, resulted in closer scrutiny at the three other heap-leach gold mines in the Black Hills.

The South Dakota Board of Minerals and Environment considered options it could use to ensure financial liability from gold mining companies if cyanide spills should occur at the mines they operate. In May, the Board decided three companies, Golden Reward Mining Co. (Golden Reward Mine), Wharf Resources Inc. (Wharf Mine), and LAC Minerals (Richmond Hill Mine), would be allowed to use net worth to meet financial assurance requirements against possible spills. Because of its less stable financial picture, Brohm Mining Corp. (Gilt Edge Mine) would be required to provide either a surety bond, commerical bank guarantee, or a collateral backed note.

Wharf Resources completed construction of a $2.2 million Counter Current Ion Exchange (CCIX) unit in October to remove excess nitrate in spent ore before offloading leached ore from the leach pads. Excess nitrate levels were noted by the State DENR in spent ore piles in 1991. The CCIX plant is designed to operate at up to 1,000 gallons per minute and remove nitrates from 120 parts per million down to fewer than 10 parts per million. According to Wharf Resources 1992 Annual Report, an added benefit of the CCIX process is its ability to recover up to an additional 31 kilograms (kg) (1,000 tr oz) of gold during the pad neutralization process. Wharf Resources is converting the waste stream from the CCIX plant to ammonium nitrate, usable as fertilizer.[3]

Despite Wharf Resources' efforts to mitigate potential environmental impact from the relic Annie Creek drainage tailings, the Environmental Protection Agency (EPA) has proposed to place the site on the National Priorities List (NPL) and under the regulations of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). With approval of the State DENR, Wharf Resources had constructed a rock buttress to contain the tailings and installed a French drain around the tailings. After a rock blanket was placed over the tailings, water quality in Annie Creek improved. Between 1906 and 1916, approximately 163,296 metric tons (mt) (180,000 short tons) (st) of processed ore from mining operations in the Annie Creek drainage was deposited on properties now owned by Wharf Resources. At yearend, it had not been determined by EPA if the site would be declared a Superfund site.

Wharf Resources' 1992 Annual Report indicated the company had agreed to conduct a technical assessment of the drainage and had set aside $1.667 million to cover expected costs of the Engineering Evaluation/Cost Analysis (EE/CA) study on the Annie Creek tailings, as well as EPA oversight costs. The technical assessment was begun in 1992 and an interim EE/CA report was expected early in 1993 and a "Record of Decision" by EPA was expected in 1994.

To limit exposure of migratory birds to process solutions containing cyanide, operators at the Wharf and Golden Reward Mines installed netting over all ponds and ditches containing process solutions. Continued maintenance of the nets is necessary to ensure they do not break under snow or wind loads. Other measures undertaken to reduce the exposure included the installation of drippers at the Wharf Mine in lieu of using sprayers for application of cyanide solution on the leach pads. About 1,300 birds have reportedly died during the past 10 years from cyanide poisoning in the Lead area of Lawrence County. Under the Migratory Bird Treaty Act, a company that kills a migratory bird faces a maximum penalty of $10,000 per bird. No South Dakota mines, however, have been fined to date.

Gold mine operators in the Black Hills have been involved in discussions with the EPA to determine if natural springs, seeps, and stormwater runoff and drainage are to be permitted through traditional or stormwater National Pollutant Discharge Elimination System (NPDES) permits. While awaiting a decision by the EPA, several operators have applied for NPDES permits to avoid possible problems or delays when a decision is reached.

On the Whitewood Creek Superfund site, Homestake Mining Co. signed a consent decree with the EPA that required the company to perform remedial work on the 29-kilometer (18-mile) stretch of the creek declared a Superfund site. Thousands of tons of mine and mill tailings were deposited in the creek over a period of more than 100 years during which Homestake Mining Co., and many other mine operators, used the creek for tailings disposal. Homestake Mining discontinued discharging tailings into the creek in the 1970's. Because Homestake Mining is the only mining company identified as having disposed of tailings in the creek that is still operating, the company was the only identified "potentially responsible party."

The State DENR received a grant from the EPA, through the Western Governor's Association Mine Waste Task Force, to more fully document the hydrogeochemical impacts of mining wastes and to identify areas where improved waste management techniques can be applied. Other States participating in the study are Alaska, California, Colorado, Montana, South Carolina, and Utah.

A proposed ash landfill near Igloo, Fall River County, has been delayed again, this time by a U.S. Army Corps of Engineers warning that the site may contain unexploded chemical and conventional ordnance from the old Black Hills Army Depot.

The Pennington County Air Quality Board tried during the year to determine why Rapid City is the only city in the State that does not meet EPA clean air standards. A study funded by the Board and the State DENR pointed a finger at, but did not make charges against, three large quarries operating west of the city. The final report on the study is expected to be released early in 1993.

Pete Lien and Sons, Inc. installed a new air pollution control device on a vertical kiln at the company's lime manufacturing facility in Rapid City. The kiln had not attained compliance for emission standards with the previous air pollution control unit. After installation of the new unit, emissions dropped from 16.8 kg (37 pounds) of dust per hour to 0.17 kg (0.38 pounds) per hour.[4]

EXPLORATION ACTIVITIES

The South Dakota DENR issued 15 exploration permits in 1992, up from 11 issued in 1991. Six of the fifteen permits were for gold exploration in Lawrence and Pennington Counties by Cyprus Gold Co., Wharf Resources, LAC Minerals, Newmont Mining Corp., and Black Hills Resources. About 1,150 exploration drill holes were permitted, 92% of which were for gold. Not all permitted drill holes were expected to be drilled.

Harrison Western Mining, in a joint venture with Cyprus Gold (Cyprus Minerals Co.) and Texas Star Resources Corp., completed an eight hole drilling program near Keystone, Pennington County. Drilling took place around the old Holy Terror, Keystone, and Bullion gold mines. The best four holes averaged 8.75 grams per mt (0.31 tr oz per st) gold over a width of 4.3 meters (14 feet) (ft). The resource was estimated at 680,400 mt (750,000 st) of ore. Cyprus and Texas Star pulled out of the project late in the year leaving Harrison Western looking for new joint-venture partners.

In Lawrence County, Newmont Mining reportedly has filed in excess of 300 mining claims. The claims are clustered around two sites, the Rochford and Custer Crossing areas. Newmont Mining acquired an interest in a property previously owned by the Noranda Mining Co., which has since discontinued its exploration operations in the Black Hills. Newmont Mining had not contacted the State concerning development on any of the claims at yearend.

In eastern South Dakota, both the South Dakota Geological Survey and private companies were evaluating manganese in the Pierre Shale, a Cretaceous sedimentary rock in Aurora, Brown, Clark, Davison, Hand, Hanson, Jerauld, Lake, Lincoln, McCook, Miner, Minnehaha, Spink, and Turner Counties. Both BHP Minerals International and Addwest Minerals have acquired exploration permits in the eastern half of the State. BHP mines and processes manganese in Australia.

Two mine permits were issued during 1992, one to Homestake Mining Co. for expansion of its Open Cut mine in Lawrence County and one to Pete Lien & Sons, Inc. for a small shale mine in Pennington County.

LEGISLATION AND GOVERNMENT PROGRAMS

During the 1992 session, the South Dakota Legislature passed, and the Governor signed, legislation requiring postclosure plans for mines, including postclosure financial assurance.

On January 1, 1992, a 2-year moratorium on expansion of large-scale gold and silver mining in the Black Hills expired. The moratorium was initiated to allow time for completion and evaluation of a Cumulative Environmental Evaluation (CEE) on such mines in the Black Hills. Following expiration of the moratorium, the 1992 State Legislature approved the Second Century Environmental Protection Act. The act includes a surface mining limit, proposed by the Board of Minerals and Environment and the CEE Task Force, allowing no more than 2,428 hectares (6,000 acres) to be affected by large-scale gold and surface mining at any one time. Mining companies also would have to reclaim 202 hectares (500 acres) by September 1997: the limit could be lifted after that date if State reclamation requirements are found to be adequate. The act also includes a requirement that operating companies file annual reports with the State on surface mine disturbed land and reclamation acreages.[5]

Despite the new law, for the third straight year South Dakota voters were asked to limit gold and silver mining activities in the Black Hills by ballot initiative. An environmental group successfully petitioned to add an initiative to the November 1992 ballot that would lower the legislated acreage limit. The ballot initiative proposed to limit mine expansions to 81 hectares (200 acres) and limit lands affected by new large-scale gold and silver mines to 129 hectares (320 acres) for each new operation. The initiative passed by a 59% to 41% margin. Because of unclear wording in the initiative, State regulators were studying the new law to determine what effect it will have on gold mining in the Black Hills.

The legislature took a historic step in 1992 when it reduced the State tax on gross earnings of mining companies from 2% to 1% for 1 year, effective July 1, 1992. Mining companies having gross sales of more than $50 million will be the only ones affected by the temporary change. All companies will continue to pay a precious-metals tax of 8% on net earnings.

Other legislative action included a bill requiring reclamation of sand and gravel pits within 3 years of the end of mining and a $500 reclamation bond. Operators are surveyed annually by the State DENR to determine when the 3-year limit has been reached.

A 3-year National Science Foundation (NSF) grant of $3 million was awarded to the South Dakota School of Mines and Technology (SDSM&T), the University of South Dakota, and South Dakota State University. SDSM&T will use the NSF "Experimental Program for Stimulation of Competitive Research" (EPSCoR) grant money to study safer ways of mining. Proposed areas of research include ground water movement and aquifer contamination, cleanup of petroleum in soils, and effects of heap-leach mining.

During the year, the two divisions within the South Dakota DENR with mineral development duties were reorganized. The Division of Geological Survey, in Vermillion, has been placed in charge of promotion of mineral development. The Division of Environmental Regulation, in Pierre, will continue to be in charge of regulatory matters related to mineral development.

Division of Geological Survey staff members will be responsible for duties such as developing a coordinated mineral resource data base and bibliography for the State, conducting an assessment of the potential uses of the States's mineral resources, and serving as the primary contact within the department for potential mineral developers.

During 1992 the South Dakota Geological Survey continued to assess the potential for economic deposits of manganese in eastern South Dakota and work on building its mineral resource data base and bibliography.

During the 1992 consideration period, the DENR received two requests from mining companies for determination of "special, exceptional, critical, or unique land determination." Wharf Resources received notification that the land area it submitted for consideration was not eligible for designation, meaning no additional restrictions on mineral resource development would be in effect in those areas. Tinton Partners expected notification early in 1993. A citizens group request for a determination on 3,205 hectares (7,920 acres) in the Dome Mountain-Lost Gulch and Anchor Hill Lookout areas of Lawrence County also was considered by the DENR. Only a limited area, about 40.5 hectares (100 acres), was determined eligible for designation. The designation would have adversely affected any future plans by Brohm Resources Inc. to expand operations at the company's Gilt Edge Mine southeast of Lead.

The U.S. Bureau of Mines Twin Cities Research Center conducted an outreach meeting with gold producers in South Dakota to discuss items of concern for the industry. Areas for possible U.S. Bureau of Mines (USBM) research and outreach were identified, including acid mine drainage, nitrate residuals from blasting, location of voids from previous underground mining, biotechnical remediation of mine wastes, and public education-communication.

An allotment grant of $16,000 from the USBM was received by the Mining and Mineral Resources Research Institute at the South Dakota School of Mines and Technology in Rapid City. The grant was given under provisions of Public Laws 98-409 and 100-483. The purpose of the institute is to coordinate and administer training and research in mining, mineral resources, minerals development, and mineral processing.

During the State fiscal year running from July 1, 1992, through June 30, 1993, research, sponsored in part by the USBM, included: (1) development of a probabilistic slope stability analysis package, (2) study of adsorption behavior of metal ions on various substrates, (3) development of a predictive procedure for pathways and fate of nitrate hydration products in spent ores at heap-leach gold mining facilities, and (4) study of potential chemical contamination from abandoned mines in the Black Hills National Forest. Allotment grant funds were used to support six graduate fellowships.[6]

A three-way land exchange in South Dakota and Colorado was completed in January between Homestake Mining Co., the U.S. Forest Service, and Summit County, CO (and several ski resorts in Colorado). Homestake traded 4,978 hectares (12,300 acres) in Spearfish Canyon in return for 350 hectares (865 acres) in Summit County, CO. Homestake then sold the Colorado land to resorts and Summit County for $8.5 million and received $2 million in timber credits from the Forest Service. The $10.5 million in compensations received by Homestake equals the appraised value of the land in South Dakota. The Forest Service had been working on the deal with Homestake for about 3 years. Because the two parties were trading land between States, the deal required congressional approval and the signature of the President.

South Dakota received $509,000 in Federal royalties for minerals produced on Federal lands within State borders, down from the $592,000 received in 1991. The money represents the State's share of bonuses, rents, and royalties collected by the U.S. Department of the Interior's Minerals Management Service.

FUELS

Permits for new oil and gas wells dropped to eight in 1992, less than one-half the number issued in 1991. Late in the year Hunt Oil Co. announced plans to drill several shallow wildcats wells on the Sioux Uplift near Chamberlain in Buffalo County. There had been no drilling in the area in the past 30 years. The nearest production is about 112.6 kilometers (70 miles) to the northwest in Dewey County.[7]

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Despite continued low gold and silver prices, increasing production costs, and a newly passed ballot initiative regulating surface mining, most gold producers in the State remained hopeful of improvements in the future. The metal mining industry in the State increased employment by 100, primarily in exploration departments. With low metal prices, companies were looking for higher grade ore deposits with low stripping ratios to lower future production costs. Resistance by environmental groups will, however, make future developments expensive and time consuming to undertake.

Gold and Silver.—The quantity of gold produced in the State increased 14% from that of 1991 and the gross value increased 8% according to South Dakota DENR figures. State figures showed gold production from mines in the northern Black Hills at 18,678 kg (600,519 tr oz) with a gross value of about $206 million.[8] Those figures make the 1992 gross value the second highest for gold produced in a single year since record keeping began in 1881 and the seventh highest production. Most of the increase was attributed to Homestake Mining Co.'s underground and open cut operations at Lead.

Production reported to the State DENR by the five operating gold mines was as follows: Homestake Mining, 12,336 kg

(396,626 tr oz);[9] Wharf Resources, 2,958 kg (95,092 tr oz); Golden Reward Mining Co., L.P., 1,590 kg (51,135 tr oz); Richmond Hill, Inc., 990 kg (30,561 tr oz) and; Brohm Mining Corp., 843 kg (27,105 tr oz).[10] USBM data indicated the average price for gold during 1992 was $356.59 per tr oz, compared with $363.29 per tr oz in 1991. About 34% of the gold and 51% of the silver produced in South Dakota came from heap-leaching operations.

Production of silver, obtained as a coproduct with gold at four of the five major gold mines, fell to 6 mt (200,500 tr oz) from the 1991 production figure of 10 mt (324,815 tr oz).

Worldwide demand for silver exceeded the supply available from mine production and secondary sources for the third straight year. The demand, however, did not translate into higher silver prices in 1992; the average price for silver during 1992 was $3.94 per tr oz, compared with $4.04 per tr oz in 1991. Companies with mines that were primarily silver producers suffered through another year of financial losses. South Dakota silver producers are less dependent of silver prices because they are primarily gold producers. Higher silver prices would improve the financial equation for all South Dakota companies producing both gold and silver but probably would never have a significant financial impact.

According to a State document,[11] in 1992 the major gold mining operations processed in excess of 7.8 million mt (8.6 million st) of ore from which 18,678 kg (600,519 tr oz) of gold and 6 mt (201,515 tr oz) of silver were recovered. More than 22.9 million mt (25.3 million st) of waste rock and overburden was moved to recover the gold and silver. The five operating gold mines reported using more than 1.4 million kg (3 million pounds) of cyanide to recover gold and silver during 1992. Of the 1,138 hectares (2,812 acres) permitted to be affected by mining, 571 hectares (1,410 acres) has been affected through 1992.

All major gold operations were within a 11.3-kilometer (7-mile) radius of Lead, in Lawrence County. Four of the five major gold producers recovered gold by heap leaching with cyanide; Homestake Mining used vat leaching with cyanide.

Homestake Mining continued to be the State's largest gold producer, accounting for two-thirds of the total output. Homestake's Annual Report for 1992 reported that gold production levels for the Homestake mines at Lead increased by 24% over production levels from 1991. Production from the underground mine amounted to 8,365 kg (268,952 tr oz), and 3,970 kg (127,674 tr oz) came from the Open Cut. Homestake's mine in South Dakota was the company's largest gold producer, accounting for about 20% of the company's total production. Average grade of processed ore was 4.46 grams (g) per mt (0.158 tr oz per st), up from the average grade of 3.95 g per mt (0.140 tr oz per st) reported in 1991. A total of 2.3 million mt (2.5 million st) of ore was milled with a recovery of 95.2%, up from the 92.7% recovery rate reported in 1991. Total production costs were $337 per tr oz of gold recovered, down from the $400 per tr oz reported in 1991. The company's 1992 annual report also listed yearend reserves at the two mines of 24.5 million mt with 6.1 g per mt gold (27.0 million st with 0.214 tr oz per st).

Increased gold production at the mines was attributed to increased ore grades and increased tonnages milled. The improvements were the result of a comprehensive program in 1991 to reemphasize safe working practices and upgrade underground working conditions. The mine achieved the best quarterly safety record in its history in the fourth quarter of 1992. To lower operating costs, both employees and equipment were shifted from low-grade areas of the underground mine into areas containing a greater density of ore-grade material. The number of stopes being mined was decreased from 309 to 138. Homestake also offered early retirement to 117 hourly workers and 15 salaried employees. In May, a 3-year contract was signed with the United Steel Workers of America. The average pay for all Homestake employees will be $13.93 per hour in 1992 and will increase to $14.21 per hour by June 1, 1994.

Expansion of the Open Cut mine continued during the year with receipt of a State DENR mining permit and relocation or demolition of houses and businesses. Reclamation bonds in the amount of $1.74 million have been posted on the project. Relocation of a highway through Lead and construction of a tunnel for another highway will take place during 1993.

The underground mine has been operated almost continuously for 117 years and has been developed to a depth of 2,438.4 meters (8,000 feet). Drilling conducted in the lower reaches of the mine during the year expanded reserves for the underground operation. The North Homestake Project drift was advanced to a length of 2,825 meters (9,270 feet). Total length of the drift will be 5,090 meters (16,700 feet) when it reaches an area 1,935 meters (6,350 feet) beneath Sheeptail Gulch, north of Central City, in 1995. Homestake believes the Sheeptail Gulch area contains a gold deposit that is an extension of the ore-bearing Homestake Formation that the company has been mining for 117 years. Exploration expenditures for the drift in 1993 will be about $8 million according to company reports.

Homestake remains interested in the possibility of recovering gold from old mine tailings along Whitewood Creek, including the area designated by EPA as a Superfund site. Plans for going ahead with the project are on hold pending higher gold prices. The project would be a joint venture between Whitewood Development Corp. (a wholly owned subsidiary of Homestake) and Goldstake Explorations.

Homestake made a major acquisition during the year when its stockholders approved the issue of 37.2 million common shares to acquire International Corona Corp., a publicly traded Canadian gold producer. The merger reportedly made Homestake the largest gold producer in North America, with about 57 mt (1.845 million tr oz) of gold produced in 1992, and the third largest holder of gold reserves with a combined reserve of approximately 622 mt of gold.

The two companies have four of the world's most productive gold mines: Homestake in South Dakota; Hemlo in Ontario; Round Mountain in Nevada; and Kalgoorlie in Australia.

The 1992 Annual Report of Wharf Resources Inc., operators of the Wharf Mine complex 8 kilometers (5 miles) west of Lead, listed a slight increase in gold production in 1992 to 2,958 kg (95,092 tr oz). According to the company report, about 3.4 million mt (3.7 million st) of ore with an average grade of 0.93 g per mt (0.033 tr oz per st) was processed during 1992. Severance taxes and royalties paid amounted to $22 per tr oz, down from $27 per tr oz in 1991. The mine reached a historic milestone during the year when it produced its 15,552d kg (500,000th tr oz) of gold. Regulatory approval was received from the State during the year to increase the annual mining rate by 12% to 4.08 million mt (4.5 million st).

Mining of the Annie Creek pit was completed in 1992, and the pit is now being backfilled with waste rock from other pits at the mine. Use of mined out pits for waste rock disposal is part of the reclamation plan for the Wharf Mine and will limit the need to disturb additional land areas for disposal of waste rock.

Wharf Resources' Annual Report cited continuing efforts at improving productivity and achieving a lower stripping ratio at the mine, resulting in a 12% reduction of the cash production costs to $183 per tr oz while gold production increased by 2%. Total cost per troy ounce was $259, down from $296 in 1991.

Overall leach pad capacity was increased by 20% to 6.44 million mt (7.1 million st) by partially filling in the areas between the four separate leach pads, making better use of the available space for leaching. The mine now uses buried drippers on each lift of the leach heaps, resulting in improved winter production, lower cyanide consumption, and less surface ponding. Overall gold recovery from the leach pads is about 79%.

Over the past 3 years, exploration activities outside the existing permitted mining area has resulted in a 49% increase in the mine's reserves and could extend the mine life by 5 years, according to the company. Wharf Resources' Annual Report listed total reserves at the end of 1992 at more than 32,000 kg (1.029 million tr oz) of gold within the permitted area and 26,687 kg (858,000 tr oz) outside the permitted area in the Clinton Project. More than 99% of Wharf Resources reserves are on patented claims, according to the company's 1992 annual report.

The process of permitting the Clinton Project area, where the new reserves were located, was begun late in the year and was expected to take 2 years to complete.

Late in 1992, Wharf Resources commissioned a $2.2 million wastewater treatment plant at the mine. According to the company, the plant is designed to remove dissolved nitrates from the spent ore dumps and is the first of its kind in North America.

According to Wharf Resources' Annual Report, despite higher gold production and lower production costs, the mine lost money during the year because of low gold prices and the $1.667 million set aside to cover expected costs associated with an EE/CA study on the proposed Annie Creek tailings Superfund site.

Management of the Golden Reward Mine, adjacent to and east of the Wharf Mine, changed hands during the year when Wharf Resources completed the purchase of 60% of the mine stock from MinVen Gold Corp. in October. Wharf Resources purchased the shares for $21.25 million and loaned MinVen $2 million, repayable over 3 years.

MinVen Gold Corp.'s 1992 Annual Report showed that during 1992, the Golden Reward Mine's first full year of commercial production, the mine processed 1.9 million mt (2.127 million st) of ore with an average grade of 1.07 g per mt (0.038 tr oz per st) to recover 1,290 kg (51,135 tr oz) of gold and 2.1 mt (67,712 tr oz) of silver. Wharf Resources' 1992 Annual Report indicated the company's share of gold production from October 8 to December 31, 1992, was 203 kg (6,534 tr oz) and MinVen's share for the full year was 775 kg (24,909 tr oz). The remaining 613 kg (19,692 tr oz) apparently went to former joint-venture partner United Coin Ltd.

MinVen Gold Corp.'s 1992 Annual Report showed cash costs at the Golden Reward Mine, including royalties and exploration costs, were $398 per tr oz compared with $269 in 1991. Higher stripping ratios and an extensive drilling program were cited as reasons for the jump in cash costs. Operations at the mine were adversely affected by lower than expected gold ore grades and a lack of continuity in the deposit. It was determined by the operating company that developmental drilling information had been inadequate and additional drilling was undertaken.

MinVen's 1992 Annual Report cites proven and probable reserves for the Golden Reward property of more than 7 million mt (7.88 million st) with an average gold grade of 1.2 g per mt (0.043 tr oz per st). Defined mineral deposits within the permitted mine area were cited as containing 3.7 million mt (4.1 million st) with an average gold grade of 1.24 g per mt (0.044 tr oz per st). Outside the permitted mine area, on contiguous acreage controlled by Golden Reward, another 19.57 million mt (11.656 million st) has been defined with a similar ore grade.

Several lawsuits involving the Golden Reward Mine were settled during the year. One involved a payment of $850,000 to MinVen by the design/construction company involved with a failed heap-leach pad. The supplier of a malfunctioning spent ore reclaimer paid MinVen $1.0 million and forgave a $400,000 debt. A dispute over royalty payments with LAC Minerals Ltd. also was settled.

LAC Minerals Ltd.'s, operator of the Richmond Hill Mine, Annual Report for 1992 reported production from the mine at 945 kg (30,373 tr oz) gold and 1.13 mt (36,453 tr oz) of silver from 1.02 million mt (1.1 million st). The average mill head ore grade was 0.76 g per mt (0.027 tr oz per st). Cash production costs were listed at $302 per tr oz with total mine site costs of $510 pe tr oz.

Exploration activities in the mine area were not successful in developing additional reserves, and the company expected to complete mining of the deposit late in 1992 or early in 1993. Treatment of stockpiled ore is expected to continue over the next 2 years. Probable reserves at the mine were listed in LAC Minerals' Annual Report at only 251,300 mt (277,000 st) with an average gold ore grade of 1.7 g per mt (0.06 tr oz per st).

The company encountered problems last year when excessive precipitation resulted in acid mine drainage that spilled into a dry creek bed. Early in 1992, State DENR inspectors detected sulfide waste rock in a valley fill waste depository and subsequent inspections detected acid mine drainage from the dumps. The State has proposed fines in excess of $400,000 as a result of the incident. As required by the State, the company filed an amendment to its reclamation plans to detail how the company will deal with the long-term problem of acid mine drainage. LAC Minerals is treating the drainage with soda ash and crushed limestone to neutralize the water. The State DENR halted new mining and waste rock dumping in July and issued two Notices of Violation in December. An additional $132,000 bond was required by the State to cover expected additional reclamation costs and more bonds may be required to cover long-term reclamation costs associated with acid mine drainage. The bond is separate from the company's original $1.2 million reclamation bond.

The State's move to stop new mining at Richmond Hill in July moved up the company's plan to close the mine late in 1992 by 6 months.

MinVen Gold Corp.'s (parent company of Brohm Mining Corp.) 1992 Annual Report showed 1992 production at the Gilt Edge Mine to have been 835 kg (26,836 tr oz) of gold and 1.4 mt (45,210 tr oz) of silver recovered from 701,064 mt (772,778 st) of ore. The Annual Report also stated that cash production costs were $308 per tr oz compared with $389 per tr oz in 1991. The parent company report indicated mining at Gilt Edge will cease early in 1993 owing to exhaustion of permitted oxide reserves. Heap leaching of mined ore will continue through mid-1993.

In August, mine operators received permission from the State to conduct a small-scale bulk test to heap-leach approximately 36,288 mt (40,000 st) of sulfide gold ore. The test is unique for two reasons. Brohm is attempting to do what no other mining operation in the Black Hills has been able to do—successfully leach sulfide-bearing gold ore.

Although relatively cheap, the process has never proven effective in recovering enough gold to be economical. Cyanide used in the heap-leaching process tends to bond with the sulfates in sulfide ore, rather than with the gold. To counter that tendency, Brohm is crushing the ore much finer than the oxidized ore and is adding an agglomeration compound to the sulfide ore to help the cyanide solution seep through the heap. The heaps also will be allowed to soak for longer periods of time, allowing cyanide to permeate the ore more efficiently. Another reason the test is unique is that if it is successful, it will provide useful information on how to neutralize sulfide ores, information that can be used by other mines in the area to address acid rock drainage problems. Brohm has experimented with adding about 68 kg (150 pounds) of crushed limestone to every 0.9 mt (1 st) of sulfide-bearing gold ore to neutralize acids.[12] The company must be able to convince the State DENR that the sulfides can be neutralized safely before there is any possibility of getting State permits for a full-scale operation.

If test results prove a recovery rate of better than 55% can be achieved, the company planned to pursue necessary permits to allow it to mine and process about 17 million mt (18.75 million st) of currently defined sulfide gold ore.

The company expected capital costs of developing the sulfide ore would be minimal due to maximum usage of existing facilities. If, however, the bulk testing does not prove successful, a substantial portion of the company's remaining $16.7 million investment in the Gilt Edge Mine could be in jeopardy, according to MinVen Gold Corp.'s Annual Report. Although sulfide ore can be treated by other methods, the capital investment required to convert the mine facility would be prohibitive for the financially strapped company.

MinVen's 1992 Annual Report indicated Wharf Mining had defined, but not permitted, 5.56 millon mt (6.13 million st) of oxide ore with a gold grade of 0.76 g per mt (0.027 tr oz per st) and a stripping ratio of 1.11:1. The 17 million mt of sulfide proposed for heap leaching at the Gilt Edge Mine has an average gold grade of 0.99 g per mt (0.035 tr oz per st). An additional 24 million mt (26.4 million st) of contiguous sulfide mineralization, with an average gold grade of 1.13 g per mt (0.04 tr oz per st), has been classified as indicated.

In November, the EPA issued a Compliance Order alleging discharge of pollutants at the mine into two small streams. The company submitted an interim compliance plan for EPA's approval and applied for a point source NPDES permit. MinVen expected future environmental compliance costs could be increased by $180,000 annually and that the costs of modifying existing facilities to meet the anticipated revised compliance standards could cost as much as $522,000.

Continuing concerns about the possibility of acid rock drainage (ARD) prompted the State DENR to require that Brohm submit a comprehensive ARD mitigation plan for the Gilt Edge Mine by June 1993.

Dakota Placers Inc. did not report any gold production to the State for 1992. The company produced 3.8 kg (122 tr oz) of gold in 1991 when it processed alluvial deposits along Whitewood Creek near Deadwood.

In September, The Tinton Partners of Lake Forest, IL, filed a "Request for Determination of Special, Exceptional, Critical, or Unique Lands and Notice of Intent to Operate" with the State DENR. Company paperwork filed with the State indicated the company planned to conduct mining on placer deposits in the historic Tinton mining district in western Lawrence County. The company listed

gold, tin, tantalum, and other precious-metal resources as the targeted metals for recovery.

Mining activities, as proposed in the Notice of Intent, would consist of a hydraulic excavator used to remove about 0.9 meter (3 feet) of material from the streambeds over an area from 3 meters to 12 meters (10 feet to 40 feet) wide and over distances from 274 meters to 914 meters (900 feet to 3,000 feet) along the streambeds of four gulches in the area. A determination by the State of the "Special, Exceptional, Critical, or Unique" qualities of the area was expected early in 1993.

Iron Ore.—Pete Lien and Sons produced iron ore (low-grade hematite) from a pit near Nemo in Pennington County. Eight employees work at the mine, which was operated intermittently during 1992. The ore was used by the South Dakota Cement Plant in Rapid City as an ingredient in cement manufacturing. Although production figures are concealed, production and value figures reported to the USBM decreased significantly from those reported in 1991. The State, however, remained the fourth largest producer of iron ore of nine States reporting production.

Industrial Minerals

The State's industrial minerals sector produced or processed 10 different industrial minerals. The top three, which accounted for more than 23% of the total nonfuel mineral value, were sand and gravel, stone, and lime.

Cement.—All cement manufactured in South Dakota came from the State-owned plant in Rapid City. Production of portland and masonry cement at the plant decreased for the second year but remained second only to gold production in value. Declining demand for portland cement was a direct reflection of a sluggish construction industry in western South Dakota.

Mineral resources used in the manufacturing of cement at this plant included clay, gypsum, iron ore, and limestone. The plant has three kilns, two wet and one dry process. The plant has a finish grinding capacity of 1.36 million mt (1.5 million st).[13] USBM data[14] indicate cement shipments in South Dakota during 1992 amounted to 645,746 mt (711,801 st) of finished portland cement and 3,666 mt (4,041 st) of prepared masonry cement.

Clays.—The South Dakota Cement Commission mined common clay in Pennington County for use in cement manufacturing. Production decreased slightly in both quantity and value, returning to levels reported in 1990. The decline in clay production was a direct result of decreased cement production.

Pete Lien and Sons (Dakota Block Co.) received a small-scale mining permit from the State for a shale mine in Pennington County. According to the permit application, the company planned to produce about 21,773 mt (24,000 st) per year during the 30-year life of the mine. The clay will be used primarily in production of concrete blocks.

American Colloid Co. processed bentonite mined in Wyoming at a mill near Belle Fourche, Butte County. The milling operation employed about 75 people.

The Oglala Sioux Tribe continued to look at the possibility of mining zeolites on the Pine Ridge Reservation, Shannon County. The tribe voted down a proposal to mine the mineral 6 years ago but appears to be willing to look at proposals again because it would boost economic development and employment on the reservation, perennial problems for the tribe. One proposal under consideration by the tribe is to mine the potassium- and calcium-rich mineral (clinoptilolite) and mix it with phosphate mined by the Shosone-Bannock Tribe at Fort Hall, ID, to make fertilizer. Another possibility is for the tribe to mine the clay to make bricks or pottery.

Feldspar.—For the fourth year in a row feldspar production decreased, both in quantity and value. Production decreased by 25% from that reported in 1991. Pacer Corp. of Custer was the sole processor of the hand-cobbed feldspar from pegmatite deposits in Custer County. South Dakota was one of only seven States reporting feldspar production in 1992.

Gemstones.—Rose quartz was the only gemstone of note produced in South Dakota. The rose quartz deposits in Custer County are perhaps the best known and largest sources in the United States. Other gemstones collected in limited quantities in the State included apatite, beryl, spodumene, and tourmaline from pegmatite deposits in Custer and Pennington Counties; Fairburn agates from Custer, Fall River, Pennington, and Shannon Counties; moss agate from Harding County; and barite crystals from Meade County. White to gray alabaster that can be used for carving is found in Pennington County; red pipestone (catlinite) in Minnihaha County also is suitable for carving. Freshwater pearls have been recovered from the Vermillion River and Big Stone Lake, and amber has been found in lignite coalbeds in the northwestern part of the State.

Gypsum.—Crude gypsum was produced in Meade County by the South Dakota Cement Commission for use in cement manufacturing. Both quantity and value of production increased significantly, 57% and 25%, respectively, from 1991 figures. The increases were not reflective of increased cement production because cement production went down. Increased production was probably the result of company stockpiling for future use.

Lime.—Pete Lien and Sons Inc. of Rapid City, Pennington County, was the sole producer of lime in the State. Although concealed, both production and value of quicklime and hydrated lime decreased from figures reported for 1991.

Pete Lien & Sons installed and tested a new air pollution control unit in a vertical lime kiln during the year. During testing, the new unit reportedly

TABLE 2
SOUTH DAKOTA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	924	$3,962	$4.29
Plaster and gunite sands	14	47	3.36
Asphaltic concrete aggregates and other bituminous mixtures	743	2,727	3.67
Road base and coverings[1]	4,478	9,681	2.16
Fill	395	622	1.57
Snow and ice control	43	117	2.72
Unspecified:[2]			
Actual	1,058	3,347	3.16
Estimated	623	1,684	2.70
Total	[3]8,279	22,187	2.68
Total[4 5]	7,511	22,187	2.95

[1]Includes road and other stabilization (cement and lime).
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data do not add to total shown because of independent rounding.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

reduced emissions from the kiln from 16.8 kg (37 pounds) of dust per hour to 0.17 kg (0.38 pounds) per hour. Although point sources for dust in Rapid City have not been identified, actions such as this taken by Pete Lien and Sons can only help improve air quality in the city.

Mica.—Mica production and value both decreased significantly in 1992, continuing a 4-year downward trend. Of the five States reporting scrap mica production, South Dakota was the smallest producer. Pacer Corp. of Custer accounted for the entire State output with scrap mica produced from pegmatites in Custer County.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the USBM for even-numbered years only: data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

South Dakota construction sand and gravel statistics are compiled according to geographical districts as depicted on the State map. Most of the production was from District 4 where population density and large highway construction projects were responsible for a higher than usual demand for sand and gravel.

Construction sand and gravel output decreased more than 14% from that of 1990, the last year of actual data, and was the third highest valued mineral commodity produced in the State in 1992.

State DENR files indicated there were 1,900 licensed sites for production of sand and gravel with permits held by 364 operators.

According to information submitted to the USBM, leading counties in terms of production were Mellette, Codington, Minnehaha, and Pennington. Companies reporting the most production to the USBM were Dakota Road Builders Inc.-Rupp Construction Co., Brownlee Construction Co., Concrete Materials-Sweetman Construction, Pete Lien and Sons-Birdsall Sand & Gravel Co., Fisher Sand & Gravel Co., Myrl & Roy's Paving Inc., and Spencer Quarries Inc. These 7 operators had 61 pits at 20 operations. Statewide, 115 operators reported production from 272 pits at 149 operations. Average unit value for all production was $2.68 per st. Reported values ranged from $5.60 down to $1.09 per st. Major use categories and unit values are shown in table 2. Use by district is shown in table 3.

Stone.—Stone production is surveyed by the USBM for odd-numbered years only: data for even-numbered years are based on annual company estimates. This report contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—Crushed stone production represents the fourth highest value mineral commodity produced in the State. USBM estimates for 1992 are based on responses to quarterly surveys from five companies representing 67% of production. Granite, limestone, quartzite, and sandstone were produced in 1992. Estimated production and value for 1992 both decreased slightly compared with 1991 when actual data were collected. Counties leading in crushed stone production in 1991 were Minnehaha, Pennington, and Hanson. Major uses of the crushed stone were in concrete aggregate, cement manufacturing, lime manufacturing, and graded roadbase.

Dimension.—South Dakota ranked sixth of 34 States in dimension stone production. Production during 1992 was estimated to have remained at about the same level as reported in 1991. Milbank Granite, a dark to medium red granite found in the northeastern part of the State, has been quarried continuously since 1907 and is the major source of dimension stone in the State. Three companies, Cold Springs Granite Co., Dakota Granite Co., and Georgia Stone Industries Inc., produced dimension stone from eight quarries in Grant County. Most of the production was used as monument stone, building stone veneer, steps, and floor tile.

During 1992, Dakota Granite applied to the State DENR to convert three small-scale mining permits in Grant County to a single large-scale mine permit. The conversion would allow the operations to exceed the 10-acre and 22,680-mt (25,000-st) limits placed on small-scale

TABLE 3

SOUTH DAKOTA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	W	W	109	511	W	W	397	1,392
Plaster and gunite sands	—	—	9	21	—	—	5	26
Asphaltic concrete aggregates and other bituminous mixtures	331	987	W	W	W	W	182	1,100
Road base and coverings[1]	1,288	2,866	816	1,667	732	1,420	1,642	3,728
Fill	W	W	W	W	59	113	297	445
Snow and ice control	3	16	3	6	6	10	31	85
Other miscellaneous uses	224	1,291	63	144	400	1,329	—	—
Unspecified:[2]								
Actual	95	262	68	111	429	1,252	466	1,722
Estimated	258	672	75	194	275	759	14	59
Total[3]	2,200	6,094	1,144	2,654	1,901	4,882	3,034	8,557
Total[4 5]	1,996	6,094	1,038	2,654	1,725	4,882	2,752	8,557

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data may not add to totals shown because of independent rounding.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

mining operations. At yearend, no action had been taken to approve or deny the permit.

Cold Springs Granite, the largest granite producer in the world with 30 quarries and 5 plants across the United States and Canada, produced about 60% of its monument granite from South Dakota quarries. The company looked at the possibility of expanding its monument stone operation at Milbank, but no decision was announced during the year.[15]

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[1]Mining engineer, U.S. Bureau of Mines, Denver, CO. She has 17 years of mineral-related work with the government.

[2]Geologist, South Dakota Geological Survey, Vermillion, SD.

[3]Durkin, T. V. State Activities 1992, South Dakota. Min. Eng., May 1992, pp. 475-476.

[4]South Dakota Dep. of Environment and Natural Resources. Water and Environment Today. Summer 1992, Vol. 6, No. 2, p. 9.

[5]———. Summary of the Status of the Large Scale Gold and Silver Surface Mining Industry in the Black Hills for the Year 1992. Feb. 1993, 20 pp.

[6]South Dakota School of Mines & Technology. South Dakota Mining & Mineral Resources Research Institute, Annual Status and Final Report-1993. U.S. Bureau of Mines Grant No. G1124246.

[7]Petroleum Information. Resume 1992.

[8]Reference cited in footnote 3.

[9]Reference cited in footnote 3.

[10]Reference cited in footnote 5.

[11]Reference cited in footnote 5.

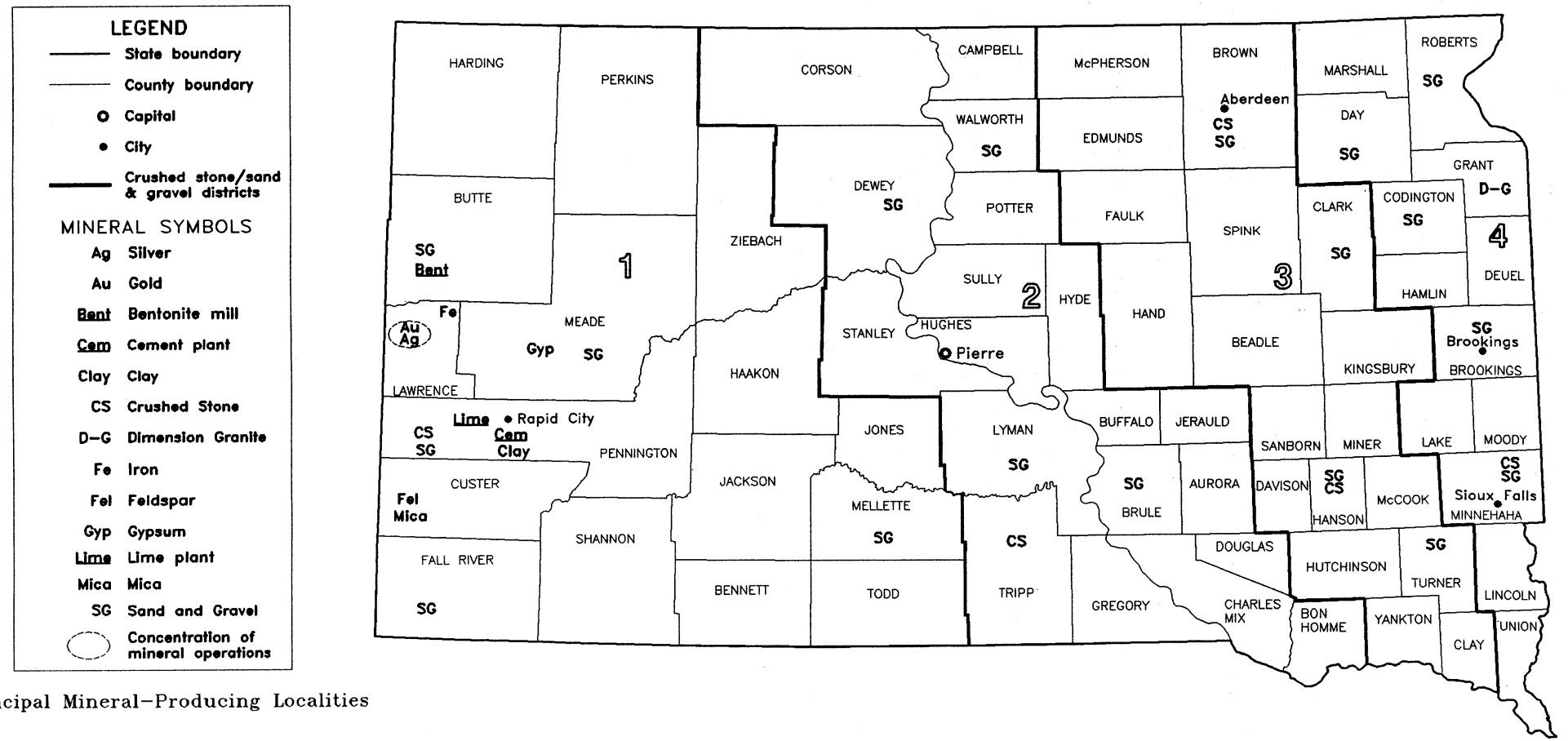
[12]Rapid City Journal. Nov. 24, 1992.

[13]Portland Cement Association. U.S. & Canadian Portland Cement Industry: Plant Information Summary. p. 65

[14]U.S. Bureau of Mines. Cement. Mineral Industry Surveys, Dec. 1992, p. 3.

[15]Daily Times (St. Cloud, MN). Dec. 23, 1992.

SOUTH DAKOTA



Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
South Dakota Cement Commission	Box 360 Rapid City, SD 57709	Plant	Pennington.
Clays:			
South Dakota Cement Commission	do.	Open pit mine	Do.
Feldspar:			
Pacer Corp.	Box 912 Custer, SD 57730	Open pit mines and dry-grinding plant	Custer.
Gold:			
Bond Gold-Richmond Hill Inc., a subsidiary of LAC Minerals Ltd.[1]	Box 892 Lead, SD 57754	Open pit and leach pads	Lawrence.
Brohm Mining Corp., a division of MinVen Gold Corp.[1]	Box 485 Deadwood, SD 57732	do.	Do.
Golden Reward Mining Co., a joint venture of Wharf Resources (U.S.A.) Inc. and MinVen Gold Corp.[1]	Box 888 Lead, SD 57754	do.	Do.
Homestake Mining Co.[1]	Box 875 Lead, SD 57754	Underground mine and open pit, cyanidation mill, gravity separation, refinery	Do.
Wharf Resources (U.S.A.) Inc.[1]	Box 897 Lead, SD 57754	Open pit and leach pads	Do.
Gypsum:			
South Dakota Cement Commission	Box 360 Rapid City, SD 57709	Open pit mine	Meade.
Iron ore:			
Pete Lien and Sons Inc.	Box 440 Rapid City, SD 57709	do.	Lawrence.
Lime:			
Pete Lien and Sons Inc.	do.	Plant	Pennington.
Mica:			
Pacer Corp.	Box 912 Custer, SD 57730	Mine and dry-grinding plant	Custer.
Sand and gravel (construction):			
Birdsall Sand & Gravel Co., a division of Pete Lien and Sons Inc.	Box 767 Rapid City, SD 57709-0767	Pits and plants	Fall River, Pennington, Sully.
Brownlee Construction Co.	717 South Broadway Watertown, SD 57201	do.	Codington.
Dakota Road Builders Inc. (Rupp Construction Co.)	Box 1 Schyton, SD 56172	do.	Millette.
Fisher Sand & Gravel Co.	Box 1034 Dickinson, ND 58602	do.	Butte and McPherson.
Myrl & Roy's Paving Inc.	1300 North Bahnson Sioux Falls, SD 57103	do.	Lincoln and Minnehaha.
Spencer Quarries Inc.	Box 198 Spencer, SD 57374	Pit	Hanson.
Sweetman Construction Inc.	Box 84140 Sioux Falls, SD 57118	Pits and plant	Minnehaha, Roberts, Yankton.
Stone:			
Crushed:			
Limestone:			
Pete Lien and Sons Inc.	Box 440 Rapid City, SD 57709	Quarry and plant	Pennington.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone—Continued:			
Crushed—Continued:			
Limestone—Continued:			
Northwestern Engineering Co. (Hills Materials Co.)	Box 2320 Rapid City, SD 57709	Quarries and plants	Pennington.
South Dakota Cement Commission	Box 360 Rapid City, SD 57709	Quarry and plant	Do.
Sandstone-quartzite:			
L. G. Everist Inc.	Box 829 Sioux Falls, SD 57117	do.	Minnehaha.
Spencer Quarries Inc.	Box 198 Spencer, SD 57374	do.	Hanson.
Sweetman Construction Co.	Box 84140 Sioux Falls, SD 57118	do.	Minnehaha.
Dimension, granite:			
Cold Spring Granite Co.	202 South 3d Ave. Cold Spring, MN 56320	Quarries and plant	Grant.
Dakota Granite Co.	Box 1351 Milbank, SD 57252	do.	Do.

[1]Also silver.

THE MINERAL INDUSTRY OF TENNESSEE

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Tennessee Division of Geology for collecting information on all nonfuel minerals.

By Steve W. Sikich,[1] Robert E. Fulweiler,[2] and Ronald P. Zurawski[3]

The value of nonfuel mineral commodities produced in Tennessee increased 5.1% to $575.8 million in 1992. The year 1992 marked the sixth time in 7 years that the value of the State's mineral output increased over that of the preceding year. However, mineral production in 1992 was 13.1% lower than the alltime record of $662.7 million set in 1990. The increase in nonfuel mineral value did allow Tennessee to improve its national ranking from 19th in 1991 to 18th. In order of value, the most important nonfuel mineral commodities produced in Tennessee in 1992 were crushed stone, zinc, cement, clays, and gemstones. The State led the Nation in the quantity and value of ball clay, in the value of gemstones, and ranked second in the production of zinc.

TRENDS AND DEVELOPMENTS

An end to the recession in Tennessee may have been signaled by an 18% increase in construction contracts, as well as by increases in the State's overall mineral output and the production of construction sand and gravel and crushed stone. Included in the construction were new residential construction (including hotels) valued at $1.78 billion, nonresidential construction valued at $0.78 billion, and alterations and additions valued at $0.57 billion.

Nonfuel mineral production in Tennessee was valued at $28 million more in 1992 than in 1991. Significant increases in the value of 5 of the 12 nonfuel mineral commodities mined or produced in Tennessee were responsible for the overall gain. Mineral commodities that increased in value included crushed stone (9.1% to $243.8 million), construction sand and gravel (26.5% to $35.1 million), industrial sand and gravel (19.8% to $10.7 million), and two metals recovered as byproducts from zinc production. Output of zinc, for which data were withheld to protect company proprietary data, remained essentially unchanged in value although the quantity produced increased. Except for clays, gemstones, and lime, mineral commodities that decreased in value were those that had low production values and, therefore, little effect on the overall mineral value. Clays decreased in value largely because one of the State's two fuller's earth operations was shut down for much of the year. Gemstone production was down because in past years pearl and shell producers included production from other States with

TABLE 1
NONFUEL MINERAL PRODUCTION IN TENNESSEE[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2]	metric tons	1,060,662	$25,776	828,635	$44,572	574,470	$24,097
Gemstones		NA	W	NA	W	NA	23,347
Sand and gravel:							
Construction	thousand short tons	7,619	23,474	e6,700	e21,100	8,478	35,077
Industrial	do.	W	W	W	W	677	10,665
Stone:							
Crushed	do.	e54,600	e268,600	44,088	223,561	e46,700	e243,800
Dimension	short tons	r,e3,460	r,e292	3,460	260	e3,400	e320
Combined value of cement, clays [bentonite (1992), common (1991-92), fuller's earth (1990, 1992), kaolin (1991)], copper, lead, lime, phosphate rock (1990), silver, zinc, and values indicated by symbol W		XX	e344,627	XX	258,294	XX	238,498
Total		XX	r,e662,769	XX	547,787	XX	575,804

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value indicated with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" figure.

Tennessee's production. The decrease in lime contradicted the national trend, in which the value of lime increased by 6.6%.

Announcements of major corporate changes, new operations, or plant expansions affecting Tennessee's mineral industry were fairly frequent in 1992. American Colloid Co. (ACC) purchased the fuller's earth facilities owned by Golden Cat Corp. in Paris, Henry County, in November. ACC also acquired the foundry clay and coal blending operation of Porter Warner Industries in Chattanooga, Hamilton County. Midwest Zinc Co. reopened the old Pacific Smelting Co. (Pasco) plant in Millington, Shelby County. Tennessee Valley Steel Corp. announced that it planned to reopen its steel mill at Harriman, Roane County. BIT Manufacturing Co. completed construction of its new sulfur burner at Copperhill, Polk County. Cyprus-Foote Mineral Co. continued construction of its new plant at New Johnsonville, Humphreys County. Two companies manufacturing equipment for the minerals industry, Linatex Corp. and Bergman USA Inc., began construction of manufacturing facilities in Gallatin, Sumner County. Both companies, which are subsidiaries of Britain's Harrison & Crosfield Plc, also moved their manufacturing and corporate headquarters from Connecticut. Eritech Inc., a North Carolina electrical component manufacturer, also announced plans to build a new facility in Gallatin.

EMPLOYMENT

The Mine Safety and Health Administration (MSHA) reported that an average of 4,447 workers, a decrease of more than 20% from 5,600 workers in 1991, was employed in the nonfuel mineral and coal mining industries in 1992. Of these, 1,451 worked in underground mines, 1,457 in surface mines, and 1,539 in mills and processing plants. Workers in the nonfuel mining sector decreased 4.4% from 3,689 in 1991 to 3,526 in 1992. MSHA also reported three fatal mining accidents in 1992, all occurring in underground coal mines.

The U.S. Department of Labor reported the average earnings of workers in the mining sector increased by 6.8% from $27,474 in 1991 to $29,346 in 1992. The 1992 figure was almost 30% higher than the overall average of $22,631 earned by all workers employed in the private sector and 23.5% higher than the $23,770 average earned by government workers in Tennessee. However, Tennessee miners earned 23.9% less than the national average of $41,553 in the mining industry.

Three-year contract agreements were negotiated by Jersey Miníere Zinc with workers at its Smith County mines and by Asarco Inc. with workers at its New Market Zinc Mine and mill. The Asarco contract ended a 3-week strike by miners.

Colquest Energy Inc. announced in February that it would close its coal mining operations following a National Labor Relations Board recommendation favoring 19 miners that charged Colquest with unfair labor practices because of their union involvement in a 17-month labor dispute. Colquest and two related companies, Four Leaf Coal Co. and Kopper-Glo Fuel Inc., operated coal mines in Campbell and Claiborne Counties.

ENVIRONMENTAL ISSUES

Regulatory issues directly related to the minerals industry were restricted primarily to local objections to proposed quarrying and mining operations. The Tennessee crushed stone industry continued to face the brunt of these challenges, especially in urban areas where residential encroachment and zoning laws have sharply reduced land available for mining operations. Aggregate producers encountering opposition included Friendsville Crushed Stone Inc. in Friendsville, Blount County; Hoover Inc. at Antioch and Nashville, Davidson County, and Nolensville, Williamson County; Harrison Construction Co. at Laws Chapel, Knox County; Standard Construction Co. in Shelby County; and Vulcan Materials Co., which formally withdrew in March its request for a rezoning permit to expand its Lebanon quarry in Wilson County. To a lesser extent, there were complaints about disturbances caused by existing operations.

The Chattanooga Quarry operated by Vulcan Materials Co. received "highest habitat" certification under the corporate wildlife habitat program of the Wildlife Habitat Enhancement Council (WHEC). WHEC is a nonprofit conservation group dedicated to creating wildlife habitat on public lands. Vulcan, 1 of 21 firms recognized in 1992, was chosen for its management of 80 acres of its 400-acre quarry site as wildlife habitat.

The Bond Forfeiture Reclamation Program (BFRC) was combined with the Abandoned Mine Land Program on July 1. The final BFRC project, which consisted of the restoration of a 20-acre site in Pickett County, was completed before yearend.

In an effort to encourage recycling, Metal Resources Inc. of Loudon agreed to pay the Loudon County Beautification Board $0.70 per pound, more than twice the current market value, for used beverage cans (UBC) when sold to the aluminum producer in 40,000-pound lots. The company processes almost 2 billion UBC annually. Of the total aluminum produced, approximately one-half comes from UBC.

The Environmental Protection Agency (EPA) spent more than $75,000 to clean up a silver recycling facility at Coalfield, Morgan County, that had discontinued operations more than 10 years ago. National Priorities List (Superfund) funds were used to pay for the cleanup, although the site was not on the Superfund list. EPA planned to recover the money spent by establishing the liability of the owner of the property at the time the recycling facility was operating, as well as the tenant and anyone who can be shown to have brought film to the site for processing.

Scientific Ecology Group operated one of the world's largest radioactive metal recovery facilities in Oak Ridge. Slightly radioactive scrap metal such as drums, piping, machinery, and tanks is melted in

induction furnaces. In the smelting process most of the contamination floats to the surface to form a slag. The recovered metal is still slightly radioactive but is low enough by U.S. Department of Transportation standards to allow it to be transported as a nonradioactive material. Ingots formed from the recovered metal are being used by the U.S. Department of Energy (DOE) as shield blocks for its high-energy physics research. The recovered slag was disposed of at Chem Nuclear Systems' radioactive disposal facility in Barnwell, SC.

DOE began a medical surveillance to determine the incidence of chronic beryllium disease among current and former workers at its Y-12 nuclear weapons facility in Oak Ridge. All 7,000 current workers and an undetermined number of former employees will be included in the testing program. Chronic beryllium disease, also known as berylliosis, is a progressive occupational lung disease caused by an immunogenic and allergic reaction to beryllium. DOE indicated that up to 5% of the workers exposed to beryllium might develop the disease, with those who inhaled dust created by the machining of beryllium-containing metals at greatest risk. To date, only two workers at the site have shown signs of the disease. The Y-12 plant was built during World War II as part of the Manhattan Project to supply enriched uranium for nuclear weapons. In recent years it has been operated by a division of Martin Marietta Corp. under contract to DOE to produce components for military weapons.

Millington police arrested the owners and three employees of the Phoenix Zinc Co. in January for involvement in alleged commercial operations at its plant in violation of a city code enforcement order. The order barred access to the plant and all other facilities on the former Pulvair Corp. property, except to repair or demolish, until violations cited by the city's fire and building codes inspectors were corrected. The Phoenix facility is included in a 50-acre site subject to a hazardous waste cleanup assessment being conducted by the EPA because of the presence of potentially hazardous waste dating back to the operation of the defunct Pulvair Corp.

Federal funds totaling nearly $500,000 were appropriated to finance the reclamation of three high-priority coal mining sites in eastern Tennessee. The funds were made available shortly before the year ended following an agreement reached by the U.S. Department of the Interior and the TN Department of Conservation and Land Reclamation. The sites were chosen from a priority list submitted by State officials to the Federal Office of Surface Mining. The mines in Anderson, Morgan, and Roane Counties each pose a health and safety hazard. Reclamation work will involve the razing of deteriorating structures, ensuring that water and land are not contaminated, and the filling of vertical shafts.

The Tennessee Department of Environment and Conservation (TDEC) ordered C&C Millwright Maintenance Co. to submit a plan by October 23 specifying how it will excavate areas of the quarry suspected of containing buried toxic waste. Toxic waste contained in 118 barrels buried in the quarry was discovered in March. TDEC has been unable to ascertain when the barrels were buried. The City of Greeneville operated the quarry as a dump from 1967 until 1980 when it was forced to shut down the dump by TDEC. C&C purchased the property from the city in 1986.

In September, C&C filed a civil lawsuit against the City of Greeneville to have its purchase of the property in 1986 rescinded because the city failed to disclose the presence of hazardous waste on the property. A criminal lawsuit had also been filed in the case by the U.S. Attorney's Office. The criminal suit, based on indictments from a Federal grand jury, alleged that six former and current employees of the Recticel Foam Corp. engaged in conspiring for the purpose of illegally treating, storing, and disposing of hazardous waste.

EXPLORATION ACTIVITIES

Exploration activity in 1992 continued at a slow pace largely as the result of weak metal prices and the weak recovery from the recession that has impacted the country for several years.

During February 1992, Tennessee Division of Geology mappers discovered a previously unknown occurrence of the zinc mineral, sphalerite, while mapping the Louisville 7½-minute Quadrangle. The sphalerite was found in the upper part of the Mascot Dolomite within 25 feet of the contact with the overlying Mosheim Member of the Lenoir Limestone. The exposure is partly covered by rubble and was estimated to be approximately 1 meter thick with a lateral extent of 3 to 5 meters. The initial suite of samples collected with the sphalerite shows trace amounts of sulfide minerals identified as chalcopyrite and pyrite that occur as minute grains and veinlets.

Silverspar Minerals Inc., a Canadian company, leased the fluorspar-bearing properties in the Sweetwater area that were once leased by U.S. Borax Co. Fluorspar was last mined in Tennessee in the 1950's. High mining and processing costs made operations in the area uncompetitive with fluorspar produced from richer fluorspar deposits in Kentucky and Illinois. Since then, fluorspar imported from China, Mexico, and South Africa has led to the closing of all but three fluorspar mines in the United States.

LEGISLATION AND GOVERNMENT PROGRAMS

There was no major legislation directly affecting the minerals industry in 1992. Legislation mandating the reorganization of the Department of Conservation into the TDEC that was enacted in 1991 took effect in 1992. As a result of the reorganization, the Tennessee Division of Geology (TDG) and several other sections of the TDEC relocated their Nashville offices. The relocation allowed many of the divisions of TDEC to be in the same building. TDG is now part of the Bureau of Resources Management within TDEC.

With the reorganization, work of TDG includes geologic hazard research, public

service, basic and applied research on the geology and mineral resources of the State, and publication of geologic information. The division also maintains a well cuttings and core sample library. In 1992, it had a staff of 12 professionals and 8 support personnel and operated on a budget of $1.18 million. Before the reorganization, TDG operated with a staff of 32.

Administration of Tennessee's oil and gas and mineral test hole laws was transferred from TDG to the Division of Water Supply in the new department's Bureau of Environment. TDG will still be responsible for maintaining files on oil and gas production, well history reports, geophysical logs and samples, and for classifying oil and gas wells.

TDG is attempting to get outside funding to take advantage of E.I. du Pont de Nemours & Co. Inc.'s offer to donate approximately 40 acres of land in Humphreys County to the division. The property encompasses the geohydrological survey well that was begun by Du Pont in early 1988 and completed in the Upper Cambrian Copper Ridge Dolomite at a depth of 5,827 feet in mid-1991. Du Pont made the offer to TDG to encourage use of the drill hole for additional research and to ensure that research opportunities would be available to all. The site is significant because of its location at a critical junction of several regional geological features: the Illinois Basin, the Cincinnati Arch (Nashville Dome), Reelfoot Rift System, and the Pascolla Arch. There is a definite need for information obtained from this well. If outside funding is obtained, TDG hopes to continue core drilling until basement (igneous) rock has been positively identified and to complete the geophysical logging initiated by Du Pont. Estimated depth to the basement at the well site is 8,500 feet. The complex of buildings also would provide an excellent base from which to conduct geological mapping in western Tennessee. The mapping is of considerable importance because of the increasing potential for renewed movement along the New Madrid Fault System. In addition, the property could be used as a staging area by the Tennessee Catastrophic Earthquake Team should a major seismic event occur in western Tennessee.

In a legal matter affecting the minerals industry, the Federal Bankruptcy Court authorized the sale of retained mineral and mining rights to owners of Tennessee Chemical Co. properties that were purchased at earlier bankruptcy auctions. The initial purchases included only surface rights.

A three-member arbitration panel ruled in March that property owners who leased mineral rights to Union Zinc Co. Inc. should receive back royalties for germanium recovered from zinc ore mined since 1987. The leases specified that the lessors would receive 4% of the value of the ore taken from the leased properties. Owners were paid for zinc and cadmium recovered from the ore when it was refined at Union Zinc's refinery at Clarksville but not for the germanium. Germanium-rich residue collected during the refining process was shipped to Metallurgie Hoboken-Overpelt SA in Belgium for processing. The processed germanium is a key ingredient in fiber optics and infrared devices for missile systems, military helicopters, and tanks. Germanium not used by the military is used by the computer industry in detectors and semiconductors.

FUELS

Tennessee's coal production dropped 35.5%, from 4.29 million short tons in 1991 to 2.77 million short tons in 1992. The Energy Information Administration, DOE, attributed the decrease, which mirrored a decrease in coal production from all States east of the Mississippi, to three principal factors. These were a decrease in demand for U.S. coal in foreign markets, a slower rate of producer/distributor stock buildup, and a drawdown of electric utility coal stocks.

Oil production increased 3.2% from 485,267 barrels in 1991 to 500,665 barrels in 1992. Gas production, however, decreased 4.3% from 1.85 billion cubic feet to 1.77 billion cubic feet.

Nerco Coal announced the cessation of mining operations at the Sequatchie Valley coal mine near Dunlap, Sequatchie County. The mine produced about 2.5 million tons of coal since beginning operations in 1981.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Eight industrial minerals were mined in Tennessee in 1992. Their value accounted for slightly less than 75% of the total mineral value produced in 1992.

Barite.—Tennessee's only barite producer, A.J. Smith Co. operated a mine and jigging plant on a 1,400-acre tract in the Head of Creek area in McMinn County under contract to New Riverside Ochre Co. (NRO) of Cartersville, GA. The property along the McMinn-Monroe Counties line was acquired by NRO from Baroid Corp. Although barite production figures were not reported to the U.S. Bureau of Mines (USBM), NRO officials agreed to publication of the following data. Since NRO acquired the property in 1989, Smith has produced approximately 20,000 metric tons of jigged barite. Production in 1992 amounted to approximately 4,500 metric tons.

Cement.—Nationally, Tennessee ranked 15th in value and 18th in quantity produced of masonry cement. Comparable figures for portland cement were 25th in value and 20th in quantity. Masonry cement was produced in 36 States and portland cement in 39 States.

Cement was produced by Dixie Cement Co. Inc., a subsidiary of Southdown Inc., Houston, TX, at Knoxville and by Signal Mountain Cement Co., a subsidiary of RC Cement Co., Bethlehem, PA, at Chattanooga. Dixie operated a two-kiln, 550,000-short-ton-per-year dry-process plant. Signal Mountain operated a two-kiln, wet-process facility with a 450,000-short-ton-per-year clinker capacity. Raw material for the plant was quarried from Signal's

limestone quarry near Jasper, Marion County, and its Serodino Clay Pit in Hamilton County. The firm has 175 employees with published annual sales of $22 million.

Clays.—Clay production, excluding bentonite, common clay, and fuller's earth that were withheld to protect company proprietary data, was 574,470 metric tons valued at $24.2 million in 1992. Published data for 1991, which included fuller's earth production, was 828,635 metric tons valued at $44.6 million. A valid comparison between the 2 years cannot be made because of the discrepancies between the types of clays included in the published data. Eight companies reported clay production from 23 pits in 10 counties.

Tennessee's national ranking remained at 11th in the volume of total clays produced, but its attendant value dropped from 4th in 1991 to 6th in 1992. The number of States producing clay increased from 44 in 1991 to 45 in 1992.

Tennessee produced 66.5% of the ball clay mined in the United States, a 1.4% increase over the 65.6% produced in 1991. Ball clay was produced by 4 companies from 13 pits in 4 counties. Almost three-fourths of the ball clay was mined in Weakley County.

The types of ball clay sold or used by producers in 1992 were air-float (53.4%), unprocessed (28.6%), and water-slurried (18.0%). The percentages of both air-float and unprocessed ball clay increased from those of 1991, while that of water-slurried ball clay decreased. Ball clay production increased 1.2% from 567,000 metric tons in 1991 to 574,000 tons in 1992. There was a significant shift in the major end uses of ball clay between 1991 and 1992. The end uses in 1991, in order of amount sold or used by producers, were sanitary ware; floor and wall tile; fiber glass; common brick; electrical porcelain; fillers, extenders, and binders; dinnerware; miscellaneous uses; exports; and refractories. In 1992, the order was floor and wall tile; miscellaneous uses; sanitary ware; dinnerware; fillers, extenders, and binders; exports; and refractories.

Ball clay was produced by Kentucky-Tennessee Clay Co. (K-T Clay), Old Hickory Clay Co., H.C. Spinks Clay Co. Inc., and United Clays Inc. K-T Clay completed installation of a new control room and testing facility at its ball clay production facilities in Gleason, Weakley County. The company closed its processing plant near Paris on October 30 but continued its Henry County mining operations in nearby Whitlock. K-T also had ball clay mining and processing operations in Gleason; Mayfield, KY; and Crenshaw, MS. Old Hickory mined from one pit in Henry County and from three pits in Weakley County. Its processing plant and office are in Gleason. Spinks had several active pits and two processing plants near Gleason. Spinks' headquarters and laboratory are south of Paris, Henry County.

United Clays Inc., a subsidiary of Britain's Watts Blake Bearne & Co. Ltd. Plc (WBB), operated six pits in Weakley County and a processing plant at Gleason. WBB purchased the Ceramics Division of Southern Clay Products, a subsidiary of another British company, Laporte Plc. The purchase, which included ball clay and talc operations in Texas, will operate as a division of United Clays. The acquisition gives United Clays operations in Indiana, Mississippi, Tennessee, and Texas.

Crossville Ceramics and Tile Co., Cumberland County, manufactured 1-inch- by 12-inch-square floor tile using a proprietary Swiss process. Principal raw materials for the ceramic tile are ball clay shipped from K-T Clay's Kentucky operation and feldspar from North Carolina.

Common clay production was reported by two companies with six pits in five counties. The State's largest clay producer, General Shale Products Corp., a brick manufacturer, operated one pit each in Anderson, Knox, and Washington Counties and two pits in Sullivan County. The company maintained a brick museum at its headquarters in Johnson City, Washington County. Displays in the museum include bricks from Pompeii and from the original construction of the Colosseum at Rome in 82 A.D. Also displayed are even older bricks from the prepottery Neolithic settlement discovered beneath the Biblical city of Jericho and some 4,000-year-old bricks from the Sumerian city of Nippur. Another exhibit features bricks used as ballast on the Mayflower.

The other company reporting common clay production was Signal Mountain Cement Co., which mined from one pit in Hamilton County for its plant at Chattanooga. Gleason Brick Div. of Boral Bricks Inc. manufactured building bricks from a mixture of ball clay and common clay overburden at Gleason.

Tennessee ranked seventh in both the quantity and value of fuller's earth produced in the United States in 1992. Major end uses of the fuller's earth were for pet waste, industrial absorbents, and as a fungicide carrier.

Fuller's earth was mined by Moltan Minerals Co. from two pits in Hardeman County and processed at its plant near Middleton and by Golden Cat Corp. from two pits in Henry County. Golden Cat discontinued mining and processing before midyear and sold the facilities to ACC in November. Golden Cat purchased the operation from Edward Lowe Industries in late 1990 for almost $3 million and sold it to ACC for the same amount. ACC plans to manufacture only one product, a carrier for agricultural fertilizers that will be sold in both the calcined and uncalcined forms. Its purchase agreement with Golden Cat prohibits ACC from producing any pet waste absorbants (kitty litter) for 5 years. The plant, which is expected to resume mining and processing operations in early to mid-1993, will employ 15 people. Although it will not be producing kitty litter at Paris, ACC developed the process of blending sodium bentonite with traditional attapulgite or calcium montmorillonite clays to form a microgranular (1 mm to 2 mm) absorbant that forms nodules or clumps when moistened by the pet's liquid waste. These clumps can easily be removed from the litter along with the solid waste by simple scooping. As a result, these products are referred to as scoopable or clumping litters. ACC has patented the

TABLE 2

TENNESSEE: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,662	$16,504	$4.51
Plaster and gunite sands	W	W	10.00
Concrete products (blocks, brick, pipe, decorative, etc.)	266	1,418	5.33
Asphaltic concrete aggregates and other bituminous mixtures	1,050	6,686	6.37
Road base and coverings	2,089	5,069	2.43
Fill	184	340	1.85
Snow and ice control	W	W	10.00
Railroad ballast	W	W	11.24
Other miscellaneous uses[1]	89	535	6.01
Unspecified:[2]			
Actual	464	1,530	3.30
Estimated	674	2,995	4.44
Total	8,478	35,077	4.14
Total[3 4]	7,691	35,077	4.56

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes filtration.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[4]Total quantity and total value in thousand metric tons and thousand dollars.

process and licensed it to other pet waste absorbant producers including Golden Cat, Excel Mineral Co., and Clorox Co. ACC also acquired the foundry clay and coal blending operation of Porter Warner Industries (PWI) in Chattanooga earlier in the year. The blending plant is the second of two that ACC operates to service the foundry industry in the southern United States. Terms of the sale and a long-term marketing agreement were not disclosed. The agreement was intended to combine the technical and marketing strengths of ACC with PWI's distribution strength.

Gemstones.—Tennessee once again led the Nation in the value of natural gemstones produced. The value of gemstones produced was reported in 1992 after being withheld in previous years. Gemstone production consisted almost entirely of cultured freshwater pearls and mother-of-pearl derived from freshwater mussel shells of the family Unioidae. Although cultured pearl farming has been established in Tennessee since the late 1970's, the majority of the mussel harvest in Tennessee was exported to Japan where the shells were used to make the bead nucleus for its cultured pearl industry. The shells also were used to make cameos and as mother-of-pearl. The largest producer of cultured pearls in Tennessee was American Pearl Farms, which operated five farms. An associate company, Tennessee Shell Co., was the major producer of mother-of-pearl in the Nation. The value of gemstones produced in 1992, $23.3 million, accounted for 35% of the total gemstone production reported in the United States, although it was significantly less than that reported in previous years. The USBM gemstone commodity specialist attributed this to the State's leading producers having included production from operations in States other than Tennessee in the figures they reported for Tennessee in past years.

A new pan-for-fee gemstone operation opened in Blountville, Sullivan County, in June. Ore containing amethyst, aquamarine, emerald, and ruby is shipped from North Carolina for the facility.

Lime.—Tennessee ranked 16th in the volume of lime produced and 18th in its attendant value in 1992, after ranking 14th in both categories in 1991. Thirty-two States and Puerto Rico produced lime in 1992. Both quicklime and hydrated lime were produced and sold by Tenn-Luttrell Lime Co., a subsidiary of Penn-Virginia Corp., Philadelphia, PA, at Luttrell, Union County. The lime was manufactured from high-calcium limestone quarried from two sites near the plant. Quicklime was produced as a byproduct by the Bowater Southern Paper Corp. at its Calhoun newsprint plant in McMinn County.

Sand and Gravel.—Construction.—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Production of construction sand and gravel increased 26.5%, from an estimated 6.7 million short tons in 1991 to 8.5 million tons in 1992. Its corresponding value increased 66.2%, from $21.1 million to $35.1 million, and its unit value increased 31.4%, from $3.15 per ton in 1991 to $4.14 per ton in 1992. Construction sand and gravel production set an alltime high in 1992, 7.6% greater than the previous record of 7.9 million tons set in 1987. Its attendant value was 21.5% greater than the previous record-high value of $28.9 million, also set in 1987. Tennessee ranked 37th in quantity and 32d in value in comparison with the 49 States producing construction sand and gravel. The value ranking was appreciably higher than the 1991 ranking, but the 1992 quantity ranking stayed the same as that of 1991.

Forty-one companies reported construction sand and gravel production from 52 pits in 24 of Tennessee's 95 counties. The leading producers in terms of quantity were Memphis Stone and

TABLE 3

TENNESSEE: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[1]	2,571	11,348	1,069	4,101	288	2,477
Asphaltic concrete aggregates and other bituminous mixtures	646	3,992	W	W	W	W
Road base and coverings	1,816	4,082	181	772	92	215
Fill	176	316	W	W	W	W
Snow and ice control	W	W	—	—	—	—
Railroad ballast	W	W	—	—	—	—
Other miscellaneous uses[2]	19	210	201	806	282	2,234
Unspecified:[3]						
Actual	325	1,083	138	447	—	—
Estimated	459	1,977	17	81	199	937
Total	6,012	23,008	1,606	[4]6,206	861	5,863
Total[5 6]	5,454	23,008	1,457	6,206	781	5,863

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes plaster and gunite sands.
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.
[5]One metric tons is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

Gravel Co., Vulcan Materials Co., Adamsville Sand and Gravel Co., Teague Brothers Sand and Gravel Co., and Ford Construction Co. Memphis Stone operated three pits in Shelby County and one pit each in Benton and Tipton Counties. Vulcan operated one pit each in Hardin and Hamilton Counties. Adamsville in McNairy County, Teague in Perry County, and Ford in Obion County each operated one gravel pit.

Industrial.—Industrial sand and gravel production increased significantly in both quantity and value in 1992. Tennessee ranked 15th in quantity and 14th in the value of industrial sand and gravel. Production, which was reported for the first time in 1992, increased to 677,000 short tons valued at $10.7 million. Three companies reported industrial sand and gravel production in 1992 compared with two in 1991. The Morie Co. Inc., the Nation's fourth largest industrial sand and gravel producer, had operations near Camden in Benton County and near Bruceton in Carroll County. The sand was sold to the container, molding and core facing, sandblasting, filtration, and traction sand industries. Short Mountain Silica Co., a subsidiary of Little Six Corp., Clintwood, VA, operated a quarry near Mooresburg in Hawkins County. Nicks Silica Co. produced sand primarily for sandblasting and silica flour at Jackson, Madison County. Annual sales of $2 million were reported in the Directory of Tennessee Manufacturers. Industrial sand also was mined by AFG Industries Inc. at Church Hill, Hawkins County, and at Kingsport, Sullivan County, for the manufacture of flat glass at its Kingsport and Greenland plants.

Industrial sand was used to manufacture auto and plate glass by Nashville Glass Co. Div. of Ford Motor Co. in Nashville. J.M. Huber produced silica flour and alum using purchased industrial sand and high-alumina clays as basic raw materials at its Etowah, McMinn County, plant. Fused silica also was produced by CE Minerals, a subsidiary of IMETAL, Paris, France, at its Tennessee Electro Minerals plant in Greeneville, Greene County.

Stone.—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—Estimated crushed stone production increased 5.9%, from 44.1 million short tons in 1991 to 46.7 million short tons in 1992. Its value increased 9.1% to $243.8 million, accounting for 56.8% of the value of industrial mineral production and 42.3% of the total value of nonfuel mineral commodities produced in Tennessee in 1992. Nationally, the State rose from 11th to 10th in the quantity of crushed stone produced and maintained its ranking of 8th in value as the unit value increased from $5.07 per ton in 1991 to $5.22 per ton in 1992. Tennessee accounted for 4.4% of the value of all crushed stone produced in the United States.

The major rock type quarried for crushed stone in Tennessee was limestone, with relatively minor amounts of dolomite, granite, and sandstone being

quarried for construction aggregate. High-calcium limestone was used in the manufacture of cement, lime, and ground calcium carbonate (GCC). Franklin Industrial Minerals quarried limestone for GCC at its Crab Orchard, Cumberland County, and Anderson, Franklin County, operations.

Vulcan, the State's largest crushed stone producer, operated 25 crushed stone facilities from division offices located in Chattanooga and Knoxville. The company also maintained a sales yard in Memphis and a slag plant in Chattanooga. Other Tennessee operations included two asphaltic concrete plants, an emulsified asphalt plant, a paving construction operation, and three ready-mixed concrete plants in Chattanooga. Vulcan also operated asphaltic concrete plants in Cleveland and Dayton, OH, and three facilities (a crusher repair facility, an emulsified concrete plant, and a Mack Truck distributorship) in Knoxville.

Dimension.—Estimated output of dimension stone decreased 1.7% in quantity, but value increased 23.1% as its unit value increased by 25%, from $75.15 per ton in 1991 to $94.12 per ton in 1992. Although the 1992 value of $320,000 was the highest attained in the 1990's, it was dwarfed by the record-high value of $1.86 million set in 1985. Nationally, Tennessee ranked 28th in value and 31st in quantity produced compared with 35 States that produced dimension stone in 1992.

Luck Stone Corp. discontinued quarrying operations at its dimension stone quarry near Friendsville, Blount County. The company continued to operate its finishing plant using both imported marble and marble shipped in from out-of-State. Both the quarry and finishing facilities were for sale at yearend.

The Imperial Black Marble Co., Thorn Hill, Grainger County, is the only producer of black marble dimension stone in the United States. As such, its chief competition is from producers in Italy and Spain. The family-owned quarry was purchased in 1940 and currently has the capacity to produce 10,000 cubic feet of marble annually, although 1992 production was much lower. The quarry owner estimated that at the present consumption rate, more than 2,000 years of black marble reserves are available at the quarry. In addition to being used for building facing and veneer, the black marble is popular as accent stone. The marble is also popular with sculptors and was used for the base of the Martin Luther King, Jr., memorial in Atlanta, GA.

Armstar Corp., Lenoir City, Loudon County, processed four shades of Tennessee limestone into tile for the Dixie Marble Co. of Sylacauga, AL. Crab Orchard Stone Co. began quarrying sandstone in the 1890's for use in construction of 11 buildings on the Scarritt College campus. Since then the distinctive dimension stone has been used worldwide.

Other Industrial Minerals.—At least 10 industrial mineral commodities were shipped into Tennessee where they were used to manufacture higher value products. The value of these added-value products is not included in table 1. Tennessee ranked first nationally in the quantity produced and second in its attendant value of synthetic graphite in 1992. UCAR Carbon Co. Inc. produced synthetic graphite that was processed into anodes, electrodes, unmachined shapes, crucibles, and other carbon products at its plants located at Clarksville, Montgomery County, and Columbia, Maury County. High-modulus fibers were manufactured by Akzo Fortafil Fibers Inc. (a subsidiary of Akzo Corp. Nederland BV, Arnhem, the Netherlands) at Rockwood, Roane County, and by Great Lakes Research Div. (Sigri Great Lakes Carbon Corp., Briarcliff City, NY) at Elizabethton, Carter County.

Holston Defense Corp., a subsidiary of Eastman Kodak Co., Rochester, NY, produced acetic anhydride in Kingsport, Sullivan County. The acetic anhydride is used to manufacture cellulose acetate, which is used to manufacture photographic films, textile fibers, packaging sheets, and varnishes. Holston also manufactured explosives at the facility.

Arsenic trioxide was converted into arsenic acid for use in the production of arsenical wood preservatives by Osmose Wood Preserving Inc. in Millington.

Chemetals Inc., Baltimore, MD, began an expansion of its synthetic electrolytical manganese dioxide (EMD) plant in New Johnsonville in midsummer. The expansion was expected to increase production of the facility by 4,500 metric tons (5,000 short tons) per year and also provide for additional incremental expansions based on market demand. Chemetals is owned by the world's fourth largest manganese producer, Cie Miniere de l'Ogoove (Comilog) based in Gabon. Comilog purchased Chemetals from Geodhem SA of Belgium in 1991. The New Johnsonville plant was built by Foote Mineral Co. and began operations in 1985. Chemetals acquired the plant from Foote in 1987. EMD is manufactured by electrolyzing manganese sulfate solutions prepared from ore that has been reduction roasted. The EMD produced at New Johnsonville was used primarily to manufacture alkaline dry batteries. ESB Materials Corp., Covington, Tipton County, was the only other producer of EMD in Tennessee. A third producer, Rayovac Corp., closed its Covington EMD plant in 1991.

Davison Specialty Chemical Co., a subsidiary of W.R. Grace & Co., Boca Raton, FL, refined thorium-free rare-earth chlorides to produce rare-earth chemicals at Chattanooga. Before switching to the thorium-free chlorides, Davison had been the only American company to process monazite for its thorium content.

Synthetic sodium sulfate was produced for the manufacture of rayon by Lensing Fibers AG of Vienna, Austria, in Lowland, Hamblen County. Lensing acquired the operation from the German Manufacturer BASF in July 1992. The operation has a production capacity of 34,000 metric tons of synthetic sodium sulfate per year, but a proposed expansion scheduled to be completed in 1994 is expected to increase production capacity to 41,000 metric tons annually. The acquisition made Lensing the second

leading rayon manufacturer in the United States. Other producers of synthetic sodium sulfate in Tennessee were North American Rayon Corp. in Elizabethton, Carter County, and J.M. Huber Corp. in Etowah.

Sulfuric acid was manufactured at Copperhill by BIT Manufacturing Co., a subsidiary of Boliden AB headquartered in Stockholm, Sweden. BIT completed construction of its new sulfur burner. The new facility, which went on-line in spring 1992, replaced the old iron roaster that was originally used in the process of converting copper ore to sulfuric acid. When copper mining ended in 1987, the roaster was converted to burn sulfur but was inefficient. The new burner allows BIT to sell electricity from its cogenerating operation to TVA. The new facility, which is a part of the No. 6 acid plant, also allowed BIT to shut down the No. 4 plant that was built in 1964 and the No. 5 plant that was built in 1971. The two plants were combined into one operation in 1976.

Sulfuric acid and byproduct gypsum were produced as byproducts of zinc refining operations at Jersey Minfere Zinc Co.'s facility in Clarksville. Byproduct gypsum was also produced by the phosphate refining operations in Maury County before they closed. Tennessee ranked seventh in quantity and fifth in value out of nine States in which byproduct gypsum was produced.

Cyprus-Foote Mineral Co. (CFM) began an expansion of its butyllithium production facilities at New Johnsonville, Humphreys County. Completion of the project was scheduled for 1993. CFM also indicated that it was beginning studies to increase production 50% by building a second plant at New Johnsonville. Butyllithium is used in rubber and pharmaceutical products produced from lithium metal as the raw material.

Olin Corp., Charleston, Bradley County, used 448,000 short tons of salt to produce chlorine at its 256-ton-capacity chloralkali plant. In all, Tennessee manufacturers used 708,000 tons of salt in 1990, 2% more than the 696,000 tons used in 1989.

Perlite from the western United States was expanded by the Chemrock Corp. of Nashville for use in lightweight aggregates, insulation, absorbents, and horticultural products.

E.I. du Pont de Nemours & Co. Inc. manufactured titanium tetrachloride from rutile, ilmenite, and high-TiO_2 slag at its New Johnsonville titanium dioxide pigment plant.

J.M. Huber Corp., Chemicals Div., began manufacturing detergent-grade zeolites at its Etowah, McMinn County, facility. Huber was previously involved in zeolite production in the 1970's and early 1980's. The decision to reenter the zeolite market stemmed from the decreased use of phosphates in detergents because of environmental regulations. Also produced at the facility were silica flour and alum, using purchased industrial sand and high-alumina clays as basic raw materials. Caustic soda and sulfuric acid also are used in processing operations at the plant.

Metals

Zinc was the only metal mined in Tennessee in 1992. Minor quantities of several other metals, cadmium, germanium, lead, and silver, were recovered as byproducts when the zinc ore was refined. Recreational gold mining continued in the old Coker Creek gold district. A gold mining club, Weekend Gold Miners headquartered in Ellijay, GA, has a nonexclusive lease on private land where members mine gold from placer deposits using portable dredges and pans. Coker Creek Village operates a pan-for-fee operation for naturally occurring gold-bearing deposits.

Secondary metals manufactured from raw and recycled materials shipped in from out-of-State or originating in Tennessee were significant contributors to the State's mineral industry, although they were not included in table 1. Included in this group are aluminum, ferroalloys, lead, manganese, steel, titanium, uranium, and zinc.

Zinc.—Zinc was mined by Asarco Inc. and Union Zinc Co. Inc., a subsidiary of Belgium's ACEC Union Minière SA. Asarco operated the Young, New Market, Immel, and Coy Mines, all in eastern Tennessee. Union Zinc's operations included two mines and mills in eastern Tennessee, a mine and mill in central Tennessee, and a refinery at Clarksville. The facilities are run by three divisions of Union Zinc. The Davis Mine and mill at Jefferson City and the Idol Mine in the Copper Ridge zinc district were operated by the Jefferson City Zinc Co. and the Clinch Valley Mining Co., respectively. In middle Tennessee, Jersey Minière Zinc Co. operated the Elmwood-Gordonsville Mine and mill in Smith County and the zinc refinery at Clarksville.

In November, Asarco announced a reorganization that company officials said reflects the completion of the company's redirection from a custom smelter and refiner to an integrated producer of nonferrous metals. Effective in April 1993, Asarco will form two organizations composed of its copper operations and its lead-zinc and aggregates operations. The latter will include Asarco's Tennessee Division of Mining, headquartered in Strawberry Plains, Jefferson County, and American Limestone Co., headquartered in Knoxville.

Although the Bureau withholds zinc production data in Tennessee to protect company proprietary data, outside sources[4] reported that Asarco's four mines in Tennessee had a production of approximately 67,900 metric tons of zinc in 1992. This represented an increase of 900 tons over that reported in 1991. Nationally, Tennessee maintained its ranking as the second leading State in the production of zinc.

Midwest Zinc Co., a Chicago-based subsidiary of U.S. Zinc Co., reopened the old Pasco plant in Millington that it purchased in June for $1.2 million. Pasco, a subsidiary of Canada's Pigment and Chemical Co., closed the plant in mid-1991. The purchase of the Pasco facility, which had the capacity to produce 3 million pounds of zinc oxide monthly, raised U.S. Zinc's total capacity to 6 million pounds per month. Midwest indicated that initially the plant would be operated at no more than 30% capacity.

Company officials indicated that it will benefit from increased demand for zinc oxide from rubber producers (up by 8% to 10% from 1991) and a lessening of competition caused by the withdrawal of at least two other zinc oxide producers from the domestic market.

Zinc Products Div. of the Ball Corp. produced penny blanks, zinc battery cans, and rolled strip zinc at its plant at Greeneville. North American Oxide produced 12 grades of zinc oxide for the rubber, chemical, paint, plastics, ceramics, and other industries at its new Clarksville plant.

Horsehead Resource Development Co. recovered cadmium, iron, lead, and zinc from electric arc furnace (EAF) dust at its recycling facility in Rockwood. The separation of the contained metals in EAF dust is made by a two-stage kiln volatilization process. In the first stage, all nonferrous metals are volatilized to produce a marketable iron metal. In the second stage, cadmium, chloride, fluoride, and lead are selectively volatilized to separate them from the zinc oxide. The volatilized product referred to as lead-cadmium concentrate is used to produce cadmium metal and a lead- and silver-rich intermediate product that is sold to lead smelters.

EAF dust also was processed at the Florida Steel Co. plant in Jackson. IMS Inc., a wholly owned subsidiary of EnviroSource Inc., Stamford, CT, operated the on-site facility.

Other Metals.—The Aluminum Company of America (Alcoa) operated a two-potline, 200-metric-ton-per-year plant at Alcoa, Blount County. Alcoa cut the work force at its aluminum can stock mill facility by 15% in mid-1992. Company officials tied the move to "current market conditions and a need to cut costs."[5]

Alcan Aluminum Ltd. operated an aluminum scrap facility at Shelbyville, Bedford County. An Alcan subsidiary, Alcan Recycling Co., operated a 140-million-pound-per-year secondary aluminum smelter at Shelbyville, Bedford County. The plant processed recycled aluminum diecaster scrap but did not process UBC. A secondary aluminum smelter and milling facility was operated by Consolidated Aluminum Corp. at New Johnsonville.

Imco Recycling Inc. completed a $3.7 million upgrading and expansion program at its Rockwood aluminum recycling facility in January. The expansion included a new recycling furnace that raised the plant's capacity by 20%. Also installed were new shredding and delacquering equipment that increased the ability to recover metal from UBC. The Texas-based company is the world's largest independent recycler of aluminum UBC and its byproducts.

Metal Resources Inc. (MRI) recycled scrap metals and processed aluminum drosses and UBC in Loudon County. In November, MRI announced plans to double the capacity of its Loudon plant. Expenditures of $7 million to build a new 35,000-square-foot building that will house state-of-the-art equipment to more efficiently clean and melt UBC and aluminum drosses were expected to be completed by January 1993. Plant capacity will increase to 24 million pounds per month from the present 12 million pounds per month. The expansion will add two more furnaces to bring the total to seven. The furnaces produce molten aluminum, which is poured into crucibles for transport and must be kept at 1,400° F to maintain its form. Each crucible of molten aluminum represents approximately 567,000 UBC.

Norandal USA Inc. declined to confirm reports that an upgrade of its aluminum mill at Huntingdon, Carroll County, was included in plans for a $15 to $17 million upgrade of mills in Alabama, North Carolina, and Tennessee. Norandal, based in Toronto, Canada, also operates an aluminum foil manufacturing facility in Brentwood, Williamson County.

Secondary lead was smelted from scrap by General Smelting and Refining Co., College Grove, Williamson County; Refined Metals Corp., Memphis; and Ross Metals Inc., Rossville, Fayette County. Aerojet Ordnance Tennessee operated a nonferrous foundry to produce shell casings at its Jonesborough plant. The plant, which manufactures ammunition, set a national record as of yearend 1992 by working more than 1.2 million worker hours without a lost-time accident.

DMS Refineries Inc., Dallas, TX, operated a plant in Jefferson County to extract silver from used X-ray film. Secondary steel was produced by Florida Steel Corp., Tampa, FL, in Jackson, with fabrication plants in Collierville, Shelby County; Knoxville; and Nashville. The company began a $3 million upgrade of air pollution control facilities at its Knoxville plant. The project was expected to be completed in 1993.

Leclede Steel Corp., Alton, IL, included the installation of additional wire-drawing machines at its Memphis plant as part of its $6.7 million capital improvement program for 1992. Tennessee Valley Steel Corp. announced at yearend that its steel mill at Harriman, Roane County, which was shut down in early 1992, would reopen by late summer 1993. The mill terminated the last of its 125 workers in February but is expected to employ 200 permanent workers when it becomes fully operational. The mill will be remodeled at a cost of $20 million with outdated rolling mills being replaced by state-of-the-art equipment. By the end of 1993, company officials plan to install additional equipment to diversify their product line. The mill's access to the Tennessee River will allow distribution of its products throughout the southeastern United States via the inland waterway system. The minimill will process brokered and processed scrap supplied by Southern Alloys and Metals, which is adjacent to the mill.

Mi-Tech Steel, a joint venture between Louisville-based Steel Technologies Inc. and Japan's Mitsui & Co. Ltd., launched a $6 million expansion of its Murfreesboro, Rutherford County, steel processing facility in September. The expansion, expected to be completed by May 1993, will expand Mi-Tech's facility by 75%, give it advanced inspection and quality-control capabilities, and increase its steel processing capacity to handle additional business at the Nissan automobile plant in nearby Smyrna. Steel

processing capacity will be expanded from 240,000 tons to 380,000 tons annually.

Copperweld Corp., Pittsburgh, PA, announced a $4.4 million expansion of its Fayetteville, Lincoln County plant. The plant manufactures copper-clad steel and aluminum wire products. Work was scheduled to begin by yearend and be completed by the end of 1993. Insteel Industries Inc., Mount Airy, NC, began construction of a $10 million plant to manufacture prestressed concrete (PC) strand in Gallatin, Sumner County. PC strand is used as reinforcement in pretensioned and posttensioned prestressed concrete construction. The new operation will have an initial production capacity of 40,000 tons per year with startup planned for the summer of 1993.

Titanium Metals Corp. of America, a subsidiary of Tremont Corp., Denver, CO, operated an alloy plant in Morristown, Hamblen County.

Martin Marietta Energy Systems operated a plant for the Department of Energy at the Oak Ridge facilities in Anderson and Roane Counties. Uranium and thorium metal alloys were manufactured by Nuclear Fuels Services Inc. at Erwin, Unicoi County.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 34 years of industry and government experience and has covered the mineral activities in Tennessee since 1989. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

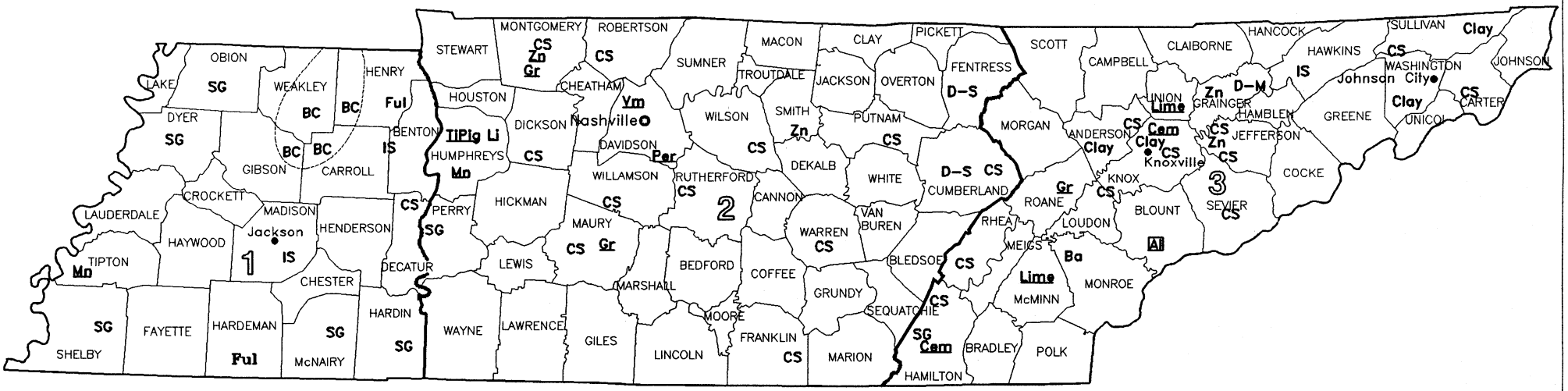
[2]Chief geologist, Tennessee Division of Geology, Knoxville, TN.

[3]Assistant State geologist, Tennessee Division of Geology, Nashville, TN.

[4]Mining Annual Review 1993 (London, UK). North America Individual Company Reports—Asarco. July 1993, p. 102.

[5]American Metal Market. Alcoa Aims Ax at Can Stock Mill. V. 100, No. 65, Apr. 3, 1992, p. 1.

TENNESSEE



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Al	Aluminum plant	CS	Crushed Stone	IS	Industrial Sand	SG	Sand and Gravel
Ba	Barite	D-M	Dimension Marble	Li	Lithium plant	TiPig	Titanium Dioxide pigment plant
BC	Ball Clay	D-S	Dimension Sandstone	Lime	Lime plant	Vm	Vermiculite plant
Cem	Cement plant	Ful	Fuller's earth	Mn	Manganese Dioxide plant	Zn	Zinc
Clay	Clay	Gr	Graphite plant	Per	Perlite plant	Zn	Zinc smelter

Concentration of mineral operations

Principal Mineral–Producing Localities

TABLE 5
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Aluminum refineries:			
Aluminum Co. of America	Box 158 Alcoa, TN 37701	Plant	Blount.
Barite:			
A.J. Smith Co.	Route 3 Sweetwater, TN 37874	Open pit mine	Loudon.
Cement:			
Dixie Cement Co. Inc.,[1 2] a subsidiary of Southdown Inc.	Box 14009 Knoxville, TN 37914	Plant	Knox.
Signal Mountain Cement Co., a subsidiary of IFI International Corp.	1300 American National Bank Bldg. Chattanooga, TN 37402	do.	Hamilton.
Clays:			
Ball clays:			
Kentucky-Tennessee Clay Co., a subsidiary of Hecla Mining Co.	Box 449 Mayfield, KY 42066	Pits and plants	Carroll, Gibson, Henry, Weakley.
H.C. Spinks Clay Co. Inc.	Box 820 Paris, TN 38229	do.	Carroll, Henry, Weakley.
United Clays Inc., a subsidiary of Watts Blake Bearne & Co. LTD.	Box 111 Gleason, TN 38229	do.	Carroll and Weakley.
Common clays:			
General Shale Products Corp.	Box 3547 CRS Johnson City, TN 37601	do.	Anderson, Knox, Sullivan, Washington.
Fuller's earth:			
Moltan Minerals Co.	3555-T Moltan Dr. Memphis, TN 38115	do.	Hardeman.
Golden Cat Corp., subsidiary of Lowe's Southern Clay Inc.	Box 819 Paris, TN 38242	do.	Henry.
Graphite (synthetic):			
Fortafil Fibers Div., Akzo-Enka America Inc.	Box 1301 Rockwood, TN 37643	Plant	Roane.
Union Carbide Corp.	Box 513 Columbia, TN 38401	do.	Maury.
Lime:			
Bowater Southern Paper Corp.	Calhoun, TN 37309	Pit and plant	Mc Minn.
Tenn-Luttrell Lime Co.	Box 69 Luttrell, TN 37779	do.	Union.
Perlite (expanded):			
Chemrock Corp.	826 Third Ave., S. Nashville, TN 37208	Plant	Davidson.
Phosphate rock:			
Occidental Chemical Corp.[3 4]	Box 591 Columbia, TN 38401	Pits and plant	Hickman, Maury, Williamson.
Rhône-Poulenc Basic Chemicals Co. Inc.[3 4]	Box 89 Mount Pleasant, TN 38474	do.	Giles and Maury.
Sand and gravel:			
Construction:			
Ford Construction Co.	Box 527 Dyersburg TN 38024	Pits	Obion.
Memphis Stone & Gravel Co.	Box 1683 Memphis, TN 38101	do.	Shelby.
Standard Construction Co.	Box 38289 Germantown, TN 38138	do.	Do.

See footnotes at end of table.

TABLE 5-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued:			
Industrial:			
Short Mountain Silica Co.	Box 208 Mooresburg, TN 37811	Pit and plant	Hawkins.
Tennessee Silica Div., Morie Co. Inc.	Box 507 Camden, TN 38320	Pits and plants	Benton and Carroll.
Stone:			
Crushed:			
American Limestone Co., a subsidiary of Asarco Inc.	2209 Blount Ave. Knoxville, TN 37901	Quarries and plants	Various.
Rogers Group Inc.	Box 25250 Nashville, TN 37202	do.	Do.
Vulcan Materials Co., Midsouth Div.	Box 7 Knoxville, TN 37901	do.	Do.
Dimension:			
Imperial Black Marble Co.	8013 Chesterfield Dr. Knoxville, TN 37909	do.	Grainger.
Ross L. Brown Cut Stone Co. Inc.	Box 398 Crab Orchard, TN 37723	Quarry and plant	Cumberland.
Turner Brothers Stone Co. Inc.	Box 297 Crossville, TN 38555	do.	Cumberland.
Zinc:			
Asarco Inc.[2]	Box 460 Strawberry Plains, TN 37871	Underground mines and plant	Jefferson and Knox.
Jersey Miniére Zinc Co., a division of Union Zinc Co. Inc.	Box 359 Gordonsville, TN 38563	Underground mines, plant, and refinery	Grainger, Jefferson, Montgomery, Smith.

[1]Also clays.
[2]Also stone.
[3]Also ferroalloys.
[4]Terminated operations in 1991.

THE MINERAL INDUSTRY OF TEXAS

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Bureau of Economic Geology, The University of Texas at Austin, for collecting information on all nonfuel minerals.

By Jean A. Dupree[1] and L. Edwin Garner[2]

Although Texas' mineral value increased about 3% to $1.30 billion in 1992, Texas dropped to ninth place (from seventh in 1991) in the value of its nonfuel mineral production. The Lone Star State accounted for 4.1% of the U.S. mineral value total. Excluding fuels, Texas' leading mineral products (in decreasing order by value) continued to be portland cement, crushed stone, magnesium metal, and construction sand and gravel. The State continued to be number one in the United States in production of magnesium metal, common clay, oil, natural gas, and zeolites. It was second in U.S. production of portland cement, crude helium, salt, sodium sulfate, and talc; it was third in production of crude and calcined gypsum, grade-A helium, crushed stone, and ball clay; it was fourth in output of total clay, dimension stone, and construction sand and gravel; it was fifth in production of industrial sand; and it was sixth in lime and coal output. Declines in value occurred for total clays, kaolin clay, grade-A helium, iron ore, industrial sand, sodium sulfate, dimension stone, and Frasch sulfur; all other commodities posted value gains in 1992 or were unchanged.

TRENDS AND DEVELOPMENTS

The State's producers of sand and gravel, crushed stone, cement, gypsum, and steel had a mixed construction market

TABLE 1
NONFUEL MINERAL PRODUCTION IN TEXAS[1]

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
Cement:							
Masonry	thousand short tons	142	$10,106	W	W	W	W
Portland	do.	7,678	296,680	e7,498	e$289,341	7,540	$308,749
Clays[2]	metric tons	2,162,095	14,652	2,265,746	13,247	2,237,093	12,610
Gemstones		NA	W	NA	W	NA	3,834
Gypsum (crude)	thousand short tons	1,868	10,166	1,609	9,240	1,790	9,920
Lime	do.	1,337	76,181	1,373	69,400	1,474	83,359
Salt	thousand metric tons	7,450	75,149	8,106	73,117	7,985	76,125
Sand and gravel:							
Construction	thousand short tons	46,083	158,080	e38,800	e135,800	45,640	166,362
Industrial	do.	1,849	40,880	1,557	27,002	1,511	26,141
Stone (crushed)	do.	e81,800	e285,700	65,813	226,836	e71,300	e253,100
Sulfur (Frasch)	thousand metric tons	2,340	W	2,056	W	1,495	W
Talc and pyrophyllite	metric tons	227,138	4,844	212,887	4,561	235,919	5,720
Combined value of clays [ball (1991-92), bentonite, fuller's earth, kaolin], helium (crude and Grade-A), iron ore (usable), magnesium compounds, magnesium metal, sodium sulfate (natural), stone (dimension), and values indicated by symbol W		XX	r486,092	XX	r417,067	XX	357,458
Total		XX	r1,458,530	XX	r1,265,611	XX	1,303,378

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value includedwith "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" figure.

during 1992. According to estimates provided by the University of Texas Bureau of Business Research, monies spent on overall residential construction was higher in 1992 than in 1991 by about 30%. Total estimated construction costs in 1992 for single and multiple family residential construction was $5.96 billion. The number of single family residences constructed during 1992 was up by 29%. In contrast, however, the budget of the Texas Department of Transportation, another barometer for sales of construction aggregate, was only $1.217 billion. Compared to 1991, the agency's budget was down 9% and at the lowest level it had been in 10 years. Very little Federal funding from the new Intermodal Surface Transportation Efficiency Act (enacted in 1991) trickled into Texas during 1992.

To aid grade-school science teachers who are increasingly challenged to engage students' interest, a new earth science curriculum was developed by Phillips Coal Co. and Texas A&M University using a grant from Phillips Petroleum Co. The program, "Resources and the Environment: A Thematic Earth Science Curriculum," was sponsored and distributed during 1992 by the Texas Mining and Reclamation Association (TMRA). According to TMRA, 47 Texas and Louisiana earth science teachers attended two July seminars to learn about the course. The new course had a "hands on" emphasis and demanded more than regurgitating information for exams. Students had to plan a fictitious "Black Gold Lignite Mine." During the pilot program, classes toured an operating coal mine, watched a drill rig, took core back to the classroom, studied geophysical logs, identified zones to sample, and sent samples to a lab for analysis (lab test costs were paid by program sponsors). Students described the deposit and overburden thickness, went to the courthouse to determine property ownership, learned about reclamation, pretended to file for a mine permit, and prepared a mine plan. The curriculum began a positive relationship between business and schools that would hopefully ultimately benefit both.

EMPLOYMENT

According to the Texas Employment Commission, 1992 Texas unemployment grew to 7.5% from an average of 6.6% in 1991. Compared with 7.17 million people in 1991, an average of 7.27 million were employed in the non-agricultural sector. About 170,600 people were employed in the mining sector for 1992, compared with 185,100 workers so employed during 1991. Jobs in the metals and coal subcategory averaged about 9,000, as opposed to 9,500 in 1991; those employed in the oil and gas subcategory totaled about 161,600, versus about 175,600 during 1991.

Sulfur prices continued to decay, triggering the layoff in October of 60 employees at Pennzoil Co.'s west Texas frasch sulfur operation. The sulfur price collapsed to $95.91, 22% of the average 1991 price. Sulfur prices had declined since 1989 because of sharp world consumption decreases.

In its 1992 economy wrap-up, the Houston Business Journal reported that energy companies continued to downsize. Shell Oil Co., for example, announced a sweeping 10% labor force cut and, subsequently, made an additional 5% payroll reduction (a total of 2,400 jobs). The litany of major Houston energy company layoffs and early retirements included the following: Exxon Co. USA (more than 700 employees), Transco Energy Co. (500 jobs), Chevron Corp. (in excess of 420 jobs), and Amoco Corp. (about 400 jobs). A few companies added employees in Houston: Unocal Corp. (140 relocated from Los Angeles and London); Solvay Minerals Inc. (40 relocated from Denver); and Amoco Corp. (plant expansion-50 new employees).

ENVIRONMENTAL ISSUES

Despite strong local opposition, the Texas Low-Level Radioactive Waste Disposal Authority approved an area in Hudspeth County as a new low-level radioactive waste dump site. The first of its kind in Texas and the fourth in the United States, the site will be near Sierra Blanca, about 90 miles east of El Paso.

In an action that streamlined permitting, the Environmental Protection Agency (EPA) announced the transfer of clean air permitting authority from the Federal Government to the Texas Air Control Board.

EPA continued remedial action at the Tex Tin Corp. tin smelter at Texas City (Galveston County). The tin smelter began operations in World War II. The 175-acre site was included on the National Priorities List because of the presence of arsenic, lead, nickel, and tin found in surface water, ground water, soils, and in ambient air. A secondary copper smelter continued to operate on the site. Late in 1992, EPA completed the second and final phase of its remedial investigation and indicated it would announce its findings in April 1993.

LEGISLATION AND GOVERNMENT PROGRAMS

The Texas Legislature meets only in odd-numbered years except for specially called sessions. At the request of the Governor, the third special session of the 72d Texas Legislature was convened in January to pass an appropriations bill, consider redistricting, address prison overcrowding, and other issues. A total of 50 bills and 2 joint resolutions were filed, of which 4 bills were enacted. Additionally, the Governor called a fourth special session during November and December to get a head start on resolving issues that would be important to the 1993 regular session. During this last-called session, 33 bills, 40 concurrent resolutions, 10 joint resolutions, and 261 resolutions were introduced into both legislative houses, of which only 33 joint resolutions and 155 resolutions were enacted.

Among the tasks the 1993 regular session likely would face was devising limits on traditional water supplies for central Texas residents and businesses, including a number of important Texas mineral producers. During April, the

Texas Water Commission (TWC) issued an emergency order that essentially instituted a takeover of the Edwards Aquifer. TWC took the action to avoid a confrontation involving the Endangered Species Act and Federal aquifer regulation. Pumping from "the Edwards"—the only water source for San Antonio and cities south of Austin, cement and lime plants, farmers, and several large tourist attractions—had never been regulated. In September, within 48 hours of new TWC pumping rules, a State District Court judge ruled that the Edwards was not subject to TWC control. A 4-day November trial in U.S. District Court ensued that threatened to throw the water-rights showdown into the 73d Legislature.

In a remarkable turnaround for a project that, months earlier, had seemed destined for extinction, the U.S. Congress agreed in September to fund the Texas supercollider $517 million for the 1993 fiscal year. In October, the Department of Energy awarded contracts to Martin Marietta Astronautics Group and Westinghouse Electric Corp. to develop prototypes of key components of Texas new atom smasher. Supercollider construction south of Dallas would require huge quantities of aggregate, steel, and other mineral products and be a major boost to the Texas economy.

The Texas High-Speed Rail Authority conducted scoping meetings during the summer to inventory public reaction to the proposed Texas bullet train. If constructed, the train would be built by a private company (the Texas High-Speed Rail Corp.) to link Dallas/Fort Worth, Austin, San Antonio, and Houston. In July, project funding was jeopardized when the U.S. House of Representatives killed a bill that would have eliminated an existing volume ceiling on the use of tax-exempt bonds for funding high-speed rail projects.

The Texas Bureau of Economic Geology, University of Texas at Austin, continued to administer the Texas Mining and Mineral Resources Research Institute (TMMRRI). The U.S. Bureau of Mines (USBM) funded TMMRRI for research and education regarding mineral sciences and engineering. TMMRRI used its $16,000 1992 allotment from the USBM to award four fellowships for graduate research in ore deposition, mining engineering, and mineral economics.

Among the publications released by the Bureau of Economic Geology during 1992 was Mineral Research Circular 82 concerning the Texas dimension stone industry. The circular documented the occurrence and distribution of dimension stone quarried in Texas, contained a market forecast, and analyzed product price and value.

FUELS

According to the Energy Information Admistration, Department of Energy, Texas led the Nation's oil production,[3] a lead it has held since 1928. According to the agency, total State production was 650 million barrels, a drop of 5% from the 1991 total of 683 million barrels. Texas also led U.S. natural gas production, a lead it has maintained since 1926. Total marketed natural gas amounted to 6.18 trillion cubic feet, also declining slightly from the 1991 total of 6.33 trillion cubic feet.[4] The "majors" continued a trend of investing in foreign operations during 1992 while independent oil companies absorbed domestic oil/gas reserves divested by the majors in favor of overseas drilling. Although Texas still led U.S. drilling and traditionally accounts for more than one-third of national drilling, its number of well completions dropped 20%, to 6,389 from 7,944 recorded in 1991. According to Petroleum Information Corp., oil well completions fell from 4,127 to 3,237, while gas well completions dropped from 1,471 to 1,335.[5] During the spring of 1992, the number of active rigs in the Gulf of Mexico plunged below 70 for the first time in two decades; however, a mid-summer turnaround put more than 50 rigs back to work. The change was due to a rebound in natural gas prices, which had fallen during early 1992 to a 20-year low of less than $1 per thousand cubic feet.

On April 7, a huge explosion, felt 130 miles away in Galveston, rocked a liquefied petroleum gas (LPG, or propane) storage facility at Brenham. The explosion, ignited by a passing car engine, killed 3 people and injured 18. The worst in history, the accident was caused by overfilling the 350,000-barrel salt-dome-cavern facility. Total damage to the facility, owned by Seminole Pipeline Co., exceeded $10 million.

A study coordinated by the Texas Bureau of Economic Geology and the Department of Energy's National Institute for Petroleum Energy Research came to an encouraging conclusion regarding the Nation's remaining recoverable crude oil reserves. The 54-page study indicated that the country's total recoverable crude oil reserves could be from four to eight times higher than currently accepted figures for producible reserves.

According to the Energy Information Administration, Texas ranked sixth in the Nation in coal production for 1992.[6] According to the Texas Railroad Commission, Texas 1992 coal production surged to 55.0 million tons, compared with 53.8 million tons produced in 1991. Texas had 15 operational lignite mines; additionally, several mines near Laredo marketed cannel coal to cement companies. The five top coal producers in Texas were: Texas Utilities Mining Co. (29.9 million tons), Northwestern Resources Co. (7.5 million tons), Aluminum Co. of America (Alcoa—5.7 million tons), Texas Municipal Power Agency (3.3 million tons), and San Miguel Electric Cooperative, Inc. (2.9 million tons). Approximately 62% of U.S. lignite was produced in Texas. About 27% of the State's electricity was generated in plants fired by Texas lignite.[7]

Because of low uranium spot prices, Uranium Resources Inc. (URI) put its in situ leach Rosita Mine (Duval County) on standby in April. The company's Kingsville Dome operation (Kleburg County), idled since September 1990, remained on standby status. Permitting continued for URI's Vasquez project (Duval County) in 1992.

On May 7, Rio Grande Resources Corp.'s Panna Maria Mill in Hobson processed its last ton of uranium ore.

Mill decommissioning and reclamation activities at the company's Rhode Ranch Mine were projected to be completed in 1995. Mill closure probably marked the end of an era of conventional surface uranium mining in south Texas as companies turned to in situ leach methods. The Panna Maria concentrator recovered more than 15 million pounds of U_3O_8 between February 1979 and May 1992.

REVIEW BY NONFUEL MINERAL COMMODITIES[8]

Industrial Minerals

Cement.—With 7.54 million short tons, Texas ranked second, behind California, of 37 States in production of portland cement. Value of the State's output was $308.7 million. Compared to 1991 output, which was estimated, 1992 production appears to have increased. Output and value of masonry cement also appears to have increased for the year. The State was eighth of 36 States reporting production.

Five of the top ten largest U.S. cement companies (as ranked by the Portland Cement Association) operated plants in Texas: Holnam, Inc., LaFarge Corp., Lehigh Portland Cement Co., Lone Star Industries, Inc., and Southdown, Inc.

After conducting one of the most thorough environmental monitoring studies ever conducted in a community where cement kilns burn hazardous waste, the Texas Air Control Board (TACB) announced that "no adverse health effects" would be expected to people living in Midlothian, a community where two of the three cement plants burn waste-derived fuels. TACB evaluated about 1,000 samples and included 5,000 chemical tests. Of 5,000 analyses, all but 1 were below State thresholds of potential health concern, thresholds that are 10 times more strict than Federal standards according to an EPA report. The 18-month survey was geared to answer questions raised by citizens and environmental activist groups alleging that such burning created adverse health effects. In July, the TACB announced formation of a task force to help the State generate appropriate public policy in the area of burning waste-derived fuel in cement kilns. The 17-member task force included an employee of Lafarge Corp., which operated a cement plant near New Braunfels.

Lafarge Corp., a subsidiary of French Lafarge Coupee, lost a Federal court contest to replace about 50% of the fuel at its Balcones Cement Plant near New Braunfels with liquid hazardous waste. Lafarge had proposed to burn waste oils, waste lubricants, waste paints, and solids that contained high heat value. The Texas Air Control Board denied Lafarge the permit on the grounds that issuance would violate a law enacted in 1991 that requires a one-half mile buffer zone between the nearest public residence and the stack of a cement plant burning hazardous waste. Lafarge claimed that the new law had grandfathered Lafarge's New Braunfels operation because Lafarge had been burning shredded tires before the law was enacted.

In October, EPA proposed more than $300,000 in fines for alleged environmental violations involving the burning of hazardous waste at Texas Industries Inc.'s cement kiln in Midlothian. Citations involved problems such as not following prescribed schedules for equipment inspection and operation of a hazardous waste landfill (for cement kiln dust) without filing for a permit. Because EPA did not approve the method used to test the kiln dust, the Agency ruled, by fiat, that all kiln dust in the company's landfill was hazardous.

In February, Hanson PLC completed acquisition of Beazer PLC, parent company of Beazer USA. Beazer USA was reorganized and consolidated with Kaiser Cement. Hanson also held a 50% interest in Gifford-Hill and Co., Inc. and a 50% interest in North Texas Cement Co. (the remaining interest was held by P.C. Investments, Inc.). Gifford-Hill manufactured concrete pressure pipe in Grand Prairie. North Texas Cement manufactured cement near Midlothian.

In 1989, Holnam PLC acquired an option to purchase the business and assets of Box Crow Cement Co. Although Holnam terminated its option to buy Box Crow in 1991, Holnam agreed to provide working capital and management services to Box Crow. In August 1992, Box Crow filed for chapter 11 bankruptcy protection. Holnam's obligations under its agreement with Box Crow expired in September, according to Holnam's annual report.

Featherlite Building Products Corp., a subsidiary of Justin Industries, Inc., manufactured concrete block marketed largely in Texas and neighboring States. Bagged concrete production and warehouse capacity were expanded in El Paso during 1992. Also, the company downsized its Lubbock plant to better fit local market needs. In another action, Featherlite modernized its Abilene facility during the year to increase productivity.

Southdown, Inc. reported in its annual report that nearly one-half (49%) the sales from its Odessa plant were to oil well cementing companies; the balance was construction-grade cement.

Struggling to escape chapter 11, Lone Star Industries received approval from the U.S. Bankruptcy Court in White Plains, NY, to reorganize its board of directors. The board of directors approved a reorganization plan in October to be filed in U.S. Bankruptcy Court on or after April 12, 1993. Lone Star operated a cement plant near Maryneal that produced portland and masonry cement.

Clays.—Only Georgia, Wyoming, and Alabama produced more clay than Texas during 1992. State mines supplied ball clay, bentonite, common clay, fuller's earth, and kaolin. For several clays, there were only one or two producers in the State, and to protect individual company data, Texas' total clay production is concealed. Total clay output and value decreased marginally from those of 1991.

Ball Clay.—United Clays of Texas Inc. remained Texas' only producer of ball clay. The company mined clay near Troup in Cherokee County. During 1992, output and value increased subtantially. Of the Nation's five ball-

clay-producing States, Texas continued to follow only Tennessee and Kansas. Texas' output, up 25% during 1992, was mainly used to make ceramic products.

The Ceramics Div. of Southern Clay Products, acquired last year by Laporte PLC, was sold to United Clays of Texas, Inc., a subsidiary of Watts Blake Bearne and Co. PLC. Assets transferred included ball clay reserves at Troup in northeast Texas, talc reserves near Van Horn, and ball clay and talc storage and processing facilities at Troup. Laporte kept Southern Clay's Gonzales facility, which produced organophyllic clays and high-grade bentonite. Finalized in February, the acquisition made United Clays the second largest ball clay producer in North America, according to Watts Blake Bearne and Co.'s annual report. The ceramic tile industry was the largest market for both the company's ball clay and talc. United Clay's sales to Mexican ceramics industries multiplied sevenfold in 1992, a feat the company attributed partly to its acquisition of Texas clay and talc operations.

Bentonite.—Although Texas' 1992 bentonite production and value increased about 5%, the State dropped a notch to seventh place of 13 producing States. Calcium bentonite (nonswelling bentontite) was mined by Mid-Tex Minerals Inc. in Fayette County and by Southern Clay Products Inc. in Angelina and Gonzales Counties. Sodium bentonite (swelling bentonite) continued to be mined near Alpine in Brewster County by Border Mines.

Laporte PLC announced it planned to expand Southern Clay's plant (Gonzales County) by 40% during the first half of 1993. Sales and profits for the company, according to Laporte's annual report, were at record levels. The primary product from Southern Clay's Texas Pits continued to be white bentonite and organo-bentonites, which have slightly out-of-the-ordinary end uses, as, for example, in cosmetics, detergent sheets, and pharmaceuticals. During 1992, Southern Clay also operated a test pit in Angelina County from which it shipped yellow bentonite to Malaysia for production of acid-activated clays. Such clays, produced by adding sulfuric acid to the bentonite to leach out silica, contain small holes and can be used in clarifying oils.

Milwhite Co., Inc. sold its Texas clay operation near Flatonia (Fayette County) to Mid-Tex Minerals Inc. in July 1992. The company continued to produce bentonite and fuller's earth. Its bentonite was used to make waterproof seals and water-treatment filters.

Common Clay.—Total common clay production for Texas in 1992 was 2.24 million metric tons, a drop of about 1% from the 1991 total. Value dropped about 5%. Texas held its lead of 43 States with reported common clay production; in value terms, the State was behind only Alabama and Georgia. Guadalupe, Navarro, Palo Pinto, Bastrop, and Henderson led the 17 Texas counties that produced common clay. Companies reporting 1992 common clay production in Texas included Acme Brick Co. (a subsidiary of Justin Industries, Inc.), D'Hanis Brick and Tile Co., Elgin-Butler Brick Co., Henderson Brick Co. (a subsidiary of Boral Bricks, Inc.) Justin Industries, Inc./Featherlite Building Products Co., Lafarge Corp., Lehigh Portland Cement Co., Marshall Pottery Inc., Mineral Wells Clay Products Inc., North Texas Cement Co., Strawn Materials Inc., Texas Clay Industries Inc., Texas Industries Inc./Athens Brick Co., U.S. Brick, Inc./Brays Div., and Willie Baulch Co. Texas Industries and Justin Industries were the clear State production leaders. Most of Texas' common clay was mined to make brick, as a source of alumina in portland cement, for highway surfacing material, to manufacture structural concrete, and for making pottery.

According to the Brick Institute of America, 10 companies manufactured brick or structural tile in Texas: Acme Brick Co., American Eagle Brick Co., Inc., Texas Industries Inc./Athens Brick Co., Cordell Brick Co., Inc., D'Hanis Brick and Tile Co., Elgin-Butler Brick Co., Henderson Brick Co. (a division of Boral Bricks, Inc.), Mineral Wells Clay Products Inc., Texas Clay Industries, and U.S. Brick. These aforementioned companies operated manufacturing plants in 14 counties.

Marshall Pottery Inc., a 97-year-old company, shipped more than 5 million clay pots, ranging from thimble-size to industrial-size 100-pound containers. The trademark of the company, in operation since 1895, was hand-turned white and blue stoneware.

Fuller's Earth.—Texas was next to last of 11 States with 1992 fuller's earth production. Production and value are estimated to have remained essentially static. Texas' fuller's earth, actually a calcium bentonite, continued to be produced by only two companies, both in Fayette County: Mid-Tex Minerals Inc. and Balcones Mineral Corp. During 1992, Milwhite Co. sold its property to Mid-Tex Minerals Inc. Texas' fuller's earth was used to manufacture oil and grease absorbent, pet waste absorbent, and electronic porcelain.

Kaolin.—With only one producer, Texas slipped to 10th of 11 States that produced kaolin during 1992. Ranked by output value, however, Texas was third, after only Georgia and South Carolina. Both production and value dropped for the year. U.S. Silica Co., a subsidiary of RTZ Corp., continued to produce both kaolin and industrial sand from kaolinitic sandstone mined in Limestone County in east-central Texas. Most of Texas' kaolin was used to make paint, but minor amounts were used to make pottery and as a binder in animal feed.

Gypsum.—Texas produced both crude and byproduct gypsum and several companies calcined gypsum for wallboard. The State ranked third in the country in output of crude gypsum and calcined gypsum and second in output of byproduct gypsum. Production of crude gypsum improved by 11% to 1.79 million short tons; correspondingly, its value also went up 7% to $9.92 million. Four companies mined gypsum in Texas: Georgia-Pacific Corp., National Gypsum Co. (Gold Bond Div.), Standard Gypsum

TABLE 2
TEXAS: LIME SOLD OR USED BY PRODUCERS, BY USE

Use	1991		1992	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Road stabilization	479,635	$27,505	620,976	$35,345
Water purification	W	W	100,242	4,383
Other[1]	893,377	41,895	752,319	43,631
Total	1,373,012	69,400	1,473,537	83,359

W Withheld to avoid disclosing confidential company data; included with "other."
[1]Includes acid water neutralization, agriculture, aluminum and bauxite, environmental uses, mason's lime, other chemical and industrial, paper and pulp, sewage treatment, sugar refining, tanning, and uses indicated by symbol w.

Co., and United States Gypsum Co. (U.S. Gypsum). Gypsum continued to be mined in Gillespie, Hardeman, Kimble, Nolan, and Stonewall Counties. U.S. Gypsum Sweetwater operation in Nolan County continued to supply the lion's share of Texas' production.

More calcined gypsum was produced during the year, increasing from 1991 by about 11%. Average value moved up about 19%. The same four companies that mined gypsum also manufactured wallboard at plants in Fisher, Guadalupe, Hardeman, Harris, and Nolan Counties. Again, U.S. Gypsum's Sweetwater plant was the largest producer in the State and the third largest wallboard plant in the country.

Of Texas gypsum producers, only U.S. Gypsum reported gypsum as a byproduct. Output of byproduct gypsum at its Galena Park facility (Harris County) was slightly higher, and its value rose significantly over that of 1991.

National Gypsum Co. continued its efforts to reorganize $1 billion in bond debt under chapter 11. In December, two reorganization plans—one by the company and another by bondholders and trade creditors—were presented at U.S. Bankruptcy Court hearings in Dallas. The company's plan would have given bondholders 30% of its common stock, whereas the bondholder's plan would have given nearly all the common stock to the bondholders. The Dallas U.S. Bankruptcy Court judge threw out the bondholder's plan and left creditors with the company's reorganization plan as their only option. The judge was expected to rule on the company's proposal in January 1993. National Gypsum announced it would relocate from Dallas to Charlotte, NC, where the company's wallboard division was based. The company operated quarries at Harper and Rotan and a wallboard plant at Rotan.

Helium.—Texas continued to be an important helium-producing State during 1992. Compared to 1991, output and value of crude helium increased 63%. That of grade-A helium fell 16%. Since 1929, the USBM has operated a helium extraction and purification facility at Masterson, north of Amarillo. At the same location, the USBM continued to operate the federally owned Cliffside Field as a domestic storage reservoir. The USBM produced crude and grade-A helium (99.995% or purer) from natural gas; two companies also operated helium extraction or purification plants in Texas: Air Products and Chemicals Inc. and Phillips Petroleum Co. Air Products produced grade-A helium at its Hansford County plant, while Phillips produced crude helium at its plant in Dumas. The USBM price, which tends to be higher than that charged by private industry, averaged $1.983 per cubic meter f.o.b. plant. Major helium applications continued to be in cryogenics, welding, pressurizing, and purifying.

Mesa Petroleum Corp. began expanding the Fain Plant north of Amarillo and expected to start producing crude helium in early 1993. Maxus Energy Corp. began construction of a crude helium plant at Sunray; plant startup was scheduled for first quarter 1993.

Lime.—Texas lime production and value rose substantially during the year, 7% and 20%, respectively. Of 32 producing States, Texas continued to follow Missouri, Ohio, Pennsylvania, Alabama, and Kentucky in terms of production; in terms of production value, it followed only Missouri, Ohio, and Pennsylvania. Quicklime was produced by six companies: APG Lime (Comal County), Austin White Lime Co. (Travis County), Chemical Lime Group (Bosque and Burnet Counties), Holly Sugar Corp. (Deaf Smith County), Redland PLC (Travis County), and Texas Lime Co. (Johnson County). Texas' leading quicklime producers were Chemical Lime and APG Lime. Chemical Lime's Clifton plant in Bosque County was the seventh largest lime plant in the Nation. Hydrated lime was produced by all companies' plants except Holly Sugar Corp.'s Hereford plant in Deaf Smith County and Chemical Lime's Marble Falls plant in Burnet County. Texas lime was marketed for road stabilization, aluminum manufacture, environmental waste and sewage treatment, paper manufacture, sugar refining, acid water neutralization, agriculture, and for hide-tanning. Highway construction funded by the new Intermodal Surface Transportation Efficiency Act promised to increase 1993 lime sales for use in road stabilization and in asphalt.

Magnesium Compounds.—Texas, among three producing States, continued to lead the country in output of magnesium metal. Dow Chemical Co. continued to manufacture magnesium compounds from seawater at its plant in Brazoria County near Freeport. Production and value remained essentially the same as those for 1991. Although Dow's principal product, magnesium chloride, was used mainly to make magnesium metal, it went into several other manufactured items, including ceramics.

Salt.—Texas followed only Louisiana of 14 States that reported salt production.

TABLE 3

TEXAS: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	23,003	$92,134	$4.01
Plaster and gunite sands	603	3,005	4.98
Concrete products (blocks, brick, pipe, decorative, etc.)	266	563	2.12
Asphaltic concrete aggregates and other bituminous mixtures	1,718	8,692	5.06
Road base and coverings[1]	3,293	11,502	3.49
Fill	5,607	10,692	1.91
Snow and ice control	7	26	3.71
Other miscellaneous uses	366	600	1.64
Unspecified:[2]			
Actual	4,096	12,907	3.15
Estimated	6,682	26,241	3.93
Total	[3]45,640	166,362	3.65
Total[4 5]	41,404	166,362	4.02

[1]Includes road and other stabilization (cement and lime).
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data do not add to total shown because of independent rounding.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

In terms of value, however, it was behind New York, Ohio, Louisiana, Michigan, and Kansas. Corpus Christi Brine Service, Dow Chemical Co., Morton International Inc., Permian Brine Sales Inc., Texas Brine Corp., and United Salt Corp. mined salt in Texas during 1992. Dow (Brazoria County), Morton International (Van Zandt County), Oxy Chemical (Chambers County), and Texas Brine Corp. (Jefferson, Matagorda, and San Patricio Counties) were the State's major producers. The companies mined salt in Brazoria, Chambers, Duval, Ector, Fort Bend, Harris, Jefferson, Matagorda, San Patricio, and Van Zandt Counties. Quantity of salt produced decreased about 1% to about 8.0 million metric tons; value, on the other hand, rose about 4% to $76.1 million.

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

During 1992, Texas placed fourth, after California, Michigan, and Ohio, in total production of construction sand and gravel; it was third in the country (after California and Ohio) in terms of value. Total 1992 production was 45.6 million short tons valued at $166.4 million. Compared to 1991, output improved slightly, as did value. The State construction picture was mixed. The State Department of Transportation's budget for 1992 was only $1.217 billion, down from $1.33 billion in 1991. Although a $0.05 gasoline tax was passed during 1992, the year marked the agency's lowest budget in 10 years. Few Federal monies from the 1991 passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) made their way into the State. ISTEA funds are allocated over 6 years for improvements to highways and bridges, although more than one-half of such funding can be used for mass transit and other nonhighway transportation construction. In contrast to slower highway construction activity, the Bureau of Business Research, Universtiy of Texas at Austin, estimated that the number of single and multiple buildings constructed in 1992 rose to 60,495, compared with 47,098 estimated for 1991. Monies spent on such construction also rose a healthy 30%. Monies spent on total nonresidential construction also jumped 25%.

The top 10 producing companies in the State (in decreasing order of total production) were: Pioneer Concrete of Texas, Inc., Fordyce Co., Beazer USA/Hanson PLC, H. B. Zachary Co./Capitol Aggregates Inc., Lafarge Corp., Texas Industries, Myre Construction Co. Inc., Redland PLC, Mike Arnold Trucking and Material Co. Inc., and Kerr Enterprises Inc. Leading counties (again, in decreasing order of output) were Colorado, Dallas, Hidalgo, Bexar, and Ellis. Nearly all of Texas' production was transported by truck; about 10% was shipped by rail. The bulk of Texas' sand and gravel traditionally has been mined from the Colorado River, Trinity River, Rio Grande, and San Antonio River floodplains.

In February, the Texas Railroad Commission amended the Texas Administration Code concerning sand and gravel shipments. Created because of a petition filed by J.& H. Truck Service, Inc., the amendment prohibits allowances granted by motor carriers of sand and gravel and their affiliated shippers, producers, or distributors. According to the Texas Aggregate and Concrete Association, aggregate suppliers with affiliated motor carriers that had in the past quoted a combined price for materials and transportation must now separate the two quote components. Companies additionally must honor the quoted price for materials when another unaffiliated carrier is used.

In April, the Texas Supreme Court refused to rehear Wise County Appraisal District's case against Gifford-Hill and Co. Inc. According to the Texas Aggregate and Concrete Association, the court stood by its initial ruling favorable to Gifford-Hill that stated a limestone deposit is not to be defined under Texas

TABLE 4

TEXAS:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	618	3,755	(2)	(2)	285	1,270
Plaster and gunite sands	W	W	—	—	W	W
Concrete products (blocks, brick, etc.)	—	—	—	—	—	—
Asphaltic concrete aggregates and other bituminous mixtures	450	2,247	—	—	W	W
Road base and coverings[3]	480	2,030	(2)	(2)	433	1,733
Fill	142	343	(2)	(2)	—	—
Snow and ice control	W	W	—	—	—	—
Other miscellaneous uses	64	336	—	—	279	1,635
Unspecified:[4]						
Actual	55	215	—	—	—	—
Estimated	—	—	43	167	272	1,094
Total[5]	1,810	8,925	802	3,859	1,270	5,732
Total[6 7]	1,642	8,925	728	3,859	1,152	5,732

	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	327	2,091	7,189	32,943	W	W
Plaster and gunite sands	W	W	W	W	—	—
Concrete products (blocks, brick, etc.)	—	—	225	419	W	W
Asphaltic concrete aggregates and other bituminous mixtures	17	55	308	1,057	47	180
Road base and coverings[3]	W	W	192	615	—	—
Fill	W	W	814	1,200	W	W
Snow and ice control	W	W	—	—	—	—
Other miscellaneous uses	178	597	493	1,503	290	978
Unspecified:[4]						
Actual	—	—	2,193	6,896	2	3
Estimated	1,276	6,913	465	1,266	663	3,492
Total[5]	1,798	9,657	11,879	45,899	1,001	4,653
Total[6 7]	1,631	9,657	10,776	45,899	908	4,653

See footnotes at end of table.

Table 4—Continued

TEXAS:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

	District 7		District 8		District 9	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	2,251	8,263	9,813	31,709	1,630	8,101
Plaster and gunite sands	294	1,414	W	W	W	W
Concrete products (blocks, brick, etc.)	W	W	23	64	—	—
Asphaltic concrete aggregates and other bituminous mixtures	W	W	W	W	W	W
Road base and coverings[3]	207	1,031	943	2,411	488	1,479
Fill	1,253	1,461	3,311	7,554	W	W
Snow and ice control	—	—	—	—	—	—
Other miscellaneous uses	144	293	52	118	290	1,731
Unspecified:[4]						
Actual	—	—	1,842	5,777	4	15
Estimated	1,109	3,668	1,776	5,683	1,078	3,957
Total[5]	5,257	16,130	17,760	53,317	3,490	15,284
Total[6 7]	4,769	16,130	16,112	53,317	3,166	15,284

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses.
[1]Excludes 571,700 short tons valued at $2,906,822, not reported by county.
[2]Withheld to avoid disclosing company proprietary data; included with "Total."
[3]Includes road and other stabilization (cement and lime).
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value in thousand metric tons and thousand dollars.

law as a mineral; thus, Wise County could not assess property taxes on underground rock reserves. The case had been pending for 5 years.

Texas Parks and Wildlife Department proposed to ban dredging on the San Jacinto River after a group sought to prevent Parker-LaFarge Corp. from dredging a 45-acre section of the river. Environmentalists were concerned that dredging would release pollutants in the river sediments. The Parker LaFarge site was 400 yards from the Highlands Acid Pits, a Superfund site. Hearings were held on the matter in December.

Industrial.—Texas ranked fifth of 38 States reporting production of industrial sand. Total production for the year was 1.51 million short tons, a slight drop from the 1991 total of 1.56 million short tons. Of eight producing counties, most of Texas' 1992 industrial sand production came from (in decreasing order) McCulloch, Johnson, and Limestone Counties. Barry and Barry Sand Co., Inc., Oglebay Norton/Texas Mining Co., Pioneer Concrete of Texas Inc., Unimin Corp., U.S. Silica Co., and Vulcan Materials Co. mined industrial sand during the year.

Texas' industrial sand was used for sand blasting, fracsand, container manufacture, and as molding sands. Although oil and gas drilling was sluggish during the first half of the year, drilling (and sand sales) increased substantially later as natural gas prices rose and yearend tax incentives spurred drilling activities.

Oglebay Norton reported in its annual report that the company intitiated a modest price increase for its sand sales, although they were below normal. The company's Brady operation (McCulloch County) reportedly had about 63 years of remaining reserves.

Sodium Sulfate.—Texas remained second, after California, of three U.S. producers of natural sodium sulfate. Ozark-Mahoning Co. operated its west Texas Seagraves facility (Gaines County) with a nameplate capacity of 141,000 metric tons. The company produced anhydrous sodium sulfate from dry lake brines. Texas brines did not yield any secondary products (as do those processed at Searles Lake, CA). Domestic sodium sulfate production continued to be weakened by the economic recession affecting the paper industry and by increased paper recycling.

Stone.—**Crushed.**—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimated data for 1990 and 1992 and actual data for 1991. In 1992, Texas deposits yielded an estimated 71.3 million short tons of crushed stone valued at $253.1 million. Both production and value appear to have increased during the year. According to Rock Products, 4 of the Nation's top 20 crushed stone plants for 1992 were in Texas: Redland Worth

Corp.'s Beckman mine and plant in Bexar County (6th), Texas Crushed Stone's Georgetown plant in Williamson County (8th), Parker-Lafarge Corp.'s New Braunfels operation in Comal County (15th), and Texas Industries Inc.' Bridgeport plant in Wise County (20th). An official of Texas Crushed Stone Co. reported in the magazine that Texas construction was on the upswing again with a substantial recovery in housing and commercial building construction.

The University of Texas at Austin and Texas A&M University were selected by the Aggregates Foundation for Technology, Research, and Education as the headquarters for the new Center for Aggregate Research (CAR). The Texas universities were selected among 11 formal proposals involving 25 colleges and universities. The National Aggregates Association and the National Stone Association raised $4 million to endow CAR. The center was billed as an applied research institute and as a repository and source for information concerning the aggregates industry.

In May, three Texas companies filed an antidumping duty petition with the U.S. Department of Commerce and the International Trade Commission against crushed stone imports from Mexico. In their petitiion, Parker-Lafarge, Inc., Texas Crushed Stone Co., and Gulf Coast Limestone alleged that Calica had been selling Mexican crushed limestone in southeast Texas at less than production cost. Calica is a joint venture of the Ingenieros Civiles Asociados and Vulcan Materials Co. The International Trade Commission ruled that the imports had not injured the U.S. industry, and the Texas companies appealed the ruling in August to the Court of International Trade in New York.

Beginning in 1992, sections of U.S. 281 and Texas 46 between San Antonio and New Braunfels were the first roads in the Nation to test a French method of waterproofing pavement. French Novachip seal was described as a combination of two paving methods used by the Texas Department of Transportation. One was the chip seal, in which crushed stone is spread on top of a seal coat of liquid asphalt. The other is an overlay of asphalt mixed with crushed stone. A French machine was used to apply a heavy coat of asphalt mixed with 1/2-inch-thick crushed limestone.

Dimension.—Like crushed stone, 1992 dimension stone production is estimated. Both output and value appear to have dropped since 1991. Texas ranked fourth of 34 producers, according to USBM estimates.

Cold Spring Granite Co. unveiled "Azalea," the newest color in the company's growing line of North American-quarried granites. The company projected that its Llano quarry would produce 200,000 cubic feet of the new color annually. The new color was reportedly similar to Sunset Red in characteristics and mineral makeup, but featured deeper red hues.

In addition to boots and bricks, Justin Industries, Inc. sold cut limestone through its subsidiary, Featherlite Building Products Corp. (Texas Quarries Div.). According to Justin's Form 10-K, the primary market for its limestone was Texas and southeastern States. The Texas Quarries Div. produced architectural limestone products, particularly its Cordova Shell stone. Because of the value of architectural limestone, the company competed across the country, and its most significant 1992 projects were outside Texas.

Sulfur.—**Frasch.**—Two companies continued to produce Frasch sulfur in Texas: Pennzoil Co. (Culberson County) and Texasgulf Inc. (Wharton County). Both production and value dropped dramatically in 1992, about 17% and 42%, respectively. Average Tampa, FL, posted price for sulfur fell 22% to $95.91 in 1992, continuing a decline begun in 1989. Sulfur prices collapsed because of sharp consumption decreases (particularly in the former U.S.S.R., Eastern Europe, Poland, and Mexico), increased production of recovered sulfur, and a jump in Canadian exports at discounted prices. Canadian exporters produce sulfur involuntarily through extraction of sulfur from sour gas. According to Industrial Minerals, U.S. Frasch producers reacted by cutting their prices to make Canadian sulfur imports less profitable. Among its uses, sulfur is marketed for fertilizer, and aggressive marketing from India and China only helped drag fertilizer prices down to their lowest level in 17 years.

Pennzoil Sulfur Co., a subsidiary of Pennzoil Co., mined Frasch sulfur at its Culberson property near Orla (Culberson County) in west Texas. Discretionary production, according to the company's annual report, was only 1.2 million tons, down from the 1.7 million tons produced in 1991. Culberson operated at only 45% capacity (design capacity of the facility was 2.5 million long tons) in 1992, compared with 68% the previous year. About 78% of the company's sulfur was sold to the phosphate industry for use in making phosphate fertilizer. Most of Pennzoil's sulfur was transported in liquid form by rail to the company's Galveston terminal facilities. Remaining reserves at the operation were about 26 million long tons. Because of the poor sulfur market conditions, Pennzoil laid off 60 employees in October.

Texasgulf Inc., a subsidiary of Société Nationale Elf Aquitaine, mined Frasch sulfur. Texasgulf's Newgulf sulfur mine southwest of Houston produced 148,000 long tons of sulfur in 1992, up 20% from 1991 production. The company remelted the balance of its vatted supplies, about 57,000 long tons. Since its 1929 debut, the mine had produced 80.8 million long tons of sulfur.

Recovered Elemental.—Environmental regulations require oil refineries to recover sulfur to control plant emissions. As the U.S. oil and gas production leader, Texas continued to have 30 companies producing nondiscretionary sulfur from 49 refineries in 26 counties. Total value of its production was $99.3 million for 2.01 metric tons, in contrast with a value of $120.3 million for 1.74 million metric tons produced in 1991.

An April 1991 fire damaged Phillips Petroleum Co.'s Sweeney Refinery atmospheric residuum desulfurization unit, which extracts sulfur and metals

from sour crude oil. As a result of the fire, two vessels in the unit were replaced during regular maintenance scheduled the third quarter of 1992. All repairs to the facility were completed, and refinery operations returned to normal.

Diamond Shamrock Inc. employees designed and began construction of a diesel desulfurizer at the company's McKee refinery (Moore County), which was projected to come on-stream in late 1993.

Talc.—During 1992, Texas supplied about 235,000 metric tons of black talc valued at $5.7 million. Of eight producing States, Texas trailed only Montana in production and was behind only Montana and New York in production value. Five companies mined talc near Van Horn including (in decreasing order of production): Dal Minerals Co. (a subsidiary of Dal-Tile Corp.), United Clay of Texas, Inc. (a subsidiary of Watts Blake Bearne and Co. PLC), Milwhite Inc., Pioneer Talc Co., and Apache Minerals Inc. About 86% of west Texas talc was sold to make ceramic products, such as tiles. Texas talc also was used as a functional mineral filler in making paint, paper, plastic, refractory materials, wall texture, and rubber. The Van Horn-area talcs, sometimes called impure talcs, tend to contain quartz and as much as 15% to 20% dolomite.

Dal-Tile Corp. announced it would open a new manufacturing plant in 1994 in southeast Dallas that would employ 200 additional workers. Dal-Tile was one of southeast Dallas' largest employers, with more than 1,100 workers.

Cyprus Minerals Co. sold its talc interests to RTZ Corp., including a talc processing plant the company operated near Houston.

Other Industrial Minerals.—Texas produced or consumed a wide variety of other industrial minerals and mineral products, including ammonia, ground barite, butyllithium, fluorspar briquettes, gemstones, humate, iodine, lanthanide compounds, expanded perlite, titanium dioxide pigments, exfoliatied vermiculite, and zeolites.

Cominco American Inc. at Borger (Hutchinson County), Diamond Shamrock at Dumas (Moore County), and E.I. du Pont de Nemours and Co. Inc. at Beaumont (Jefferson County) continued to manufacture anhydrous ammonia. After reactivating the second of two 70,000-ton-per-year plants during 1992, Diamond Shamrock's Center Plains facility produced 390 short tons per day of anhydrous ammonia marketed by the company as fertilizer.

Although oil and gas drilling activity remained sluggish, several companies shipped barite into Texas for grinding. Milwhite Co. Inc. operated its Brownsville plant in Cameron County and a Houston grinding plant in Harris County; M-I Drilling Fluids Co. (subsidiary of Dresser Industries, Inc.) had a grinding plant at Galveston in Galveston County. According to Industrial Minerals, some filler-grade barite also was sold by M-I Drilling Fluids and by Milwhite Co. Milpark Drilling Fluids operated a grinding plant in Nueces County. Hitox Corp. of America produced six grades of filler barite from its plant in Corpus Christi. According to Mining Engineering, Excalibur Minerals operated a Houston-area grinding plant that produced filler-grade and American-Petroleum Institute-grade barite. Old Soldier Minerals moved its Pecos (Reeves County) grinding plant to Bruni (Webb County) and also produced barite for well-drilling fluids.

FMC Corp. opened its new Bayport butyllithium facility in February and, according to the company's annual report, was at forecast production by yearend.

Oglebay Norton announced it was pursuing new markets for the product from its Brownsville fluorspar grinding plant. The 24,000-ton-capacity plant dried fluorspar imported from Mexico and produced fluorspar briquettes.

Several companies produced natural and synthetic gemstones in Texas during 1992, including agate, freshwater pearls, jasper, and petrified wood. Value of Texas' natural gemstone output increased during the year to $3.8 million.

Humate, or leonardite, was mined by two Texas companies in 1992. Badlands Minerals Co. produced humate from oxidized coal at its mine north of Study Butte in Brewster County. In Henderson County, Blackjack Chemical Co. also produced humate from organic clay units in the Wilcox Group.

Although no Texas companies manufactured iodine, two—Hoechst Celanese Chemical Co. and AKZO Chemicals Inc.—in the Houston area continued to consume iodine. Hoechst Celanese's Pasadena plant consumed hydroiodic acid for the manufacture of petrochemicals; AKZO consumed elemental iodine for the manufacture of catalysts and chemicals.

Rhône-Poulenc Basic Chemicals Co. processed rare-earth nitrates to make lanthanide compounds at its facility in Freeport.

Six companies expanded perlite shipped into Texas from other sources: Filter Media Co. (Harris County), Nord Sil-Flo Corp. (Tarrant County), Pamrod Products (Comal County), Perlite of Houston Inc. (Harris County), South Texas Perlite (Bexar County), and U.S. Gypsum Co. (Nolan County). Total production for the State was 25,600 short tons, down slightly from the 1991 total of 29,500 short tons. Nord Sil-Flo Corp. (a subsidiary of Nord Resources Corp.) and Filter Media Co. led State production. Perlite expanded in Texas went overwhelmingly into production of filter aids; it also was used in horticulture, concrete aggregate, various types of insulation, acoustic tile, plaster aggregate, and as a filler. In 1992, Nord Resources Corp. announced that Nord Sil-Flo and Mid-Atlantic Perlite Products Co. (collectively known as Nord Perlite Co.) were for sale.

Hitox Corp. of America produced titanium dioxide pigments at its 15,000-short-ton-per-year plant in Corpus Christi. The company produced a range of unconventional buff-colored pigments from synthetic rutile imported from Malaysia. Hitox's buff-colored pigments were used in lieu of more expensive white pigments where pigment

performance and opacity were not as critical, for example, as primer for car paint.

Two companies exfoliated vermiculite in Texas during 1992: W. R. Grace (Dallas County) and Vermiculite Products Inc. (Harris County). The bulk of their combined output was used as lightweight aggregate in concrete; lesser amounts were used to make insulation, fireproofing materials, and to loosen soils in horticulture. Production and value fell by 14% and 9%, respectively.

Texas led seven States in 1992 U.S. zeolite production. Zeotech Corp. mined zeolite (clinoptilolite) from its Tilden Pit in McMullen County. The company reportedly increased production of sized clinoptilolite for animal waste absorbents. AKZO Chemicals Inc. announced plans to build a new plant in Pasadena that would produce synthetic zeolites for the oil refining industry.

Metals

Aluminum.—Continued smelter capacity increases coupled with sluggish world economies glutted 1992 world aluminum supplies. Aluminum Co. of America (Alcoa) continued to operate a smelter near Rockdale and a refinery at Point Comfort. Reynolds Metals also ran an alumina refinery near Corpus Christi. Two other companies, ACX Technologies, Inc. and Kaiser Aluminum Corp., operated aluminum mills in Texas. Value of State primary aluminum production (from Alcoa's Rockdale smelter) increased during 1992, although output is estimated to have dropped slightly.

In December, Adolph Coors Co. spun off ACX Technologies, Inc., which included Golden Aluminum Co. and its San Antonio minimill. At yearend, the company was still trying to qualify the mill, 9 months behind schedule. According to ACX, the mill, when operational, will manufacture rigid container sheet and nearly triple the company's aluminum sheet capacity. The mill was designed to employ continuous casting technology and produce 95% of its sheet from recycled metal.

Alcoa continued producing alumina at its Point Comfort refinery (Calhoun County) from bauxite shipped from the Republic of Guinea. Early 1993 was the target completion date for the expansion of facilities for drying alumina trihydrate at Point Comfort. Alumina trihydrate was used heavily in petrochemical processing, water treatment, and in a variety of other applications. The company also operated its primary aluminum smelter at Rockdale (Milam County). The smelter was fueled by lignite, mined on-site at the company's 12,764-acre Sandow Mine. Company-owned generating units supplied about one-half the smelter power requirements; the balance was purchased from a dedicated powerplant. In May, Alcoa's Sandow Mine won an Excellence in Surface Mining Award from the Federal Office of Surface Mining Reclamation and Enforcement for its success in reclaiming coal mine sites as new pasture and wildlife habitats.

Reynolds Metals Co. refined bauxite into alumina at its Sherwin refinery near Corpus Christi (San Patrico County). According to Mining Engineering, the 1.7-metric-ton-per-year plant operated at a reduced production level in 1992 as a result of the closure of Reynolds' Troutdale, OR, reduction plant. Reynolds also manufactured extruded products at its El Campo (Wharton County) facility and aluminum cans in Houston (Harris County). According to its annual report, the primary use for Reynolds' aluminum was in cans and other packaging.

Kaiser Aluminum Corp.'s Extruded Aluminum Products Div. was headquartered in Dallas and included among its soft alloy extrusion facilities a plant at Sherman (Grayson County). The extruded products group's major market was the transportation industry, to which it supplied extruded shapes for automobiles, trucks, trailers, cabs, and shipping containers. The group also supplied aerospace, durable goods, defense, building and construction, ordnance, and electrical markets. The Sherman plant set monthly plant records in casting and tolling along with a new shipment level of 50 million pounds, 21% higher than that in 1991.

Antimony.—Two Texas smelters continued to produce primary antimony metal and oxide products: Anzon Inc. in Laredo (Webb County) and Laurel Industries Inc. in La Porte (Harris County).

Copper, Gold, and Silver.—Two companies, ASARCO Incorporated and Phelps Dodge Corp., continued to operate copper refineries or smelters in Texas. Asarco operated a smelter in El Paso and a refinery in Amarillo. Phelps Dodge maintained a refinery in El Paso.

Frustrated by permitting difficulties and by opposition from environmental groups, Mitsubishi Materials Corp. scrapped its plans for a new copper smelter at Texas City. The company had spent $11 million on the project through its subsidiary Texas Copper Co. The plant would have produced 200,000 metric tons of copper and 600,000 metric tons of byproduct sulfuric acid per year.

Asarco announced it would consolidate operations of its Amarillo refinery and El Paso copper smelter under its Southwestern Copper Div. To replace the reverberatory furnace at the El Paso smelter, Asarco began constructing a new ConTop furnace, which would permit flash smelting of concentrates. Scheduled for completion in early 1993, modernization was expected to boost smelter capacity from the 70,000 metric tons (80,000 short tons) per year produced in 1985 to 100,000 metric tons (110,000 short tons) by 1994. Including processed scrap, total annual smelter capacity was projected to increase to 120,000 metric tons (130,000 short tons). The new furnace also was declared to be more environmentally friendly, cutting sulfur dioxide emissions from 37,000 metric tons (40,776 short tons) to 2,740 metric tons (3,024 short tons) per year; lead emissions were expected to fall from 18 to 13 metric tons (20 to 14 short tons) per year. Asarco reported in its annual report that the El Paso smelter had produced 98,900 metric tons (107,900

short tons) of copper, up from 96,100 metric tons (105,900 short tons) produced in 1991. The company's refinery in Amarillo yielded 423,800 metric tons (467,200 short tons) of cathode copper, also higher than its 1991 output of 408,400 metric tons (450,200 short tons). According to Asarco's annual report, the Amarillo refinery also produced 1,238 metric tons (39.8 million troy ounces) of silver, up from 998 metric tons (32.1 million ounces) produced during 1991; the refinery also produced 7,000 kilograms (225,400 troy ounces of gold), up from 6,100 kilograms (195,200 troy ounces) produced in 1991.

According to the company's annual report, Phelps Dodge Corp. continued to operate the second largest copper refinery in the world in El Paso. Nameplate capacity of the refinery was 390,000 metric tons (430,000 short tons) of electrolytic copper. According to the company's annual report, its El Paso refinery produced 352,100 metric tons (388,100 short tons) of copper cathode, increasing from 350,200 metric tons (386,000 short tons) produced in 1991. Phelps Dodge indicated in its annual report that the refinery also yielded 2,450 kilograms (78,800 troy ounces) of gold, up from 1,770 kilograms (56,800 troy ounces) produced in 1991; the refinery also produced 74 metric tons (2.38 million troy ounces) of silver, also up from 68 metric tons (2.2 million troy ounces) produced in 1991. Most copper refined by the company was used to make electrical wire and cable products marketed around the world.

Iron and Steel.—East Texas continued to produce a small amount of iron ore, none of which was consumed by the steel industry. With two producers, Texas was last in 1992 U.S. production of iron ore. Mathis and Mathis Mining Co. (Cass County) mined limonite and siderite as a cattle feed nutrient. Hudson Brothers Mining Co., Inc. (Cherokee County) produced limonite and siderite iron used in cement manufacture and for road aggregate.

Texas was 10th of 28 States in shipments of steel slag. International Mill Service Co. and Warner Co. were the only two companies in Texas that milled iron and steel slag. International Mill Service operated mills in Gregg, Jefferson, Leon, and Tarrant Counties; Warner Co. operated one mill in Guadalupe County. State production for 1992 was about 24% higher than that for 1991.

Texas was sixth in 1992 national steel production; according to the American Iron and Steel Institute 1992 Annual Report, the State supplied 4.34 million net tons, up from 4.052 million net tons produced in 1991. Eight companies operated steel minimills in Texas: Border Steel Mills, Inc. at El Paso; Chapparal Steel Co. in Midlothian; CMC Steel Group/Structural Metals Inc. in Seguin; North Star Steel Co. in Beaumont; Nucor Corp. in Jewett; Lone Star Steel in Lone Star; IRI International Corp., Inc. in Pampa; and Marathon Le Tourneau Co. in Longview. Post-cold war economic restructuring weakened prices for steel scrap. Average cost of scrap declined in 1992 to about $100 per gross ton from about $110 per ton in 1991.

CMC Steel Group's Structural Metals Inc. minimill closed the year with record sales of 595,000 short tons. Conversion to a new 120-ton-capacity furnace resulted in a record ton-per-hour production for the facility. The rolling mill rolled a record 477 sizes and had a 12% improvement in changeover and sizeup delays. CMC also operated 11 steel fabrication plants and 11 secondary metal processing plants in Texas. CMC acquired the assets of Kramer Trading Corp., a ferrous scrap processor in Houston, and planned to consolidate the assets with Kramer's existing Houston facilities.

Nucor Steel continued operation of its Grapeland-Jewett steel mill, which produced bar and light structural carbon and alloy steels. In its annual report, Nucor reported that its highly automated mills processed steel scrap primarily into hot-rolled shapes, cold-rolled joists, and deck manufactured from cold-rolled steel.

Lone Star Steel Co., a subsidiary of Lone Star Technologies Inc., continued manufacturing steel tubular products and flat rolled steel at its 600-acre east Texas facility. Although Lone Star also had extensive iron reserves in Texas, it had not mined iron in Texas for several years.

LTV Corp. relocated its Dallas corporate headquaters to Cleveland. The company's Energy Products Div., which employed 1,100, remained headquartered in the Dallas suburb of Garland. According to LTV's annual report, erosion of domestic drilling activity and low natural gas prices created a 15% decline of sales.

Quanex Corp. manufactured rolled steel tube in Bellville and Rosenburg. Gulf States Tube in Rosenburg set a record in 1992 for production rate at its extrusion mill for the fifth year in a row. The Bellville Tube Div., impacted by sluggish oil and gas drilling, sought to increase international sales and secured a large Russian order for electric-resistance, welded oil-country tubing.

Magnesium Metal.—With a single producing company, Texas continued to lead the country in production of magnesium metal. Dow Chemical Co. processed seawater to recover both magnesium metal and magnesium compounds at its Freeport plant (Brazoria County), rated at a 109,000-metric-ton annual capacity. Company production increased moderately, and value of its output rose impressively in 1992. Dow produced hydrous magnesium chloride from seawater by adding dolomitic limestone and adding hydrochloric acid to magnesium hydroxide to yield a neutralized magnesium chloride solution. The solution was dehydrated until it contained about 25% water and then was recovered electrolytically. Magnesium was primarily alloyed with aluminum to increase its hardness and corrosion resistance. Two-piece beverage cans, which contain 2% magnesium, are the principal outlet for magnesium-aluminum alloys. Magnesium and its alloys also are used in automobile, aircraft, computer, and power tool components.

Other Metals.—In processing copper ore, selenium and tellurium accumulate

TABLE 5
TEXAS: PRIMARY SMELTERS, REFINERIES, AND REDUCTION PLANTS

Product, company, and plant	Location (county)	Material treated
Aluminum:		
Aluminum Co. of America:		
Point Comfort	Calhoun	Bauxite.
Rockdale (reduction)	Milam	Alumina.
Reynolds Metals Co.:		
Sherwin plant (alumina)	San Patricio	Do.
Antimony:		
ASARCO Incorporated:		
El Paso smelter	El Paso	Ore.
Cadmium:		
ASARCO Incorporated:		
El Paso smelter	do.	Do.
Copper:		
ASARCO Incorporated:		
Amarillo refinery[1]	Potter	Blister and anode.
El Paso smelter	El Paso	Ore and concentrates.
Phelps Dodge Refining Corp.:		
Nichols refinery[2]	do.	Blister and anode.
Magnesium:		
The Dow Chemical Co.:		
Freeport plant, electrolytic	Brazoria	Seawater.

[1]Asarco's Amarillo refinery also produced gold, nickel sulfate, palladium, platinum, selenium, silver, and tellurium.
[2]Phelps Dodge's El Paso (Nichols) refinery also produced copper sulfate, gold, palladium, platinum, selenium, silver, and tellurium.

with precious metals in anode slimes produced during electrolytic refining. All primary electrolytic copper refineries generate selenium/tellurium-bearing slimes, but most lack circuits to recover the metals. Asarco's refinery in Amarillo and Phelp Dodge's refinery in El Paso were two of only three U.S. refineries that processed anode slimes for selenium in 1992. Commercial-grade tellurium metal and tellurium dioxide were produced by Asarco at Amarillo, principally from copper slimes, but also from lead-refinery skimmings. The largest end use for domestic selenium was in the manufacture of glass.

Additionally, three companies continued operating secondary lead smelters in the State. RSR Corp. operated one smelter in the Dallas area; Tejas Resources operates one secondary lead smelter at Terrell; and Lead Products Inc. operated one in the Houston metropolitan area.

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[1]State Mineral Officer, U.S. Bureau of Mines, Denver, CO. She has 14 years of mineral-related work with the government and industry.

[2]Research associate, Bureau of Economic Geology, The University of Texas at Austin, TX.

[3]Petroleum Supply Annual 1992, v. 1 and 2. Energy Information Administration. May 1993.

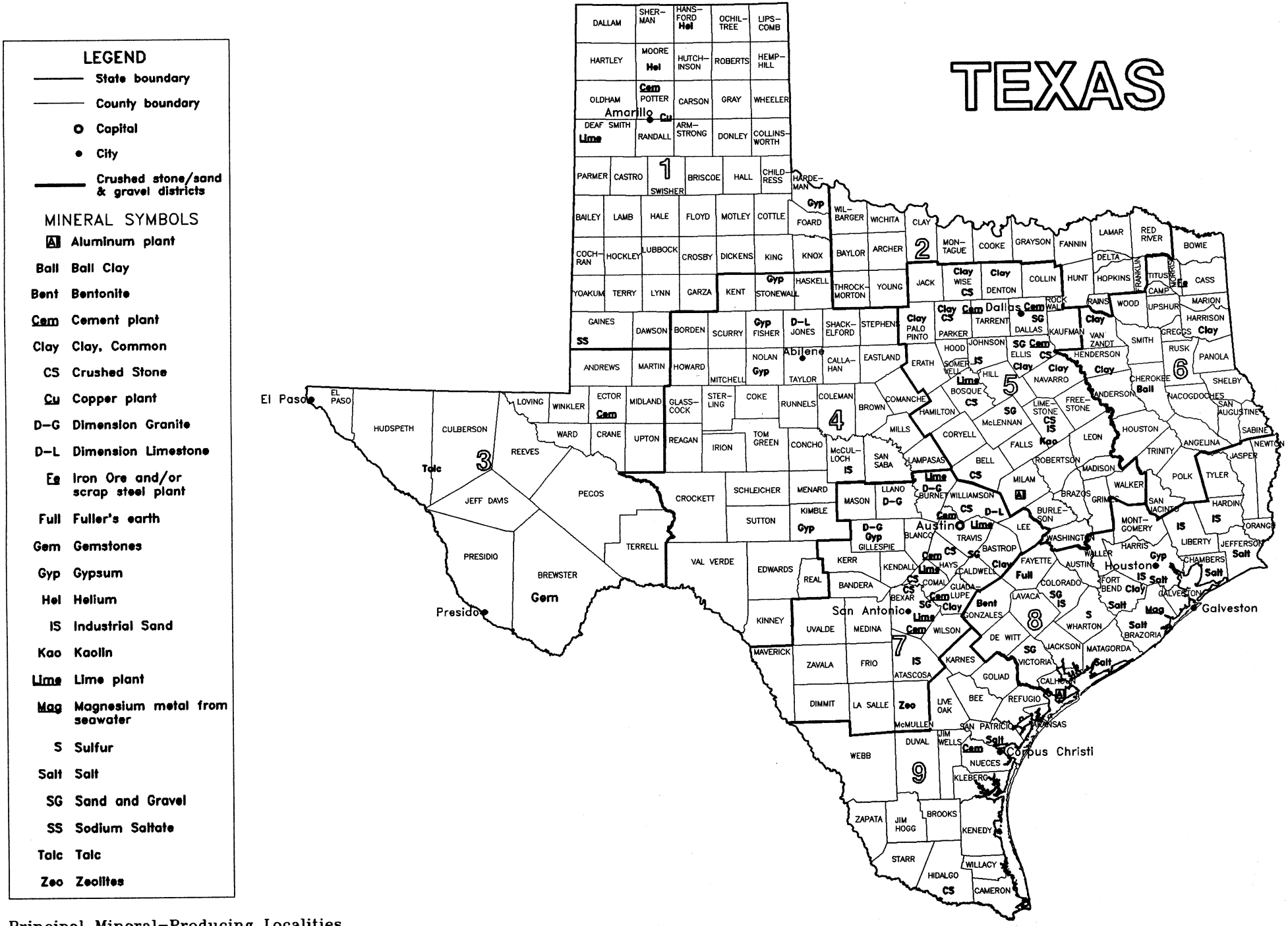
[4]Natural Gas Supply Monthly. Energy Information Administration. Mar. 1993.

[5]Resume 1992. Petroleum Information Corp.

[6]Weekly Coal Production. Energy Information Administration. Week ending May 8, 1993.

[7]Coal Surface Mining Operations. Texas Railroad Commission. Report on Activities through Dec. 1992. Apr. 1, 1993.

[8]Unless noted, specific mine or plant production data in this section are from company annual or Form 10-K reports.



Principal Mineral–Producing Localities

TABLE 6
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Box Crow Cement Co.	700 Dove Lane Midlothian, TX 76065	Plant	Ellis.
Beazer U.S.A./Hanson (Gifford-Hill & Co. Inc.)[1]	2515 McKinney Ave Dallas, TX 75201	Quarry and plant	Do.
Lafarge Corp.[2]	11130 Sunrise Valley Dr. Suite 300 Reston, VA 22091	Quarries and plant	Comal, Dallas, Tarrant.
Texas Industries Inc.[3]	7610 Stemmons Freeway Dallas, TX 75247	do.	Comal and Ellis.
Texas-Lehigh Cement Co., a division of Centex Corp.	7660 Imperial Way Allentown, PA 18195	Pits and plants	Hays.
Clays:			
Acme Brick Co., a division of Justin Industries Inc.	Box 425 Fort Worth, TX 76101	do.	Bastrop, Denton, Guadalupe, Nacogdoches, Parker, Van Zandt, Wise.
Balcones Mineral Corp.	Drawer B Flatonia, TX 78941	do.	Fayette.
Border Mines Inc.	Box 1327 Alpine, TX 79831	do.	Brewster.
Mid-Tex Minerals Co. Inc.	Box 389 Flatonia, TX 78941	do.	Fayette.
Southern Clay Products Inc., a subsidiary of Laporte PLC	Box 44 Gonzales, TX 78629	do.	Gonzales.
United Clays of Texas, a division of Watts Blake Bearne and Co. PLC[4]	Box 174 Troup, TX 75789	do.	Cherokee.
Gypsum:			
Georgia-Pacific Corp.	133 Peachtree St., NE Atlanta GA 30348-5605	Quarry and calcining plant	Hardeman.
National Gypsum Co., Gold Bond Div.	Suite 4500, Lincoln Plaza Dallas, TX 75201	Quarries and calcining plants	Fisher, Kimble, Stonewall.
Standard Gypsum Co.	14901 Quarum Dr. Suite 455 Dallas, TX 75240	do.	Gillespie and Guadalupe.
USG Corp. (parent of United States Gypsum Co.)	101 South Wacker Dr. Chicago, IL 60606	Quarry and calcining plant	Harris and Nolan.
Iron ore:			
Hudson Brothers Mining Co. Inc.	Box 301 Rusk, TX 78785	Pit and plant	Cherokee.
Mathis & Mathis Mining & Exploration Co.	Box 2577 Silver City, NM 88061	do.	Cass.
Lime:			
APG Lime Corp.	Route 6, Box 662 New Braunfels, TX 78132-5011	Plant	Comal.
Austin White Lime Co.	Box 9556 Austin, TX 78766	Quarry and plant	Travis.
Chemical Lime Southwest Inc.	3724 Hulen St. Fort Worth, TX 76107-6816	Plant	Bosque and Burnet.
Holly Sugar Corp.	Drawer 1778 Hereford, TX 79045	do.	Deaf Smith.
Redland Corp.[5]	Route 2, Box 222 San Antonio, TX 78229	Quarry and plant	Bexar.
Texas Lime Co., a subsidiary of Rangaire Corp.	Box 851 Cleburne, TX 70631	do.	Johnson.

See footnotes at end of table.

TABLE 6—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Salt:			
Diamond Shamrock/OXY Chemical Corp.	9830 Colonnade San Antonio, TX 78230	Brine	Chambers.
The Dow Chemical Co.[6]	2020 Dow Center Midland, MI 48640	do.	Brazoria.
Morton International Inc.	100 North Wacker Dr. Chicago, IL 60606	Underground mine and brine	Van Zandt.
United Salt Corp./Texas Brine Corp.	2000 West Loop S. Houston, TX 77027	do.	Fort Bend, Harris, Jefferson, Matagorda.
Sand and gravel:			
Construction:			
Capitol Aggregates Inc. (H. B. Zachry Co.)	Drawer 33240 San Antonio, TX 78265	Stationary plants	Bexar, Hudspeth, Reeves, Travis, Val Verde.
The Fordyce Co.	Box 1981 San Antonio, TX 78297	Pits and plants	Hidalgo and Victoria.
Myre Construction Co. Inc.	Box 721 Rockwall, TX 75087	do.	Dallas, Ellis, Wise.
Pioneer Concrete of Texas Inc.[7]	800 Gessner Road Houston, TX 77024	do.	Colorado, Liberty, Montgomery, Travis.
Industrial:			
Oglebay Norton Co., Texas Mining Co.	2104 East Randol Mill Rd. Suite 101 Arlington, TX 76011	Pits and plant	McCulloch.
Speciality Sand Co.	Box 9877 Houston, TX 77105	Pits	Colorado, Harris, Newton.
Unimin Corp.	50 Locust Ave. New Canaan, CT 06840	Plant	Johnson.
U.S. Silica Co., a subsidiary of RTZ Corp.[8]	Box 187 Berkeley Springs, WV 25411	Pits and plants	Limestone.
Sodium sulfate (natural):			
Ozark-Mahoning Co.	1870 South Boulder Tulsa, OK 74119	Brine field and plant	Gaines.
Stone:			
Texas Crushed Stone Co.	Box 1000 Georgetown, TX 78626	Plant and quarry	Williamson.
Vulcan Materials Co.[9]	Box 530187 Birmingham, AL 35253	Plants and quarries	Bexar, Brown, Eastland, Grayson, Kerr, Parker, Taylor, Uvalde, Wise.
Sulfur:			
Byproduct:			
Amoco Production Co. (Standard Oil Co., Indiana)	Box 3092 Houston, TX 77253	Secondary recovery	Andrews, Ector, Galveston, Hockley.
Chevron U.S.A. Inc.	Box 36366 Houston, TX 77236	do.	Crane, El Paso, Hopkins, Jefferson, Karnes.
Exxon Co., USA	Box 2180 Houston, TX 77252-2180	do.	Atascosa and Harris.
Phillips Petroleum Co.	Box 1967 Houston, TX 77251-1967	do.	Andrews, Brazoria, Crane, Ector, Hutchinson, Moore.
Shell Oil Co.	Box 576 Houston, TX 77001	do.	Cass, Harris, Yoakum.
Texaco Chemical Co.	Box 27707 Houston, TX 77227-7707	do.	Franklin and Freestone.

See footnotes at end of table.

TABLE 6—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sulfur—Continued:			
Native:			
Pennzoil Co.	700 Milam Pennzoil Place Houston, TX 77002	Frasch mine	Culberson.
Texasgulf Inc., a subsidiary of Elf Aquitaine Inc.	Box 1512 Pecos, TX 74772	do.	Wharton.
Talc:			
Apache Minerals Inc. and Pioneer Talc Co.	1000 Coolidge St. South Plainfield, NJ 07080	Pits and plant	Hudspeth.
Dal Minerals Co. (Dal-Tile Corp.)	Box 17130 Dallas, TX 75217	Pits	Do.
The Milwhite Inc.	Box 15038 Houston, TX 77020	Mine and plant	Culberson.
Vermiculite (exfoliated):			
W. R. Grace & Co.	2651 Manila Rd. Dallas, TX 75212	Exfoliating plants	Dallas.
Vermiculite Products Inc.	3025 Maxroy Houston, TX 77008	do.	Harris.
Zeolites:			
Zeotech	3202 Candelaria NE Albuquerque, NM 87107	Pit and plant	McMullen.

[1]Also sand and gravel, Brazos, Dallas, Ellis, and McLennan Counties; and crushed stone, Comal, Cooke, Ellis, Limestone, Walker, and Wise Counties.
[2]Also clays, Dallas and Gaudalupe County; sand and gravel, Dallas, Henderson, Johnson, Tarrant, Wise, and Williamson Counties; and crushed stone, Comal, Freestone, and Wise Counties.
[3]Also clays, Ellis, Fort Bend, Guadalupe, Henderson, Navarro, and Van Zandt Counties; sand and gravel, Dallas, Ellis, Parker, Travis, and Wise Counties; and crushed stone, Comal, Ellis, and Wise Counties.
[4]Also talc, Hudspeth County.
[5]Also sand and gravel, Atascosa, McLennan, and Midland Counties; crushed stone, Bexar, Hidalgo, Limestone, Medina, Midland, and San Patricio Counties.
[6]Also magnesium compounds and magnesium chloride for magnesium metal, Brazoria County.
[7]Also crushed stone, Burnet, Parker, and Wise Counties; and industrial sand, Colorado and Liberty Counties.
[8]Also clays, Limestone County.
[9]Also industrial sand, McCulloch County.

THE MINERAL INDUSTRY OF UTAH

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Utah Geological Survey for collecting information on all nonfuel minerals.

By Eileen K. Peterson[1] and Robert W. Gloyn[2]

Utah mines reversed the decline in value of nonfuel mineral production seen last year by about 14% to a total value of more than $1.35 billion in 1992, compared with $1.18 billion in 1991. This value ranked the State seventh in the Nation, up from ninth in 1991, with 4.2% of the Nation's nonfuel mineral production. Copper, gold, magnesium metal, portland cement, and construction sand and gravel were the leading commodities in terms of value.

Metal output accounted for nearly 80%, or about $1.06 billion, of Utah's nonfuel mineral value with copper leading the way. Production and value of beryllium, copper, gold, magnesium, molybdenum, and silver all increased from 1991 levels. Utah remains the only source of mined beryllium in the Nation. The State ranked second in copper and magnesium metal; third in gold, iron ore, and molybdenum; and silver production was sixth highest in the Nation. Utah was one of only three States reporting production of mercury.

A relatively strong construction industry encouraged increased production of cement, clays, gypsum, sand and gravel, and crushed stone. In production of nonmetals, Utah ranked second nationally in potash, third in sulfuric acid and magnesium compounds, and sixth in salt.

TRENDS AND DEVELOPMENTS

The value of exports from Utah in 1992 was $2.9 billion. Metals, the leading contributor, accounted for 45% of that total. Metallic ore exports

TABLE 1
NONFUEL MINERAL PRODUCTION IN UTAH[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrates	metric tons	4,548	$5	r4,339	$5	4,826	$5
Clays[2]	metric tons	277,795	1,774	210,382	1,028	242,769	2,714
Gemstones		NA	713	NA	489	NA	634
Lime	thousand short tons	354	18,878	325	18,634	W	W
Salt	thousand metric tons	1,062	50,436	1,310	29,959	1,367	44,498
Sand and gravel:							
Construction	thousand short tons	13,601	44,881	e14,400	e48,200	17,678	54,819
Industrial	do.	2	42	—	—	—	—
Silver[3]	metric tons	147	22,750	W	W	W	W
Stone:							
Crushed	thousand short tons	e4,600	e20,200	4,450	18,259	e5,300	e22,400
Dimension	do.	r e17,559	r e1,109	e23,079	r1,429	—	—
Combined value of cement, clays [bentonite, fuller's earth (1992)], copper, fluorspar (1990), gold, gypsum (crude), iron ore (usable), magnesium compounds, magnesium metal, mercury (1990, 1992), molybdenum, phosphate rock, potash, sodium sulfate (natural), vanadium ore (1990), and values indicated by symbol W		XX	1,174,213	XX	r1,067,184	XX	1,222,593
Total		XX	r1,335,001	XX	r1,185,187	XX	1,347,663

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" figure.
[3]Recoverable content of ores, etc.

contributed another 9.7%, bringing the total contribution from the mining industry to 54.7%.

Although most of the United States continued to show slow growth because of the recession and a slow recovery, Utah experienced growth in nearly all economic sectors. That growth is expected to continue through 1993. Six Rocky Mountain States were described as the hottest economic area in the country in 1992 because the economies of the States were performing at a level significantly better than the national economy. Utah was one of the States performing at a level much higher than the national economy.

Rumors of an upcoming repeal, or drastic change, in the 1872 mining law caused concern for many mining companies and government agencies in Utah. Expected impacts include loss of jobs, loss of income from taxes to the State, and loss of access to public lands. Despite nearly 2 years of hearings, the U.S. Congress did not pass a proposed 1-year moratorium on sales of Federal land to miners. Applications for patenting of mining claims are expected to increase significantly in 1993 in anticipation of additional legislation along these lines. Uncertainties during the year and apprehension over upcoming Federal legislation resulted in cautious, generally reduced, exploration activity in Utah and the rest of the Western United States in 1992.

Because of increasing Federal, State, and local regulations, mine operators continued to place more emphasis on creating environmentally sound operations to meet regulatory requirements, satisfy public interest groups, and protect fragile ecosystems. Compliance with new and existing regulations will undoubtedly require more of mine operators' time and staff and increase operating expenses at all mines.

The Bureau of Economic and Business Research at the University of Utah reported that construction activity in Utah increased dramatically from 1991 levels with the number of residential units permitted up 37.7% and valuation up 40.8%. New residential units numbered more than 13,000, valued at about $1.1 billion. The value of nonresidential construction was about $286 million, up about 32.2%. The increases were attributed to a growing population in Utah, low mortgage interest rates, and the expanding economy of the State.

Passage of the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) provided highway construction money and was expected to boost both quarrying and construction activities for several years to come. Although the U.S. Congress did not fully fund the bill during its first 2 years, ISTEA funding increased nationwide highway and street construction in 1992 by 11%. Future funding commitments were expected to increase construction activity by about 8% in both 1993 and 1994.[3] Production of construction aggregate should closely reflect increases in highway funding.

Suburban growth, coupled with increasingly restrictive environmental and zoning regulations and depletion of reserves at existing production sites, could result in significant increases in construction aggregate costs in the near future. The use of crushed stone may increase, relative to the use of sand and gravel. Producers may also be forced to look at underground mining to avoid some public visibility and protests.

In the future it may be necessary for land use planners to "require" that usable construction aggregate resources be mined prior to zoning for residential, recreational, or landfill use. As producers are forced to move farther from points of consumption, costs to consumers will increase dramatically. Protection of aggregate deposits from urban encroachment is, however, very uncommon in most urban communities.

EMPLOYMENT

The annual report of the Utah Department of Employment Security, Labor Market Information and Research, showed that during 1992 Utah's population grew 2.5% and nonagricultural employment increased by 3.1%. Utah's 1992 unemployment rate was 4.9%, unchanged from that of 1991.

Utah's mining industry employed an average of 8,487 workers in 1992, down slightly from the 8,596 reported in 1991. Metal mining employed 2,959; oil and gas extraction, 2,455; coal mining, 2,211; and nonmetallic minerals mining, 862. The mining industry comprised 1% of employment in Utah in 1992. The mining industry provided $327.7 million in wages to its workers. Average monthly earnings per mining employee rose $215 from those of 1991 to $3,217. Primary metal manufacturing, including smelters and foundries, employed another 6,317 people with total wages of about $212 million.

Employment in the construction aggregate-dependent construction industry rose nearly 7% with the addition of about 4,000 new employees, according to the Bureau of Economic and Business Research at the University of Utah. This was a modest increase considering the dramatic increase in building construction.

According to the U.S. Department of Labor, injuries reported from Utah's nonfuel surface and underground mines during 1992 totaled 52 with no lost workdays and 37 nonfatal injuries with lost workdays during 3.1 million hours worked. During the 2.7 million hours worked in nonfuel mills and preparation plants, 37 injuries resulting in no days lost and 23 injuries with lost workdays were reported. A total of 149 injuries were reported during nearly 5.8 million hours worked at nonfuel mills and preparation plants.

ENVIRONMENTAL ISSUES

With increased regulations and environmental concerns, environmental planning and reclamation of depleted mining sites have become integral parts of current mining operations and a significant component of the cost of doing business. In response to legislation, public pressure, and concern for the environment, mining companies have drastically changed the way they do business. In the past 20 years the domestic mining industry has spent $14 billion on environmental mitigation,

second only to oil and gas industry expenditures among all manufacturing groups.[4]

Imports of hazardous wastes increased drastically and accounted for an estimated 90% of waste stored or incinerated in Utah in 1992. Most waste material came from California. The combination of Utah's old fee of $22 per ton for out-of-State firms (among the lowest in the West) and a 1991 U.S. Supreme Court decision that States cannot prohibit the import of hazardous waste from other States had made Utah a favorite dumping place. However, in 1992, in response to the increasing level of imports of low-level hazardous wastes, the Utah Legislature passed legislation to increase commercial disposal fees. Two hazardous waste facilities for burial of such waste have been approved and in 1992, permit applications were submitted for two incinerators. When the incinerators come on-line, Utah's capacity for handling hazardous waste will be 200,000 short tons.

The APTUS hazardous waste incinerator in Tooele County started final testing in March. The facility, wholly owned by Westinghouse Electric Corp., was built at a cost of about $74 million and is expected to burn between 50,000 and 60,000 short tons of hazardous waste yearly.

An incinerator under construction in Tooele County by USPCI, a subsidiary of Union Pacific, would be the State's second commercial hazardous waste incinerator. The facility will be able to burn up to 130,000 short tons of material annually when completed.

The U.S. Environmental Protection Agency (EPA) completed studies to determine the effects of burning a wide variety of wastes, such as waste fuels, industrial waste, spent organic solvents, and used tires, as fuel in cement kilns. EPA found there was no threat to human health or to the environment from emissions created by burning these wastes in cement kilns. New regulations are expected in 1994 to eliminate excessive regulations prohibiting the use of waste in the production of cement or other building materials.

Ash Grove Cement Inc. (parent company of Ash Grove Cement West Inc.) proposed to burn waste at the company's cement plant in Juab County. The site, however, had not been designated as a waste disposal site, a State requirement. The requirement that the plant must meet strict State siting rules for commercial incinerators effectively ended Ash Grove's plans.

A Federal proposal to study whether a short-term, high-level radioactive storage facility could be built in San Juan County met with immediate opposition from some politicians and environmental groups. The proposal will be considered further in 1993.

A $2.5 million treatment plant was completed to treat water from the Spiro mine tunnel near Park City. High levels of arsenic had been found in water coming from the tunnel.

The EPA Midvale Superfund site, Salt Lake County, continued to be a point of controversy. Despite local opposition to the Superfund designation and tests showing no elevated lead levels in blood of residents, the EPA stuck by its designation of the town of Midvale as a Superfund site. EPA obtained $62 million for site cleanup from Potential Responsible Parties, including Sharon Steel and ARCO. By the end of December, EPA had spent $5 million of the funds just for engineering feasibility studies. Despite the fact that the site meets eligibility standards for inclusion in the National Register of Historic Places, demolition of buildings has begun.

At the request of the EPA, the U.S. Bureau of Mines (USBM) began investigating the characteristics of mill tailings at the Sharon Steel Superfund site at Midvale to determine the feasibility of reprocessing the tailings. The mill processed ores from many different mines during its 50 years of operation, resulting in a mineralogically and chemically complex tailings pile with elevated and highly variable metal content.

The USBM Western Field Operations Center (WFOC), Spokane, WA, used analytical data generated by the USBM's Salt Lake City Research Center (SLRC), Salt Lake City, UT, from 453 samples to determine spatial distributions of arsenic, cadmium, lead, and zinc in the tailings pile. Bulk samples were being used by the USBM's Rolla Research Center, Rolla, MO, and SLRC for ongoing process and beneficiation testing.

Abandoned mine reclamation work continued throughout Utah. The State received nearly $2 million from the Federal Government as part of a long-range effort to close the estimated 17,000 abandoned mine openings in Utah. Completion of the task could cost $174 million.

The EPA abandoned plans announced in April to redefine what and when waste material is hazardous. At least 42 State Attorneys General had objected to the rule changes. As a result of widespread criticism of the planned changes, the Agency will develop a new proposal within 2 years. Under current regulations, the EPA requires that refinery wastes, heavy-metal sludge, and toxic solvents be given special treatment and not be disposed of in landfills used for conventional garbage. Industry had argued that the definition is too broad; it does not consider the effects of dilution with other nontoxic wastes and includes nontoxic materials derived from a waste that is considered hazardous.

EPA and the Utah Department of Environmental Quality conducted soil sampling around 15 old Salt Lake County metal smelter sites. More than 1,500 soil samples were collected for analysis during the fall and winter. The samples will be tested for heavy-metal contamination, including lead and arsenic, left in the soil by operation of unregulated smelters in the late 1800's and early 1900's. Data will be analyzed to determine if any sites require cleanup. If testing reveals dangerous toxic metal contamination, soil removal projects could begin in 1993.

The Millard County Local Emergency Response Committee and the EPA received $10,000 and $44,500, respectively, from fines and restitution payments levied against Brush Wellman Inc. EPA assessed the fees on Brush Wellman for not immediately reporting a release of toxic anhydrous ammonia gas

in 1990. Between 700 and 5,000 pounds of gas apparently escaped a company facility in Millard County.

Provo decided to purchase contaminated, but clay capped, land south of Provo for about $500,000. The city plans to work with USX Corp. to clean up the 60-hectare (149-acre) site formerly occupied by a steel mill. By buying the land, Provo assumes part of the responsibility for removal of the hazardous wastes. The action drew immediate criticism because of the financial responsibility the city assumes with the purchase. The city planned for USX Corp. to contribute heavily in financing the cleanup project.

Cleanup at EPA's Bingham Creek Project in West Jordan, Salt Lake County, began in 1991. Cleanup of lead contaminated soil in residential areas along Bingham Creek has been completed. Kennecott Corp. agreed to a financial commitment of about $4.75 million, including the cost of hauling the contaminated soil to a permanent disposal site on its property in the Oquirrh foothills.

The RTZ Corp.'s (parent company of Kennecott) 1992 Annual Report indicated that in April, the EPA, Utah Department of Environmental Quality, and Kennecott signed a nonbinding Agreement in Principal to clean up historic and more recent contamination. The contamination to be cleaned up is on, or emanating from, Kennecott's property around the Bingham Canyon mine and smelter. The proposed cleanup program will comply with provisions of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA). A definitive Consent Decree was being negotiated among the parties. The proposed pilot program will incorporate several unique provisions intended to provide a cleanup that is faster and more efficient than remediation actions required under the normal regulatory process. Kennecott hoped to avoid designation of the area as a Superfund site by working closely with EPA on the cleanup project. Negotiations concerning the nature of the cleanup continued among the three parties involved.

A Federal judge rejected a $12 million settlement between Kennecott and the State of Utah for ground water pollution in Salt Lake County. Kennecott had estimated the damage to surface and ground water at $101 million in 1989. However, an agreement between the State and Kennecott called for a payment of $12 million to the State. The State reportedly reached that figure based on the belief that EPA would later require Kennecott to clean up the contamination and the State would seek only a natural resource damage claim. The judge threw out the $12 million settlement on the grounds it was too small and failed to protect ground water from future contamination.

The judge's action will force the 1989 suit filed by the State against Kennecott to go to trial or for the two parties to negotiate a new solution. Kennecott appealed the decision but no further decision had been announced by yearend. The judge also ruled that the Salt Lake County Conservancy District can participate in the State's 1986 lawsuit, bringing a third party to the negotiations. The conservancy district felt the area of water pollution to be much larger than what the State believed to be involved.

In June, Kennecott announced a major pilot cleanup program in cooperation with EPA and Utah Department of Environmental Quality oversight. The pilot program will include all the company's Utah copper operations, virtually all of which are on private Kennecott property. Some of the material found on the sites predates Kennecott's operations but because the land is now owned by the company it is now primarily the responsibility of Kennecott.

Environmental concerns also covered waste management practices related to oil and gas. The Division of Oil, Gas and Mining conducted field investigations of trucking companies collecting used oil. State officials were concerned about what was being collected and where it was being disposed of. The possibility that hazardous wastes were being dumped in landfills along with water and oil was examined. Other inspection activities of the division included reclamation of plugged and abandoned well sites and seismic lines, protection of surface and subsurface freshwater zones, and testing of oilfield safety equipment.

EXPLORATION ACTIVITIES

The Utah Geological Survey (UGS) reported exploration in Utah continued at a modest and declining pace during 1992. The 3-year decline in exploration activity was attributed to continued weak precious-metal prices and proposed changes in the holding cost for mineral claims. The pattern of decline is expected to continue for several years unless there is a significant increase in metal prices or discovery of a sizable new deposit.

The Utah Division of Oil, Gas, and Mining received 65 new and 37 amended notices-of-intent for exploration, down from 74 new and 40 amended notices in 1991. At least 18 of the notices were for precious metals, 4 for base metals, 3 for industrial minerals, and 40 for unspecified minerals, although most were believed to be for precious metals. Most precious-metal notices were filed for Beaver and Tooele Counties followed by Juab, Millard, Box Elder, and Utah Counties.

No major discoveries were announced during 1992; however, several properties changed ownership and exploration activities continued.

LEGISLATION AND GOVERNMENT PROGRAMS

The following Utah legislative bills, signed by the Governor, addressed the environment, reclamation, safety, taxes, and wilderness.

House bill 16 removed the repeal date of May 1, 1992, on House bill 165, passed by the 1991 General Session. The legislation requires kilns to meet the siting criteria established for commercial hazardous waste disposal facilities before accepting hazardous waste for recycling or use as fuel. The bill effectively ended plans to burn hazardous materials in

cement kilns in Utah for the time being.

House bill 129 allowed the Air Quality Board to implement a federally required air pollution operating permit program.

Senate bill 25 increased commercial disposal fees for hazardous, radioactive, and solid wastes. The bill, however, set different fees for wastes generated instate versus out-of-State. Instate fees would increase from $8 per short ton to $14 per short ton over 3 years and out-of-State fees would increase from $20 to $35 per short ton over the same time period. A recent U.S. Supreme Court ruling overturned a similar fee schedule in Alabama as unconstitutional. Utah's Governor did not call a special session to resolve the issue but left it for the 1993 regular session to rewrite the law.

In 1991, the Utah Legislature passed House Concurrent Resolution 13 urging Congress to add no more than 566,802 hectares (1.4 million acres) of Bureau of Land Management (BLM)—administered land in Utah to the National Wilderness Preservation System. Early in 1992, however, the BLM recommended to the President approval of 793,212 hectares (1.975 million acres) for wilderness protection. The BLM recommendation was based on 14 years of study with input from the USBM, U.S. Geological Survey, and Utah State agencies. In June the President passed that recommendation on to the U.S. Congress. At yearend, no action had been taken by Congress.

Because of the wide variety of wilderness acreage recommendations proposed, from 0 to 5,261,100 hectares (13 million acres), numerous studies relating to wilderness designations in Utah have been conducted. At the request of a member of the Utah Congressional delegation, Representative Owen, the U.S. General Accounting Office (GAO) evaluated a study by the Western Economic Analysis Center (Center). The Center's study concluded that Utah's economy would lose more than $13 billion annually if the 2,023,500 hectares (5 million acres) proposed by Representative Owen were approved for wilderness. The GAO study[5] concluded that the Center's study was flawed but did not attempt to determine what the loss might be.

In October another member of Utah's congressional delegation, Representative Hansen, presented a plan for designating 477,546 hectares (1.18 million acres) of wilderness on BLM land.

Federal actions affecting Utah included a decision by the U.S. Senate not to approve a 1-year moratorium on Federal land sales by granting patents, or title, to mining claims. The U.S. Department of the Interior issued regulations that would halt what it called "frivolous" appeals on land management decisions. The BLM will no longer automatically halt exploration or development work while an appeal is being heard by the Interior Board of Land Appeals. The Department also set a limit of 30 days in which an appeal must be made, and subsequent stays of action will follow for just a 40-day review period.

The fiscal year 1993 Appropriations Act for the U.S. Department of the Interior, signed in October 1992, included a requirement for holders of unpatented mining claims to pay the Federal Government a new rental fee of $100 per claim per year. The rental fee will expire September 30, 1994, unless extended. Payment of the fee replaces a requirement for performance of a minimum of $100 of assessment work per claim per year. The two rental years start September 1, 1992, and run to August 31, 1994. Enforcement of this fee is expected to result in forfeiture of many mining claims in Utah. Many claimholders able to conduct the $100 of assessment work on their own time may not be able to raise the money to pay rental fees. BLM is expected to draft rules for implementing the rental fee provisions with final rules expected in early 1993.

The Comprehensive National Energy Policy Act, signed by the President, included a provision that obligates the Federal Government to reimburse remediation expenses of uranium mill sites where the waste was generated in fulfilling Government contracts. According to a Department of Energy study, more than 55% of the tailings at Atlas Corp.'s Moab site fall into that category. Atlas closed the facility in 1987 and began preliminary reclamation efforts.

A Utah Court of Appeals decided that the Federal Land Policy and Management Act (FLPMA) does not give private parties a right of action for charging noncompliance of another party. The decision was made in a legal battle between two rival claimants to mining claims, one of which tried to claim improper filing of mining claims with the BLM under FLPMA to invalidate the mining claims of the other claimant.

In September, the first of what likely will be many public hearings was held concerning the drafting of a resource management plan for 1 million hectares (2.5 million acres) in the Escalante and Kanab Resource Areas administered by the BLM. The resource areas contain some of the most scenic areas in Utah but also are rich in natural resources. The potentially volatile planning process will pit environmentalists, who want to preserve scenic values, against local residents, who rely on natural resource development for jobs. The environmentalist position that the most important resources in the area are open spaces and pristine beauty and that Federal lands do not belong to the people in Kane and Garfield Counties exclusively will not set well with residents of the two counties. One county commissioner has voiced an opinion that "environmental fanaticism has wreaked havoc on the nation's economy and traditional values."[6] A draft of the Resource Management Plan was not expected until 1995.

BLM accused a gold prospector of illegally grading a road through a wilderness study area in southern Utah and ordered the alleged offender to rehabilitate and reseed affected areas. Because the area is on the list being considered for designation as a wilderness area (Westwater Canyon Wilderness Study Area), it must be managed to protect wilderness values. The BLM accused the claimholder of using road-maintaining machinery to make improvements beyond what was there when the mining claims were originally located, without the benefit of an approved plan of operations.[7] Similar

disputes have arisen concerning developments within wilderness areas throughout the West.

During 1992, the UGS continued to investigate the mineral and energy resources of the State. Energy resources investigations included: (1) a study of all major gasfields in Utah as part of a cooperative four-State "Atlas of Major Rocky Mountain Gas Reservoirs," (2) a stratigraphic-structural-hydrocarbon show study of the "Cane Creek" oil play area in Grand County, (3) an evaluation of the coalbed methane potential of the Book Cliffs coalfield, (4) a coal resource assessment of the Henry Mountain coalfield, (5) continued work on geological and geophysical evaluation of thermal areas in the Escalante and Sevier Desert areas of southwestern Utah, and (6) continued compilation of coal resource and coal quality information.

Mineral investigations included a study of the dimension stone industry in Utah with particular emphasis on quartzite in Box Elder County, an evaluation of mines and prospects in the Farmington Canyon complex and surrounding areas, continued research on high-calcium limestone in Utah, and additional inventory and documentation of mineral occurrences in western Utah. Mapping investigations included work on more than 30 7.5 degree quadrangles, mostly in Millard and Grand Counties, by both UGS staff and contract mappers. In addition, the UGS organized and cosponsored a 3-day symposium on "Hydrocarbon and Mineral Resources of the Uinta Basin" in Vernal, UT. The UGS established a geophysical log library with more than 9,000 logs, created, in cooperation with industry, an "Oil Sample Bank" with more than 75 oil samples from 38 fields, and operated the Utah Sample Library.

During 1992, the UGS released the following maps and economic reports: (1) 10 maps of 7.5 degree quadrangle (3 in the formal map series and 7 as open file reports), (2) a special study on the Newcastle geothermal systems, (3) a report of investigation on mineral and energy resources in Kane County, (4) an open file report on the "Cane Creek" exploration play area, and (5) four contract reports covering the Grassy Trail Creek oilfield, the origin of gilsonite veins in western Utah, Sevier overthrust structures, and a computer program for petroleum source rock maturity.

The following Utah projects are part of the ongoing research at the USBM (SLRC). In cooperation with the Forest Service and local regulatory agencies, two low-maintenance circuits of porous polysulfone beads (containing immobilized samples of algae and peat moss) were installed to treat abandoned mine drainage (AMD) water emanating from the Columbus Rexall Tunnel near Alta, UT. Water emanating from the tunnel had a pH of 4.1 and contained cadmium, copper, iron, lead, and zinc. During 4 months of continuous operation, about 42,000 gallons of water was treated in each circuit. One circuit was a compartmental trough and the other was a series of buckets connected by flexible hose. Average effluent from the trough circuit met drinking water and/or aquatic criteria for all metals except cadmium. Average effluent from the bucket circuit met all drinking water and most aquatic standards. The above technology may prove to be a long-term, low-maintenance option for meeting EPA requirements for pollution control at abandoned mine sites.

Three firms have acquired licenses to market the technology: ATA Technologies Inc., Harrison Western Environmental Services, and RAHCO Inc. SLRC is providing technical support to assist in commercial application of the technology.

Samples of hot-rolling mill, open-hearth, and Q-BOP mill sludges were collected from the Geneva Steel plant to initiate a sludge dewatering project. Both SLRC and the Tuscaloosa Research Center (TURC) in Alabama will work on the project. Staff from the two centers met with members of the American Iron and Steel Institutes Sludge Dewatering Task Force to discuss research approaches for recovery of contained metal from sludges.

Studies on advanced applications of flotation included testing on coal resin separation. Coal from the Cyprus-Plateau Mining Corp. mine near Price, UT, was selected for study (Cyprus-Plateau Mining is considering installing a coal resin flotation circuit). Samples were collected for testing of new instrumentation and control strategies in laboratory flotation columns. Coal resins, when refined, are used in printing inks, dielectric varnishes, waterproofing agents, special synthetic rubbers, and rubber cements.

Project research of general interest to the mining industry included concentration and recovery of heavy rare-earth elements, innovations for precious-metal recovery from refractory ores, cobalt upgrade utilizing double-membrane electrolytic cell technology, synthetic rutile from hard-rock ilmenite, in situ mining leach solutions, and recovery of titanium dioxide pigment from domestic perovskite.

The USBM Intermountain Field Operations Center (IFOC), Denver, CO, completed its Inventory of Land Use Restraints Program (ILURP) study of Utah. This long-term program, begun in 1988, was initiated by the USBM to inventory Federal land use restrictions to assess the availability of Federal lands for mineral exploration and development.

Mineral land assessments conducted by IFOC in Utah included fieldwork on an extension of the Deep Creek Wilderness area of western Utah, as requested by the BLM.

USBM WFOC in Spokane, WA, conducted research on the spatial distribution of arsenic, cadmium, lead, and zinc in the tailings pile at Sharon Steel/Midvale Tailings Superfund site in Salt Lake County. Both the Rolla Center (Missouri) and SLRC used bulk samples from the site for process and beneficiation testing.

In Utah, the Federal Government owns approximately 66% of the land base. Total royalties collected by the Minerals Management Service (MMS) for production from Federal land in Utah was $49.4 million, down from the $51.3 million collected by the Federal Government in 1991. According to MMS's 1992 annual report, royalties collected in 1992 included $10.7 million for oil, $7.7 million for gas, $30.3 million for coal, and $700,000 for other

products including gas lost, gas plant products, geothermal energy, gilsonite, magnesium, potash, and sodium. Utah received $32.1 million from the mineral lease royalties and bonuses in 1992, down from the $32.25 million received in 1991. The U.S. Congress approved $9 million for payment in lieu of taxes to county governments in Utah for 1992.

FUELS

Utah's coal production continued to fall from its historic peak recorded in 1990. Utah ranked 14th in the Nation for total coal production in 1992, according to U.S. Department of Energy statistics. Utah is the only State with all its coal production coming from underground mines. The estimated value of coal production in 1992 was $469 million, about 25% of the total value of all mineral resources produced in Utah.[8]

Fifteen underground coal mines produced 19.3 million metric tons (mt) (21.3 million st) of bituminous coal, the third highest annual production level on record, exceeded only in 1991 and 1990.

Sixteen years after backers of a proposed coal mine on the Kaiparowits Plateau decided not to pursue construction of a powerplant and strip mine, the fight is on again. Andalex Resources Inc. has submitted a permit application for a mining operation in the area. Local residents and environmentalists squared off again in the fight over development versus preservation. Andalex Resources proposed to mine about 68 million mt (75 million st) of coal over 30 years from an underground mine. The Warm Springs project would employ 150 people in the mining operation and another 220 in trucking the coal from one of several proposed loadout sites.[9] Numerous meetings were held by the Kanab Resource Area BLM office to identify issues to be addressed in environmental impact documents prepared for the proposed mine.

According to the U.S. Department of Energy, 1992 oil production in Utah decreased to 22.3 million barrels, down from the 25.75 million barrels produced in 1991, and gas production was 171.3 billion cubic feet. The Utah Division of Oil, Gas, and Mining reported that of the 17 counties with production in December 1992, Uintah County had the highest number of producing oil and gas wells with 1,669, followed by San Juan with 985, Duchesne with 830, and Grand with 590.

Petroleum Information[10] reported that drilling for oil and gas was up sharply from 1991 levels. The increase was due in large part to development work in the Natural Buttes gasfield in northeastern Utah. The Utah Division of Oil, Gas, and Mining reported that at yearend, 328 wells had been completed statewide, up about 50% from 1991. The 1992 wells included 171 producers, 109 shut-in, 41 abandoned, and 7 service wells.

Utah has 95% of all tar sand resources in the United States, but various problems have thus far precluded significant development of the resource. Officials of the Utah Department of Community and Economic Development will work with the U.S. Department of Commerce to assess strategies to develop markets and processes for Utah's tar sands.

There was no reported uranium production in Utah in 1992. Energy Fuels Exploration Co. acquired Exxon Corp.'s Bullfrog uranium deposit in Garfield County. Reserves at Bullfrog exceed 20 million pounds of ore grading at least 0.35% U_3O_8.[11] The mine is 240 kilometers (150 miles) northwest of the White Mesa uranium mill co-owned by Energy Fuels.

REVIEW BY NONFUEL MINERAL COMMODITIES

The UGS's annual report to the Governor reported that during 1992, the Utah Division of Oil, Gas, and Mining received applications for 56 new Small Mine permits (less than 5-acres disturbance) and 4 applications for Large Mine permits. Sixty large and fifty-four small mines reported production to the division in 1992. Nearly 57% of the large mines produced industrial minerals, 27% produced coal, and less than 2% produced base and precious metals. Of the small mines reporting 1992 production, about 43% produced industrial minerals and 24% produced base or precious metals.

Metals

Production value of both base and precious metals increased in 1992, rising from about $950 million in 1991 to more than $1 billion in 1992. Production and value of all metals except usable iron ore increased. Utah's Division of Oil, Gas, and Mining reported there were seven large mines (more than 5 acres of disturbance) and 13 small mines with production of base and/or precious metals during 1992.

Beryllium.—Brush Wellman Inc.'s Topaz Mine at Spor Mountain, Juab County, continued to be the only beryllium-producing mine in the Nation. The mine was also the largest operating beryllium mine in the world. Mine production rose from that reported in 1991, reversing a decline that started in 1988 and reached the highest level reported since 1988. The Utah operations supply virtually all of the U.S. beryllium needs and more than 60% of the world market.

Mine production for 1992 was 244,000 mt (269,000 st) with 75,300 mt (83,000 st) of ore stockpiled,[12] a record production year for the mine.

Ore from the mine consists of bertrandite-bearing tuffs and is mined by open pit methods. Brush Wellman's 1992 Annual Report reported proven bertrandite ore reserves to be 6,787 thousand dry short tons (6,157 mt) with a grade of 0.251% beryllium. Probable reserves were listed at 7,482 thousand dry short tons (6,788 mt) with a grade of 0.281% beryllium.

Brush Wellman is the only fully integrated supplier of beryllium products in the world. Bertrandite ore is transported from the mine in Juab County to the company's extraction plant near Delta, Millard County. The company processing plant at Delta is the only plant in the world to extract beryllium from both bertrandite and beryl ores

(imported). About 87% of the beryllium in the bertrandite ore is recovered in the extraction process, which produces beryllium hydroxide. The beryllium hydroxide is shipped to Elmore, OH, where it is converted into beryllium alloys and metal as well as ceramic-grade beryllia powder. Brush Wellman's annual report also indicated the company produced beryllium oxide at a plant in Tucson, AZ, from the beryllium hydroxide recovered at Delta, UT.

Beryllium is a strategic metal with unique physical properties of high strength, light weight, and high thermal conductivity that allow it to be used for a variety of products. Beryllium uses include electronic and electrical components, computers, telecommunications cellular telephone, air-bag restraint systems, oilfield components, experimental fusion reactors, aerospace, defense systems, and lasers.

In January, Brush Wellman acquired all the remaining shares of Tegmen Corp. The main business of Tegmen Corp. was designing and manufacturing electronic circuits and packages using a direct-bond process to combine conductive copper with insulating substrates. The acquisition was expected to broaden the range of beryllia ceramic applications for Brush Wellman and may allow the company to increase production from the Utah mine.

A 1990 Brush Wellman contract with the Defense Logistics Agency was extended in 1992 for an additional 11,800 kilograms (26,000 pounds) of vacuum hot-pressed beryllium billets to be delivered to the National Defense Stockpile (NDS) through June 1994. The estimated value of the billets was $7 million. This extension brings the contracted total to 72,580 kilograms (160,000 pounds) of billets, worth about $46 million, over a 4-year period.

Copper.—In 1992, Utah gained its position as the second largest copper producer of 13 States reporting production to the USBM. Nearly all production was from the Bingham mine, Salt Lake County, operated by the Utah Copper Division of Kennecott. The mine was the second largest domestic producer of copper during the year and it is the largest excavation in the world (2.5 miles wide and 0.5 mile deep). Although concealed, the value of copper production represented a significant portion of the value of all nonfuel mineral production in Utah.

The 1992 Annual and 10-K Reports of Kennecott's parent company, The RTZ Corp., reported the Bingham Canyon Mine increased ore treated by 27%, but owing to the planned lower cutoff grade, contained copper was only 22% higher than that in 1991. Refined copper production rose 3%. About 90.9 million mt (100 million st) of rock was mined, 49 million mt (54 million st) was milled, and 982,000 mt (1.08 million st) of copper concentrates was produced, yielding 288,700 mt (318,234 short tons) of copper.

RTZ's 10-K Report listed proven and probable ore reserves at Bingham Canyon, as of yearend 1992, as 1,059 million mt (1,170 million st) of ore at 0.62% copper, 0.38 gram per mt (0.013 troy ounce (tr oz) per st) gold, 0.027% molybdenum, and 3.1 grams per mt (0.11 tr oz per st) silver. At 1992 production rates, reserves will last about 20 years.

A fourth grinding line and flotation circuit at the Bingham Canyon mill was completed in January at a cost of $219 million, $8 million under budget. The new facilities reached nominal operating capacity in April. The expansion was designed to increase overall ore treatment capacity by 33% to 128,820 mt (142,000 st) of ore per day. During its first 5 years of operation, this fourth line will add an average of 32,000 mt (35,264 st) of copper and 2,600 kilograms (84,000 tr oz) of gold to annual production figures.

In March, Kennecott announced plans to invest $880 million to construct a new on-site smelter and expand the existing refinery. Engineering and construction management services contracts were awarded in July and completion of the project was expected sometime in 1995. According to RTZ's annual and 10-K reports, the smelter was designed to process 1 million mt (1.1 million st) of concentrate per year, and the capacity of the refinery would be increased to produce about 272,000 mt of copper per year. The new construction will double the capacity of the current facility and significantly reduce operating costs (by up to 50%) while meeting current and anticipated environmental regulations, including new air quality standards going into effect in 1995.

Kennecott reported that pollution controls on the new smelter should be able to recover 99.9% of the sulfur released during smelting of the copper concentrate compared with the 93% recovery achieved by the current smelter. Sulfur dioxide emissions should be reduced to 90 kilograms per hour (200 pounds per hour), down from the 4,700 pounds per hour released from current smelting operations. If these levels are achieved, Kennecott's new smelter would be the world's cleanest. Water consumption will be reduced by about 75% by recycling and the smelter will generate 85% of its own electrical energy requirement by cogeneration.

The new smelter will utilize an Outokumpu flash furnace followed by flash converting technology, developed by Kennecott and Outokumpu. The process eliminates the open-air transfer of molten matte. The planned project represents the largest single private investment ever made in Utah. When completed the new smelter complex will be able to treat all of Kennecott's copper concentrate, about 40% of which is now being shipped to Japan for treatment.[13]

Kennecott Exploration Co. acquired a staged option to purchase most of MLP Associates Ltd.'s interest in the Lisbon Valley copper property, 71 kilometers (44 miles) south of Moab, San Juan County. The deposit contains an estimated resource of 15 million mt (16.7 million st) of 0.64% copper. The copper deposit consists of sulfide and oxide copper mineralization localized in fractures as disseminations and fracture fillings in sandstones of the Cretaceous Dakota and Burro Canyon formations. Malachite and azurite have been found from the surface to a depth of 37 meters (120 feet). Below that depth the copper mineralization is mostly chalcocite.

Mirco Copper Corp. mined some copper from the Lisbon Valley project in 1960, Keystone-Wallace Resources operated a copper oxide heap-leach precipitation plant from 1967 to 1973, and Centennial Development Corp. optioned the property from Keystone-Wallace and subleased it to Noranda (in 1975) who conducted feasibility studies. Kelmine Corp. acquired the lease in 1985, completed feasibility studies, and obtained a permit to operate a mine and plant. Because of low copper prices at the time, 1986, Kelmine transferred the lease to MLP Associates Ltd. Sindor Resources Inc. optioned the property in 1989 and did some drilling and, in 1991, began mine permitting but later dropped the project because of a lack of financing.[14]

Gold.—In 1992, Utah remained the third largest gold-producing State. All of Utah's production was from lode mining, except some reprocessing of old dumps.

Despite the roller coaster that gold prices have been on for several years, mining companies remain interested in gold for the long term as can be seen by the number of companies conducting exploration, development, and production activities in Utah. While some economic analysts stated we had seen the bottom for gold prices, the market price did not reflect a comeback during 1992.

Kennecott's Bingham Canyon Mine, where gold was recovered as a byproduct of copper mining, was the largest gold producer in Utah for 1992. The State's largest primary gold producers, in order of decreasing production, were Barrick Mercur Gold mine, Kennecott's Barney Canyon Mine, Tenneco Minerals Co./USMX Inc.'s Goldstrike Mine, North Lily Mining Co.'s leaching operation in the Tintic district, and Sunshine Mining Co.'s Trixie Mine.

RTZ's annual report indicated that although production improved, lower gold grades at Kennecott's Bingham Canyon Mine resulted in a 3% decrease in refined gold to 16,016 kilograms (515,000 troy ounce), produced as a byproduct of copper mining. Bingham Canyon continued to be the third largest gold-producing mine in the Nation.

American Barrick Resources Corp., parent company of Barrick Mercur Gold Mines, Inc., reported in the company's 1992 Annual Report that production from the Mercur Mine, Tooele County, had a nearly 5% drop in gold production in 1992. The mine, however, remained Utah's largest primary gold producer. American Barrick's annual report listed production from Mercur's two open pits as 3,770 kilograms (121,239 troy ounce) during the year. Barrick Mercur reported a higher than planned oxide mill grade resulting in a higher than expected gold recovery for 1992. Less leach grade ore was mined than in 1991, and that trend is expected to continue into 1993. The company's autoclave circuit, in operation since 1988 to treat refractory ore, had an average throughput of 770 metric tons (848 short tons) per day in 1992. The company's annual report also listed proven and probable reserves at yearend to be 12.7 million metric tons (14 million short tons) with an average grade of 1.5 grams per metric tons (0.053 troy ounce per short tons).

The RTZ Corp. reported gold production from Kennecott's Barney Canyon Mine, Salt Lake County, to be about 3,608 kilograms (116,000 troy ounce). Company reports indicate the mine has about 3 1/2 years of mine life left with 12,190 kilograms (392,000 troy ounce) of recoverable gold in reserves at the mine. The possibility of expanding reserves at the mine still exists.

Tenneco Minerals Co.'s Goldstrike Mine, about 64 kilometers (40 miles) northwest of St. George, Washington County, was sold to USMX Inc. in November. After the acquisition, the name of the wholly owned subsidiary was changed to USMX of Utah, Inc. The purchase included approximately 2,580 kilograms (83,000 troy ounce) of recoverable gold from proven reserves and partially leached ore on leach pads, processing facilities, and about 11,330 hectares (28,000 acres) of partially explored lands. USMX will conduct exploration on the property in 1993. Included in the sale was Tenneco Minerals' interests in the Mineral Mountain claims held with Mountain West Resources Inc.

According to USMX Inc.'s 1992 Annual Report, the Goldstrike Mine produced about 1,180 kilograms (38,000 troy ounce) of gold in 1992. Remaining minable reserves at yearend were estimated at 2.1 million metric tons (2.3 million short tons) containing about 2,580 kilograms (83,000 troy ounce) of gold with a stripping ratio of 2:1. In addition, USMX Inc. estimated that about 622 kilograms (20,000 troy ounce) of gold can be recovered from reserves classified as probable.

During 1992, the Goldstrike Mine consisted of four open pits, two backfilled pits, two waste rock dumps, a crushing plant, heap-leach facilities, and a new carbon adsorption processing plant for gold recovery. The new gold recovery process allowed cyanide to run through a carbon filtering process rather than the large mechanical filtering process formerly used. Cyanide solution requirements were reduced thus lowering costs and, with lower cyanide requirements, lessening the potential for environmental impact.

During the year, Tenneco Minerals had received BLM approval to expand the operation and extend the mine life through mid-1995 with reclamation to continue through 1998.

North Lily Mining Co.'s joint venture with International Mahogany Corp. produced 160 kilograms (5,157 troy ounce) of gold from heap-leaching operations at Silver City, Juab County, according to North Lily's 1992 Annual Report. North Lily Mining has been recovering gold and silver from old mine dumps in Utah's historic Tintic mining district since 1987. Mine dumps and mill tailings from at least eight old mines have been moved to company heap-leach pads for processing. At yearend it was uncertain as to whether the tailings recovery would continue in 1993. Continued low gold prices and low gold grades in the tailings may make continued operation of the mine uneconomic. A company decision was expected early in 1993.

South Standard Mining Co. reported

that Sunshine Mining Co.'s Trixie Mine, Utah County, produced 190 kilograms (6,158 troy ounce) of gold in 1992; silver also was produced. Sunshine Mining Co. decided in October to suspend operations at the Trixie Mine and effective December 31, returned all properties in the East Tintic mining district to the lessors. Full control of the Trixie Mine and other properties in the district reverted to either, or both, Chief Consolidated Mining Co. and South Standard Mining Co.

At the Trixie Mine, ore production continued through October as did drifting, drilling, and stope development. South Standard entered an agreement with Kennecott through which Kennecott will purchase flux material from a dump at the mine.

Sunshine Mining also conducted exploration drilling at the Eureka Standard and Burgin mines in the lease area. Work at the Eureka Standard Mine did not result in the expected high ore grades.

On the exploration front, several properties changed hands during the year while exploration continued on several known gold properties and some new exploration targets.

In November, Crown Resources Corp. terminated its joint venture with Centurion Mines Corp. and completed acquisition of 100% of the Kings Canyon property in southwestern Utah, Millard County. The project includes approximately 51,400 hectares (127,000 acres) of unpatented lode claims and State mineral leases. Centurion Mines Corp.'s 1992 Annual Report indicated the company received $125,000 and future production royalties for its share of the project. The deposit, which measured 762 meters by 91 meters (2,500 feet by 300 feet), contains an estimated 6,220 kilograms (200,000 troy ounce) of gold.

Centurion Mines Corp. reported that during 1992, Kennecott Corp. made three deals with Royal Minerals Inc., a subsidiary of Centurion Mines Corp. (as of January 1992). Early in 1992, Kennecott purchased 32 hectares (80 acres) of Royal Minerals land adjacent to Kennecott's Barney Canyon South open pit, heap-leach gold mine for $100,000 and a 5% production royalty. The Barney Canyon South Mine, in the Bingham Mining District, west of Salt Lake City, started production in 1992.

In July, Kennecott acquired 6,800 hectares (16,800 acres) of mining claims and State and private mineral leases in the North Oquirrh Mountains for $250,000 and Royal Minerals retained a 2.5% production royalty. Kennecott immediately began exploration activities.

Later in the year, Centurion Mines Corp. reported that Kennecott had acquired an additional 2,300 hectares (5,700 acres) of mining properties from Royal Minerals in the Barney Canyon mine area, about 32 kilometers (20 miles) west of Salt Lake City. Royal Minerals received $250,000 and retained a 2.5% production royalty on all metals produced from the properties. Kennecott reportedly planned to conduct exploration on the property during 1993. Because the property is in an active mining area, it could be brought into production quickly should commercial-grade ore be discovered. Kennecott has two mines in the area producing gold and copper. Kennecott's processing facilities are 1.2 to 8 kilometers (3/4 to 5 miles) from the newly acquired property.

Centurion Mines Corp.'s annual report listed continued exploration activities in the Sunbeam area of the Tintic mining district, about 28 kilometers (70 miles) southwest of Salt Lake City. Exploration on the 930 hectares (2,300 acres) controlled by the company resulted in identification of a gold- and silver-bearing zone 1,220 by 1,525 meters (4,000 to 5,000 feet).

Centurion Mines also acquired a 25% interest in 550 hectares (1,350 acres) of private land in the Dugway mining district, about 145 kilometers (90 miles) west of Salt Lake City. The area was under exploration by Santa Fe Pacific Minerals Corp. as part of a joint-venture agreement with Gold Standard Inc. involving 3,650 hectares (9,000 acres). Santa Fe had been conducting an aggressive drilling program since July 1992. Past production from the area has included copper, gold, lead, silver, and zinc.

Centurion Mines, through its subsidiary Royal Minerals, conducted exploration on numerous other projects during the year.

Gold Standard Inc. entered into a joint-venture agreement with Santa Fe Pacific Mining, Inc. for exploration in the Dugway mining district, Tooele County. During 1992, Gold Standard expended $46,149 on sampling, mapping, and geochemical analysis in the area. Sante Fe can earn a 60% interest in the project by performing specified amounts of exploration. During 1992, Santa Fe drilled nine exploratory holes and completed other exploratory work worth $150,000. Gold Standard sold 25% of its interest in the project to Centurion Mines.

Gold Standard's litigation against American Barrick Resources Corp., over Gold Standard's interest in the Mercur Mine, continued throughout the year without resolution.

Goldstack Resources and partner American Consolidated Mining Co. were actively exploring the Yellowhammer and Centennial prospects in the Gold Hill mining district in west-central Utah, about 93 kilometers (55 miles) south of Wendover, NV. Drilling results on the Yellowhammer prospect indicated a resource 24 to 27 meters (80 to 90 foot) long with 1.02 to 33.94 grams per metric tons (0.0297 to 0.99 troy ounce per short tons) gold and 2.5% to 4.3% oxide copper within 30 meters (100 feet) of the surface.[15]

Work on the Centennial prospect has indicated an induced polarization anomaly 1,830 meters (6,000 feet) long, 760 meters (2,500 feet) wide, and at least 915 meters (3,000 feet) deep.[16] Drilling results announced late in the year indicated a breccia pipe with 11.5% copper and 1.13 grams per mt (0.04 troy ounce per short tons) gold.[17] Exploration in the area is expected to continue into 1993.

Iron Ore and Steel.—Utah was the third largest iron ore (usable) producer in the Nation of 10 States that reported production. Utah ranked eighth of 12 States that produced iron slag and ninth

among 28 States reporting iron and steel slag production.

The U.S. steel industry is cyclical by nature and highly competitive in recent years. Stiff competition from foreign steelmakers significantly affected domestic steel manufacturers in the 1980's and early 1990's. Recent drops in the value of the dollar have made U.S. steel markets, and takeovers, less attractive to foreign producers. The disparity in the value of the U.S. dollar as compared to certain foreign currencies has effectively increased the average price of steel imported into the United States and helped domestic producers compete.

In Utah, Geneva Steel operated two open pit mines, the Comstock and Mountain Lion, in the Pinto District, Iron County, throughout 1992. About 475,000 gross short tons (430,920 metric tons) of natural ore reportedly was produced during 1992.[18] Coarse ore and fines were shipped about 350 kilometers (220 miles) by railroad to Geneva's plant at Vineyard, Utah County. At the plant, the iron ore is rescreened to produce sinter feed and fluxed pellets. Additional fluxed pellets are shipped from U.S. Steel's Minntac Plant in Minnesota to make up the remainder of the mill's requirement for fluxed pellets. Limestone flux was mined by Geneva at the Keigley quarry near Santaquin prior to installation of new furnaces at the company's steel mill. The quarry continued to provide dolomite required in the new blast furnaces.

Geneva Steel owns and operates the only integrated steel mill west of the Mississippi River. The mill location near major deposits of the principal raw materials contributes to the economy of the operation. However, continued weak steel prices and company financial losses during the first three quarters of 1992 forced the company to lay off 200 workers during 1992, leaving a work force of about 2,500 at the steel mill.

Geneva Steel's 1992 Annual Report showed that the company manufactured hot-rolled sheet, plate, and pipe products for sale primarily in the Western and central United States. The plant also produced salable byproducts of ammonium sulfate, tar, creosote, light oil, and slag.

Geneva Steel's annual reports indicate the steel mill, 72 kilometers (45 miles) south of Salt Lake City, includes 4 batteries of 63 coke ovens, 3 blast furnaces, and 2 basic oxygen process (Q-BOP) furnaces. Ongoing modernization projects at the mill include: (1) completion of the continuous casting facility, (2) construction of a wide plate coiler and related plate processing facilities, (3) installation of rolling mill finishing stand improvements, and (4) completion of other related projects. All projects are expected to be completed by the end of 1994.

The modernization projects will enhance sheet product quality and allow Geneva Steel to compete more favorably with other domestic steel producers. The steel mill was built during World War II and had not previously been modernized to reflect advances in steelmaking technology.

Geneva Steel joined 11 other U.S. steel producers in a lawsuit accusing 21 foreign countries of dumping state-subsidized steel on the U.S. market at prices below fair market value. The Department of Commerce and Interstate Trade Commission will evaluate the charges.

Compliance with environmental regulations is a significant consideration in all company operations. Geneva Steel entered into an agreement with the Utah Department of Environmental Quality regarding limits of ammonia, nitrogen, and other effluents contained in water discharged from the steel mill into Utah Lake. Geneva Steel also paid the State about $128,000 for violations. A wastewater treatment facility has been completed, and the facility is in compliance with EPA regulations.

Nucor Corp. continued to operate a minimill at Plymouth, Box Elder County. Nucor Corp.'s annual report listed steel shapes, joists, and grinding balls as being produced at the mill. The company uses electric arc furnaces to melt ferrous scrap. Steel is produced from the melt on continuous casting equipment. Annual production capacity of the minimill is about 544,320 metric tons (600,000 short tons) of billet.

Two companies processed iron and steel slag during 1992. Alexander Mill Services got slag from an electric arc furnace for processing in Plymouth, UT, and Heckett Co. produced air-cooled slag, from slag produced from an open-hearth furnace, at its facility in Provo, UT. Blast furnace slag is used as a ground product to replace portland cement in concrete and as lightweight aggregate in blocks. Air-cooled blast furnace slag's most significant end use is as road base.

Magnesium.—Utah ranked second of the three magnesium-metal-producing States in the Nation. In terms of value, magnesium metal production was the third largest nonfuel mineral industry in Utah, after copper and gold.

Magnesium Corp. of America is Utah's sole producer and the second largest producer in the United States. The company operated newly installed pollution control equipment in its plant at Rowley, Tooele County, and has reduced chlorine emissions by 44% over the past 2 years. The company used an electrolytic process to recover magnesium from lake brines. Plant capacity at the Magnesium Corp. facility is 35,000 metric tons.

Magnesium Corp. uses an anhydrous magnesium chloride feed for its electrolytic cells. Solar evaporation is used for the initial concentration of magnesium chloride brines from the Great Salt Lake. Calcium chloride is added to precipitate sulfate impurities, then boron is removed by solvent extraction. The brine is then concentrated further and dehydrated, in a spray dryer. Powder produced from the spray dryer is purified, concentrated, prilled, and dehydrated, resulting in anhydrous magnesium chloride. Electrolytic cells are used to recover magnesium from the anhydrous magnesium chloride with chlorine gas as a byproduct. Calcium chloride recovered during the process also was marketed. About 80% of the magnesium metal

produced in the United States comes from seawater and brines.

Nationally, magnesium metal production in 1992 increased to 136,947 metric tons, 4% higher than that in 1991. Exports were down about 7% from those in 1991, but imports were down about 69%. At yearend, total countervailing and antidumping duties on primary magnesium were 38.9% ad valorem, and these duties were 7.61% ad valorem on alloy magnesium.[19]

Magnesium metal market prices have stabilized following 2 years of declines due to alleged unfair marketing practices of Canadian exporters. Markets for magnesium metal are expanding and should result in improved demand for Utah production over the next several years. Automakers represent a growing share of the magnesium market in the United States. Replacement of some aluminum and steel components in cars and trucks with magnesium parts has resulted in significant increases in primary magnesium consumption in the diecasting sector.

Molybdenum.—Utah ranked third, behind Colorado and Arizona, of the six States reporting molybdenum production. Molybdenite concentrates were recovered as a byproduct of copper production at Kennecott's Bingham Canyon Mine. According to the 1992 RTZ Corp. PLC Annual Report, molybdenum concentrates from mined production increased to 8,600 metric tons (9,500 short tons), up from the 7,000 metric tons (7,700 short tons) produced in 1991. Sulfide concentrates were roasted and converted to molybdic oxide in the company plant at Magna.

Silver.—Utah remained the sixth largest silver-producing State in the Nation of 18 States reporting silver production. Production from Utah mines increased about 14% from that reported in 1992. Production was mostly as a byproduct from copper or gold mines.

Worldwide demand for silver in 1992 exceeded the total new supply for the third consecutive year. Silver supplied from mine production and secondary sources totaled 15,604 metric tons (501.7 million troy ounces) while demand for fabrication uses was 18.4 metric tons (590.3 million troy ounces).[20] Domestic silver producers were hopeful the trend would boost the price of silver, a reaction not observed during 1992. The average price for silver during 1992 was $3.94 per troy ounce, down from $4.04 per troy ounce in 1991.

Production of byproduct silver at Kennecott's Bingham Canyon Mine ranked the mine fourth among all silver producers in the Nation. According to Kennecott's parent company's annual report, refined silver production at Bingham Canyon increased in 1992 to 133 metric tons (4.3 million troy ounces), up from the 112 metric tons (3.6 million troy ounces) produced in 1991. Other producers of byproduct silver included Tenneco Minerals/USMX Inc.—Equinox Resources Ltd. (Goldstrike Mine), Washington County; Sunshine Mining Co.—South Standard Mining Co. (Trixie Mine), Utah County; Barrick Resources (Mercur Mine), Tooele County; and North Lily Mining Co. (Silver City Mine), Juab County.

At part of Sunshine Mining Co.'s decision in October to return all properties in the East Tintic mining district to the lessors, the Burgin mine property was returned to Chief Consolidated Mining Co. According to Chief Consolidated Mining Co.'s reports, Sunshine Mining had drilled out proven and probable reserves at the Burgin mine of 1.7 million metric tons (1.875 million short tons) with 743 metric tons (23.9 million troy ounce) of silver, 249,480 metric tons (275,000 short tons) lead, and 81,820 metric tons (90,189 short tons) of zinc. The lessors intend to seek a joint-venture arrangement with a mining company to bring the Burgin mine property back into production. Kennecott operated the Burgin mine from 1966 to 1978. Sunshine Mining leased the Burgin mine property in 1980 and performed both surface and underground exploration.

Other Metals.—Hecla Mining Co. has patented and unpatented mining claims in Washington County that cover one of only two known major reserves of germanium in the United States. The germanium is found in the iron oxide ore zone of a depleted copper mine. Hecla's Apex Unit in Washington County was originally designed to process germanium and gallium. However, owing to continued depressed prices for those metals, the company suspended operations at the Apex Unit in 1990. It was reported that gallium was recovered at the plant during the year from scrap materials, predominantly scrap generated during the production of gallium arsenide.

According to Hecla Mining's annual report, the company is now evaluating the possibility of redesigning the plant for custom recovery of specialty metals and chemical products. A trial test was conducted during the year on recovering cobalt sulfate for domestic copper producers. The project will be evaluated in 1993 to determine if this is a best use case for the sophisticated hydrometallurgical processing plant. About $1.3 million was spent by the company on research during 1992; $1.5 million was spent during 1991.

Umetco Minerals Corp.'s (subsidiary of Union Carbide) White Mesa uranium and vanadium mill near Blanding, San Juan County, was idle during the year. The mill has a production capacity of 6,800 mt of vanadium pentoxide per year. Continued low prices were cited for the lack of production.

Utah is one of three States reporting byproduct mercury production. Mercury was produced from Barrick Mercur Gold Mines, Inc.'s Mercur Mine, Tooele County.

Various trace metals, including palladium, platinum, and selenium, were recovered from anode slimes at Kennecott copper refinery by Rio Tinto Zinc Corp. Ltd. Of two States reporting selenium production, Utah was ranked second in amount produced in 1992.

Nobel Peak Resources Ltd. reported ore reserves of 5.44 million metric tons (6.0 million short tons) of sulfides grading 8.5% zinc plus an additional 3.2 million metric tons (3.5 million short tons) grading 8.0% zinc at its Crypto zinc

project in Juab County. Nobel Peak Resources has a 100% interest in the Crypto deposit subject to Cyprus Metals' option to acquire 100% by April 30, 1994. The joint-venture partners have completed three phases of drilling to define and increase reserves.[21]

Industrial Minerals

Both production and value of most industrial minerals produced and/or processed in Utah increased in 1992. A strong construction industry, driven in part by a rising population and a stronger than average economy, was reflected in significant improvements in construction-related mineral industries such as cement, brick clay, gypsum, lime, construction sand and gravel, and crushed and dimension stone.

Increasingly stringent zoning and environmental regulations have put a strain on aggregate producers (sand, gravel, and crushed stone) and other industrial mineral processors. Most companies have experienced difficulties in getting permits approved when trying to expand operations or develop new operations, particularly quarries. The "not in my back yard" or "NIMBY" syndrome is forcing operations to move farther from market areas resulting in higher transportation cost, and ultimately, in higher aggregate prices and construction costs to be passed on to the consumer.

Construction aggregate is used extensively in infrastructure construction as bulk material and as an ingredient in "bound materials" such as asphalt and concrete.

Although construction aggregate is an important part of the industrial minerals market in Utah, several other commodities contribute significantly to the total value, including bentonite and fuller's earth clays, gemstones, magnesium compounds, phosphate rock, potash, salt (halite), and sodium sulfate.

Cement.—Production of cement in Utah increased by about 3% over that estimated for 1991. The State ranked 20th of 37 States in reported combined production of portland and masonry cement. Ash Grove Cement West, Inc. (subsidiary of Ash Grove Cement Co.) produced portland cement at its dry-process plant at Leamington, Millard County, and Holnam, Inc., Ideal Div. (subsidiary of Holderbank Financiere Glaris Ltd.) produced portland and masonry cement from its wet-process plant at Morgan, Morgan County.

Holnam uses limestone from the Jurassic Twin Creek Limestone, a natural cement rock, found in numerous outcrops in northeastern Utah. Other mineral resources used include silica, gypsum, and iron ore. Ash Grove used limestone and shale from pits adjacent to the cement plant, silica from a mine a few miles east of the plant, gypsum from the San Rafael Swell, slag from Kennecott, and mill scale from Nucor.

Clays.—Production of both bentonite and common clay in Utah increased over 1991 production levels and some production of fuller's earth was reported. Bentonite production reported to the USBM returned to about the same level as reported in 1990. Utah ranked sixth among the 13 States reporting production in 1992. Production of common clay rose slightly, and for the first time in some years, there was reported production of fuller's earth.

Interpace Industries, Utah and Weber Counties, and Interstate Brick Co., Box Elder, Piute, Summit, Tooele, and Utah Counties, were the two largest clay producers in the State. They blended common clays from several quarries to manufacture brick in Ogden and West Jordan.

Bentonite was mined by the Western Clay Co. in Sevier County and by the Redmond Clay and Salt Co. in Sanpete County. Western Clay Co. produced fuller's earth at its mine near Aurora, Sevier County, for use in clarifying mineral oils and greases. Utelite Corp. mined an organic-rich shale in western Summit County, which is expanded and used as lightweight aggregate. Ash Grove Cement West Inc. produced common clay in Juab County for use in cement manufacturing.

Gypsum.—Both crude gypsum and calcined gypsum were produced in Utah during 1992. Crude gypsum production increased from 1991 levels but calcined gypsum production decreased. Gypsum was mined from open pits northeast of Sigurd in Sevier County by Georgia-Pacific Corp. and United States Gypsum Co. The gypsum is mined from a single bed that is repeated by folding and faulting. Crude gypsum was calcined at company-owned wallboard plants at Sigurd. Georgia-Pacific produced wallboard, plaster, and fireproof cores for doors. U.S. Gypsum produced wallboard, plaster, and wallboard joint compound. Although not reported to the USBM, a few smaller companies reportedly produced gypsum for sale as cement retarder and agricultural gypsum.

A UGS report, Circular 82, indicates that Utah has one of the largest resources of gypsum in the United States with an estimated resource of 1.8 billion metric tons (2 billion short tons) of material averaging more than 85% gypsum in beds a minimum of 1.2 meters (4 feet) thick within 9 meters (30 feet) of the surface.

Lime.—Lime production increased slightly over production levels reported to the USBM in 1991. Producers were Chemstar Lime Inc. in Tooele County and Continental Lime Inc. in Millard County. Chemstar mines dolomitic lime and calcines the lime at two kilns about 3.2 kilometers (2 miles) apart in Tooele County. The dolomitic lime averages 55.3% $CaCO_3$. Continental Lime completed installation of a third rotary kiln at its Delta, UT, plant. The used kiln came on-line in September.

Chemstar Lime Inc. acquired the idle Material Energy Research & Recovery Corp. (MERR Corp.) Marblehead Mt. lime plant near Grantsville, Tooele County, in November. No production from the plant was reported to the USBM for 1992.

Most lime produced in Utah was used in construction applications, for removal of sulfur dioxide from smokestack gases, and for control of pH in mineral processing. MERR Corp., also in Tooele

County, used quicklime as a neutralizer in the company-owned landfill.

The long-term outlook for lime production is good for several reasons. A continued upswing in the economy of Utah can be expected to be reflected in a continued strong construction industry. New tariffs on steel imports should result in increased domestic steel production, the largest industrial consumer of lime. The largest boost, however, will come from passage of the Clean Air Amendments. Demand for lime for flue gas desulfurization will steadily increase as the January 1, 1995, deadline for phase 1 compliance approaches. A significant number of utilities will use lime for desulfurization as a compliance strategy. Use of lime for water purification will be boosted by Safe Drinking Water Act regulations requiring corrosion control to lower the rate at which lead in water pipes dissolves. Clean Air and Water Quality regulations also should increase demand for lime for pH control in industrial and mine drainage wastewater treatment and disposal of sewage sludge.

Magnesium Compounds.—Magnesium compounds (magnesium chloride) production increased more than 40% from that reported in 1991. Great Salt Lake Minerals and Chemicals Corp. produced magnesium chloride as a byproduct of potash and salt production from Great Salt Lake brines at the company plant west of Ogden in Weber County. Reilly Industries Inc. produced magnesium chloride from subsurface brines of the Bonneville Salt Flats at a plant south of Wendover in Tooele County. Plant capacities are 90,000 metric tons of MgO equivalent at the Great Salt Lake Minerals and Chemicals Corp. plant and 45,000 metric tons at the Reilly Industries Inc. plant.

Seawater, brines, and bitterns account for more than 60% of magnesium compounds produced annually in the United States. Magnesium chloride is used in chemical processing and in oxychloride cements. Magnesium chloride brines are used for road dust control and chemical processing.

Phosphate Rock.—Utah's phosphate rock production increased slightly from that reported in 1991. Of the five States with production of phosphate rock, Utah ranked fourth.

FS Industries (a joint venture between Farmland Industries and J.R. Simplot) completed purchase of the Chevron Resources Co. operation near Vernal, Uintah County, where phosphate rock is mined and beneficiated. Ground phosphate is pumped through a slurry pipeline to the company's fertilizer plant at Rock Springs, WY.

Although fertilizer prices were at a 30-year low, the mine will continue to operate because of its unique situation as a captive operation: the mine and plant operators and end users are all part of FS Industries.

Potash.—Utah was the second largest of four potash-producing States in 1992. Potash production increased about 9% from that reported in 1991 while the value increased about 6%.

Moab Salt Inc. produced muriate of potash for Texasgulf Chemical Co. Production was from underground bedded evaporite deposits by two-well solution mining followed by solar evaporation. Moab Salt is solution mining an old underground potash mine near Moab, Grand County. A flotation circuit is used to separate the sylvite from halite harvested from the solar evaporation ponds. Elf Aquitaine Inc.'s (Texasgulf's parent company) 1992 Annual Report showed improved performance of the solar ponds during 1992.

Great Salt Lake Minerals & Chemicals Corp. (GSLMC) produced sulfate of potash (potassium sulfate) from brines of the north arm of Great Salt Lake by solar evaporation and beneficiation. The State Land Board increased royalties charged to GSLMC for production of chemically enhanced potash. The increase related to the chemical (potassium chloride) the company adds to lake brines to increase production of potassium sulfate—a more valuable form of potash. The increase will be effective January 1, 1995.

GSLMC began work on a new solar-evaporation pond on the west side of the lake. Brines will be brought to the pond through a 32-kilometer (20-mile) underwater channel that carries concentrated brines across the lake to the intake of the Weber County facility. The new 7,080-hectare (17,500-acre) pond will increase available evaporation pond size to 14,970 hectares (37,000 acres) and should result in increased potash production from 181,440 metric tons (200,000 short tons) per year to about 308,448 metric tons (340,000 short tons) per year.

Reilly Industries Inc. produced muriate of potash and manure salts (potassium chloride) by solar evaporation of near-surface brines at the Reilly Wendover plant at the west end of the Bonneville Salt Flats. The potash was beneficiated by froth flotation where sylvite was separated from the sylvinite (a sylvite-halite salt mixture).

Salt.—The production of salt (sodium chloride) in Utah increased slightly in 1992 from that reported in 1991. Utah ranked sixth out of 14 States producing salt with about 5% of the total domestic production. The significant change in the value of salt production for 1991, shown on table 1, apparently was the result of incorrect interpretations of survey data and does not reflect an actual change in the unit value of salt produced. Because the source of the error has not been identified, the value for 1991 production has not yet been revised.

Akzo Salt Inc., Great Salt Lake Minerals and Chemicals Corp., and Morton International Inc. used shallow solar evaporation ponds to harvest solar salt from Great Salt Lake brines. Reilly, at its plant near the Bonneville Salt Flats in Tooele County, and Crystal Peak Minerals Corp., at its plant at the southern end of Sevier Lake in Millard County, produced solar evaporated salt from shallow subsurface brines. The Redmond Clay and Salt Co. mined rock salt from a bedded salt deposit at its underground mine in Sevier County. Moab Salt Inc., Grand County, produced salt as a byproduct from its potash solution mining operation.

TABLE 2

UTAH: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,888	$14,402	$3.70
Plaster and gunite sands	59	271	4.59
Concrete products (blocks, brick, pipe, decorative, etc.)	267	982	3.68
Asphaltic concrete aggregates and other bituminous mixtures	2,066	8,601	v4.16
Road base and coverings	4,741	12,931	2.73
Fill	2,129	3,132	1.47
Snow and ice control	37	67	1.81
Railroad ballast	W	W	4.00
Other miscellaneous uses[1]	54	199	3.69
Unspecified:[2]			
Actual	2,768	8,759	3.16
Estimated	1,668	5,474	3.28
Total[3]	17,678	54,819	3.10
Total[4 5]	16,037	54,819	3.42

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes filtration.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data may not add to totals shown because of independent rounding.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

North American Salt leases a salt plant from GSLMC (sister company of North American Salt through parent company G. Harris Associates). North American Salt purifies and markets the salt residum from GSLMC operations.

In addition to salt (sodium chloride), magnesium chloride, potassium sulfate, and sodium sulfate are produced from brines from the Great Salt Lake.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

The State's production increased about 29% from that of 1990, the last year of actual data, and the value increased 22% during the same period. Utah construction sand and gravel statistics are compiled according to geographical districts as depicted on the State map. Most production was from District 2, which includes the major population centers of Ogden, Provo, and Salt Lake City.

Most sand and gravel produced in Utah comes from Pleistocene Lake Bonneville shoreline deposits along the Wasatch Front urban corridor. Two major benches along the former shoreline are the source of most of the sand and gravel production.

Major producers in Utah include, in descending order of production, Gibbons and Reed Co., Geneva Rock Products Co., Harper Excavation Inc., and Glens Excavation and Grading. These four companies operate 27 sand and gravel pits, primarily in Salt Lake and Tooele Counties. Of the sand and gravel produced in Utah, most is from Salt Lake County, followed by Davis, Tooele, Box Elder, and Utah Counties. Seventy-four companies operated 154 pits at 116 operations during 1992.

Major end uses were as construction aggregate in concrete and asphaltic concrete, and as road base and fill. The average unit value of all production was $3.10 per short ton. No production of industrial sand was reported to the USBM for 1992.

Sodium Sulfate.—Utah was one of three States that produced natural sodium sulfate in 1992. Great Salt Lake Minerals Corp. pumped brine from the concentrated northwest segment of Great Salt Lake and placed it in solar evaporation ponds. As winter weather cools the brine, mirabilite precipitates in a fairly pure state. The mirabilite crystals are collected and stored for further processing to anhydrous sodium sulfate, with a purity of 99.5% to 99.7%. Sodium sulfate fertilizer produced by the company goes to Kentucky and North Carolina as well as to Pacific Rim counties.

Stone (Crushed).—Crushed stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Estimated crushed stone production increased 19% from 1991 production. A variety of rock types were quarried; these included dolomite, granite, limestone, quartzite, sandstone, scoria, and volcanic cinder. Crushed stone was used for construction, agricultural, chemical, and metallurgical products. The largest use for crushed stone was for lime manufacturing, followed closely by cement manufacturing.

The largest producers of crushed stone for all end uses during the latest survey year were Ash Grove Cement Co., Juab County; Cache County Road Department, Cache County; Chemstar Inc., Tooele County; Continental Lime Inc., Millard County; Geneva Steel, Utah County; Holnam Inc., Morgan County; and Staker Paving & Construction Co., Salt Lake County.

Although no Utah dimension stone

TABLE 3

UTAH:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[2]	904	3,659	3,012	10,942	298	1,054
Asphaltic concrete aggregates and other bituminous mixtures	401	1,479	1,103	4,064	276	2,322
Road base and coverings	1,601	4,438	2,098	5,755	865	2,375
Fill	541	712	1,461	2,190	127	230
Snow and ice control	(*)	(*)	W	W	2	3
Railroad ballast	(*)	(*)	W	W	—	—
Other miscellaneous uses[4]	—	—	51	182	2	3
Unspecified:[5]						
Actual	—	—	2,733	8,615	35	144
Estimated	315	1,068	1,066	3,407	287	999
Total[6]	3,790	11,411	11,525	35,155	1,892	7,131
Total[7 8]	3,438	11,411	10,455	35,155	1,716	7,131

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Excludes 470,853 short tons valued at $1,122,423, not reported by county.
[2]Includes plaster and gunite sands.
[3]Withheld to avoid disclosing company proprietary data; included with "Total."
[4]Includes filtration.
[5]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[6]Data may not add to totals shown because of independent rounding.
[7]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[8]Total quantity and total value in thousand metric tons and thousand dollars.

production was estimated by the USBM for 1992, numerous small operators produced quartzite flagstone and sandstone, with lesser amounts of limestone, rhyolite, scoria, and tufa for use as building stone. Flagstone and veneer were produced from sandstone quarries in the northwest part of the State (Summit and Wayne Counties). Red, tan, and reddish brown sandstones were processed for building veneer and paving stones. Thin sheets of micaceous quartzite and quartz mica schist, ranging from silvery white to gold and light green, were produced for the same uses.

Other Industrial Minerals.—The value of gemstones produced in Utah increased nearly 30% from that reported in 1991. Gemstones produced in Utah included topaz, variscite, obsidian, and red beryl. The Violet claims in the Wah Wah Mountains were the only known location in the United States for commercial production of red beryl. Four companies, Penney's Gem Stones, Steal Eagle, Tetla Septarians, and Violet Claims, were the major processors of gemstones in Utah.

Utah ranked ninth among 13 States reporting production of synthetic graphite in 1992.

Perlite mined in Idaho was expanded in Utah by Pax Co. Production was used as a soil conditioner and as a filler.

Sulfur and sulfuric acid were produced as byproducts of copper smelting (Kennecott) and oil refining (Standard Oil of California, Davis County).

Custom Milling & Supply produced crushed and ground barite in Salt Lake County (from out-of-State sources) for use in oil well drilling muds.

General Refractories Co., Lehi, UT, is the last facility in the United States manufacturing silica refractories for coke ovens. Coke ovens are lined with silica shapes to insulate the oven for maximum conservation of fuel used to fire the oven.

[1]Mining Engineer, U.S. Bureau of Mines, Denver, CO.

[2]Senior Geologist, Utah Geological Survey, Salt Lake City, UT.

[3]Rocky Mountain Construction. Jan. 6, 1993.
[4]———. Oct. 5, 1992.
[5]U.S. General Accounting Office. Wilderness, Effects of Designation on Economy and Grazing in Utah. Dec. 1992, 51 pp.
[6]Deseret News (Salt Lake City, UT). Oct. 6, 1992.
[7]———. Oct. 18, 1992.
[8]Bon, R.. State Activities 1992-Utah. Min. Engr. May 1993.
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[10]Petroleum Information. Resume 1992.
[11]Mining Activity Digest. V. 21, No. 1, Feb. 1993.
[12]Rocky Mountain Paydirt. Feb. 1993.
[13]Mining Magazine. Apr. 1993.
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[15]Engineering & Mining Journal, Mining Activity Digest. Nov. 1992.
[16]Mining Business Digest. Sept. 1992.
[17]Utah Mining Association Management Digest. V. 48, No. 11, Nov. 1992.
[18]Skillings Mining Review. July 31, 1992.
[19]Mineral Industry Survey, Magnesium in the 4th quarter, 1992, USBM.
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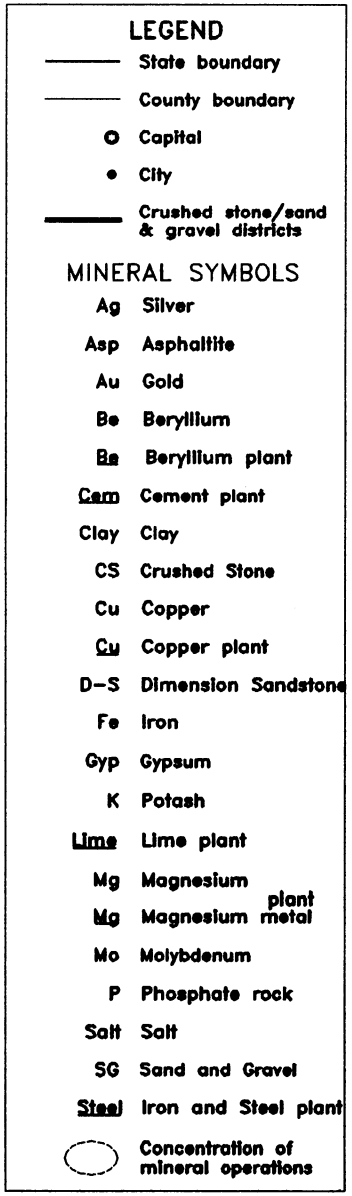
UTAH

Principal Mineral–Producing Localities



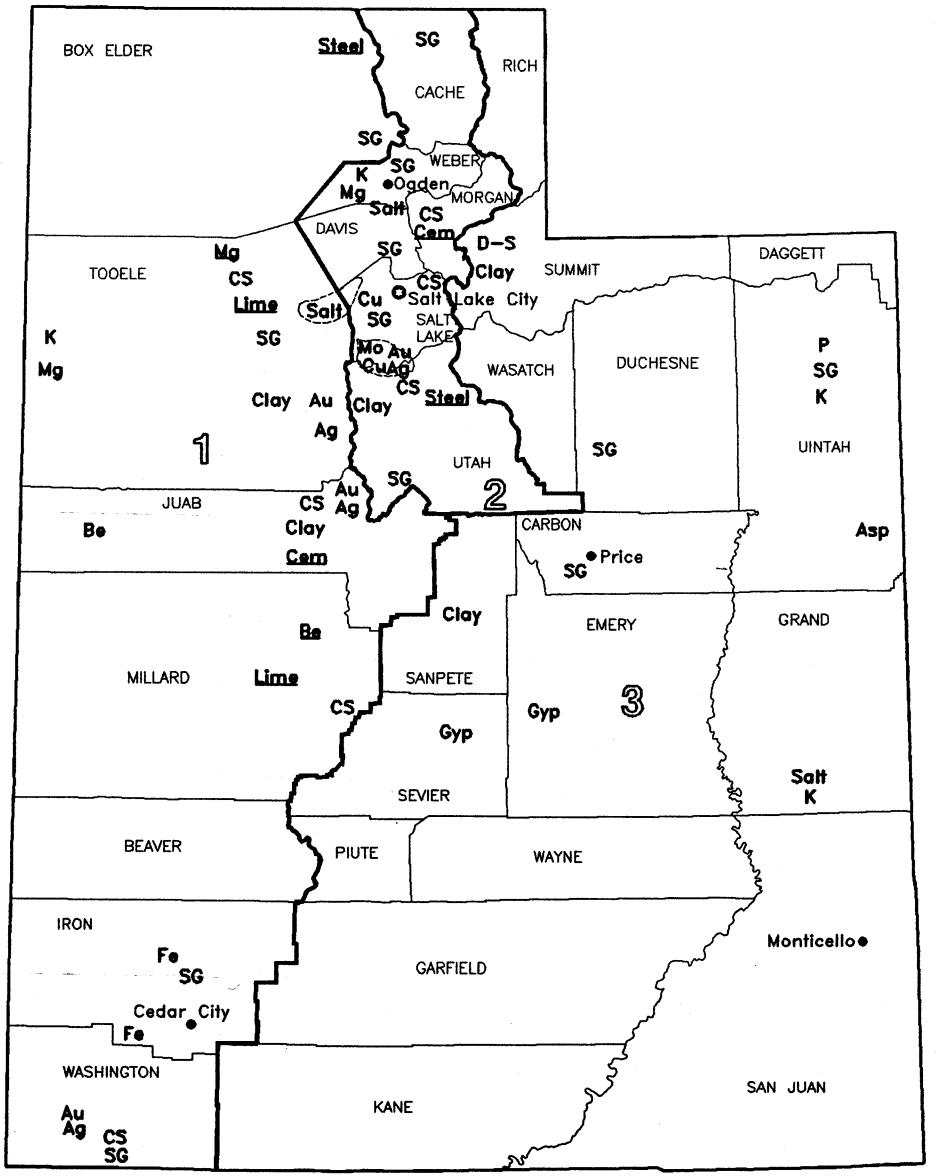


TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Asphaltite:			
American Gilsonite Co.	Box 28 Bonanza, UT 84008	Underground mines and plant	Uintah.
Ziegler Chemical & Mineral Corp.	Star Route Little Bonanza Vernal, UT 84078	do.	Do.
Beryllium:			
Brush Wellman Inc.	Box 815 Delta, UT 84624	Open pit mines and plant	Juab and Millard.
Cement:			
Ash Grove Cement West Inc.,[1] a subsidiary of Ash Grove Cement Co.	Box 51 Nephi, UT 84648	Quarries and plant	Do.
Holnam Inc., Ideal Div.,[1] a subsidiary of Holderbank Financier Glaris Ltd.	Aux. Route 3 6055 East Croydon Rd. Morgan, UT 84050	do.	Morgan.
Clays:			
Interpace Industries	Box 12118 Ogden, UT 84412	Open pit mines and plant	Utah and Weber.
Interstate Brick Co., a division of Pacific Coast	9780 South 5200 West West Jordan, UT 84088	do.	Box Elder, Piute, Tooele, Utah.
Redmond Clay & Salt Co., Inc.[2]	6005 North 100 West Redmond, UT 84652	Underground mine	Sanpete.
Utelite Corp.	Box 387 Coalville, UT 84017	Open pit mine and plant	Summit.
Western Clay Co.	Box 127 Aurora, UT 84620	Quarry and open pit mines	Sevier.
Copper:			
Kennecott Utah Copper,[3] a division of Kennecott Corp.	Box 525 Bingham Canyon, UT 84006	Open pit mine, mill, smelter, refinery	Salt Lake.
Gold:			
Barrick Mercur Gold Mines, Inc.,[4] a subsidiary of American Barrick Resources Corp.	Box 838 Tooele, UT 84074	Open pit mine, heap leach, mill, plant	Tooele.
Kennecott Corp., a subsidiary of The RTZ Corp. PLC	8362 West 10200 South Box 311 Bingham Canyon, UT 84006	Open pit mines, heap leach, mill, refinery	Salt Lake.
North Lily Mining Co.[4]	Box 421 Eureka, UT 84628	Heap leach and plant	Juab.
Sunshine Mining Co.[5]	Box 250 Eureka, UT 84628	Underground mine and mill	Utah.
Tenneco Minerals Co.[4]	Box 2650 St. George, UT 84771	Open pit mines, heap leach, plant, refinery	Washington.
Gypsum:			
Georgia-Pacific Corp.	Box 570080 Sigurd, UT 84657	Quarries and plant	Sevier.
United States Gypsum Co., a subsidiary of USG Corp.	Box 570160 Sigurd, UT 84657	do.	Do.
Iron and steel:			
Alexander Mill Services	7285 W. 21200 North P.O. Box 99 Plymouth, UT 84330	Plant	Box Elder.
Geneva Steel[1]	Box 2500 Provo, UT 84603	Mines, quarry, plant	Iron and Utah.

See footnotes at the end of table.

TABLE 4—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Lime:			
Chemstar Inc.,[1] a subsidiary of Chemical Lime Group	Box 537 Grantsville, UT 84029	Quarry and plant	Tooele.
Continental Lime Inc.,[1] a subsidiary of Steel Bros. Canada Ltd.	Box 669 Delta, UT 84624	do.	Millard.
Materials Energy Research & Recovery Corp.,[1] a subsidiary of United States Pollution Controls Inc.	Box 596 Grantsville, UT 84029	do.	Tooele.
Magnesium:			
Magnesium Corp. of America, a subsidiary of Renco Group Inc.	238 North 2200 West Salt Lake City, UT 84116	Plant and solar evaporation ponds	Do.
Phosphate rock:			
Chevron Chemicals, a subsidiary of Chevron Corp.	9401 North Highway 191 Vernal, UT 84078	Open pit mine and plant	Uintah.
Potash:			
Great Salt Lake Minerals & Chemicals Corp.,[6] a division of GSL Acquisition Corp.	765 North 10500 West Ogden, UT 84404	Plant, concentrator, solar evaporation ponds	Weber.
Moab Salt Inc.,[2] a division of Texasgulf, Inc., a subsidiary of Societe Nationale Elf Aquitaine	Box 1208 Moab, UT 84532	Solution mine, solar evaporation, concentrator, plant	Grand.
Reilly Wendover Inc.,[7] a division of Reilly Industries Inc.	Box 580 Wendover, UT 84083	do.	Tooele.
Salt:			
Akzo Salt Inc.	1428 James Palmer Rd. Lake Point, UT 84074	Solar evaporation ponds and plant	Do.
Morton International Inc.	Box 506 Grantsville, UT 84029	do.	Salt Lake and Tooele.
Sand and gravel (construction):			
Concrete Products Co., a division of Gibbons & Reed Co.	Box 7356 Murray, UT 84107	Pits	Davis, Salt Lake, Utah, Weber.
Geneva Rock Products Inc.	Box 538 Orem, UT 84057	do.	Davis and Salt Lake.
Glen's Excavating and Grading	Box 428 Tooele, UT 84074	do.	Summit, Tooele, Utah.
Harper Excavating Inc.	4655 West 5415 South Kearns, UT 84118	do.	Salt Lake.
Stone (crushed):			
Cache County Road Department	525 North 1000 West Logan, UT 84321	Quarries and mill	Cache.
U.S. Forest Service	324 25th Street Ogden, UT 84401	Quarries	Cache, Carbon, Duchesne, Garfield, Iron, Juab, Kane, Millard, Piute, San Juan, Sevier, Summit, Uintah, Utah, Wasatch, Washington, Wayne.

[1]Also stone (crushed).
[2]Also salt.
[3]Also gold, molybdenum, and silver.
[4]Also silver.
[5]Also copper and silver.
[6]Also magnesium compounds, salt, and sodium sulfate.
[7]Also magnesium compounds.

THE MINERAL INDUSTRY OF VERMONT

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Agency of Natural Resources, Division of Geology and Mineral Resources, for collecting information on all nonfuel minerals.

By Donald K. Harrison[1] and Diane L. Conrad[2]

The value of nonfuel mineral production in Vermont in 1992 was $59.8 million, essentially unchanged from that of 1991. Principal mineral commodities produced, in descending order of value, were dimension stone, crushed stone, construction sand and gravel, talc, and asbestos. Nationally, the State ranked third of eight States that produced talc. It ranked third in output but first in value of dimension stone and was only one of two States that produced asbestos.

TRENDS AND DEVELOPMENTS

The average value of construction contracts (AVCC) for all categories of construction in Vermont kept pace with that of the entire six-State New England region. In 1992, the AVCC in Vermont rose by 8%. This was in keeping with the 10% gain for all of the New England States. Nationally, the AVCC rose only 3% from 1991 to 1992. Although the value of nonbuilding contracts was down nearly 40% from that of 1991, gains were reported in other construction categories. The largest gain was reported in the value of residential contracts, which rose by 48%. Nonresidential construction contracts also showed a gain of 13% in the same period.

Because the mineral construction industry is highly dependent on construction activity, the modest recovery in 1992 helped to at least stabilize this industry. Because construction aggregates accounted for 97% of the State's overall mineral value, the modest 8% gain in 1992 indicated that there were some signs of recovery in construction activity in Vermont. This was especially evident in the gain reported for residential construction, which had been continuously declining since the peak building years of 1988 and 1989.

EMPLOYMENT

In 1992, the average number of workers employed in the mineral extractive industries in Vermont was 977, 62 less than that of 1991.[3] This included 24 workers at underground mines, 563 at surface operations, and 390 working in mineral-related mills and preparation plants.[4]

LEGISLATION AND GOVERNMENT PROGRAMS

House bill 678 was introduced into the 1992 legislative session to officially designate the State's gem, rock, and mineral. The bill was signed into law in May as Act 221. It was determined that the State gem shall be grossular garnet. The State rock was designated to be marble, granite, and slate, while the State mineral was defined to be talc.

The Vermont State Geologist, together

TABLE 1
NONFUEL MINERAL PRODUCTION IN VERMONT[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Asbestos	metric tons	W	W	W	W	4,575	$1,686
Gemstones		NA	$10	NA	$5	NA	1
Sand and gravel (construction)	thousand short tons	3,675	11,948	e3,000	e9,900	3,474	11,291
Stone:							
Crushed	do.	e3,700	e35,000	2,685	12,666	e2,500	e12,200
Dimension	short tons	r e106,265	r e33,522	r92,658	31,013	e125,000	e34,639
Combined value of other industrial minerals and value indicated by symbol W		XX	6,046	XX	6,236	XX	(2)
Total		XX	r86,526	XX	59,820	XX	3,59,817

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Value excluded to avoid disclosing company proprietary data.
[3]Partial total, excludes values that must be concealed to avoid disclosing company proprietary data.

TABLE 2

VERMONT: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	300	$973	$3.24
Plaster and gunite sands	W	W	6.10
Concrete products (blocks, brick, pipe, decorative, etc.)	W	W	6.10
Asphaltic concrete aggregates and other bituminous mixtures	261	1,457	5.58
Road base and coverings[1]	1,112	3,190	2.87
Fill	346	826	2.39
Other miscellaneous uses	71	343	4.83
Snow and ice control	314	752	2.39
Unspecified:[2]			
Actual	584	2,683	4.59
Estimated	486	1,068	2.20
Total	3,474	[3]11,291	3.25
Total[4 5]	3,152	11,291	3.58

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data do not add to total shown because of independent rounding.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

with five other New England State Geologists, began a study administered through the New England Governors' Conference to assess the availability of onshore sand and gravel in the region. The supply study, funded by the Minerals Management Service, is the second phase of a total resource assessment; the first phase, which involved a demand projection, was published in January. In the supply study, a series of maps is being prepared for each State to show sand and gravel deposits that are amenable to mining and those that are off limits to mining. The volume of aggregates that are off limits will be subtracted from the total aggregate resources to give a presently usable volume. The study is expected to be completed in late 1993. A third and final report of the findings will be published with recommendations for future initiatives.

The U.S. Geological Survey (USGS) published a report on the geology and mineral resource assessment of the Big Branch and Peru Peak Wildernesses and the Wilder Mountain Roadless Area in Rutland and Bennington Counties.[5] The study areas are the west flank of the Green Mountain Anticlinorium in the south-central portion of the State. The study concluded that marginal mineral resources in the areas included stone, permeable fill in sparse kame and stream terraces, and organic-rich deposits and peat in swamps. A low potential exists for uranium and thorium, pegmatite minerals in small segregation deposits in the basement rocks, and lead-zinc in sandstone lead deposits in clastic rocks of the cover sequence. No potential for other metals was evident.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Asbestos.—The Vermont Asbestos Group Inc. (VAG), one of only two active asbestos operations in the country, operated an open pit mine and dry processing mill on Belvidere Mountain near Lowell, Orleans County. VAG produced a wide range of chrysotile grades of asbestos. In 1992, both output and value declined from those of 1991. Most (80%) of the asbestos was shipped to foreign countries; the remainder was for domestic use. The asbestos was used primarily to manufacture brake linings and brake pads.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines (USBM) for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Construction sand and gravel was the State's third leading mineral commodity produced in terms of value. In 1992, production and value increased 16% and 14%, respectively, compared with the estimates of 1991. A total of 71 companies mined construction sand and gravel from 97 pits in all of the State's counties. Leading counties, in order of output, were Washington, Rutland, Bennington, Orleans, and Lamoille. Main uses were for road base and coverings, concrete aggregate, and fill.

Pompy Farms Crushed Stone Co. in Norwich, one of the State's largest producers of construction sand and gravel, received an Act 250 land use permit that allows the company to continue mining sand and gravel from its 50-year-old operation at the company's current rate for another 30 years. Before the permit was issued, there was opposition from neighbors who feared that the company was planning to increase production at the site. Under the guidelines of the permit, the total number of truckloads that may leave the site each day cannot exceed 96. The permit also contains the usual State conditions governing such matters as dust control and blasting distances at mining operations.

Stone.—Stone production is surveyed

by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—Crushed stone was the State's second leading mineral commodity produced and accounted for one-fifth of the State's total mineral value in 1992. Estimated output of crushed stone declined by 7% from that of 1991. The 1992 estimated output was also the lowest since 1989, when more than 3 million short tons was produced. Limestone was the primary rock quarried, followed by marble and granite. Crushed stone was produced in 10 of the State's 13 counties. Leading counties, in order of output, were Chittenden, Rutland, Addison, Caledonia, and Washington. Major uses were for road base and bituminous aggregate.

Dimension.—Dimension stone, the State's leading mineral commodity produced, accounted for 58% of the State's total mineral value. Nationally, the State ranked third in output but first in value of dimension stone. A total of 15 companies operated 22 quarries in 4 counties. Leading counties, in order of output, were Washington, Rutland, Windsor, and Caledonia. Types of rocks quarried, in descending order of output, were granite, slate, and marble.

In December, R.E.D. Graniti announced that it would be leasing Vermont Marble Co.'s Danby quarry, the world's largest underground marble quarry. R.E.D. Graniti is part of European Granites Co., a Dutch conglomerate that is the world's largest distributor of raw marble and granite blocks. The new company that will operate the quarry will be known as Vermont Quarries Corp. The new company indicated that it plans to increase production and invest in new equipment at the quarry. It also indicated that it had no interest in acquiring the other assets of the Vermont Marble Co.

OMYA Inc., 1 of 15 companies that mined dimension stone in the State, began operating a new 8-megawatt gas turbine cogenerating plant in Florence. The exhaust heat from the plant is used to assist in drying ground calcium carbonate produced at the Florence plant. The electricity will go into the grid of OMYA Vermont Marble Co.'s Power Div., about 10% of which serves the Proctor area residents. The other 90% meets the need of the massive rock crushing plant in Florence and marble cutting and finishing plant in Proctor and related facilities.

Near yearend, the District 1 Environmental Commission granted an Act 250 land use permit for North American Slate Co. to reopen an abandoned slate quarry in Pawlet despite strong opposition from neighbors. The quarry had not been in operation for at least 30 years. Before that, it operated for more than 50 years. North American Slate expects that each year it will quarry two sections of slate measuring 20 feet long, 30 feet wide, and 30 feet deep.[6]

Talc.—During the year, Cyprus Industrial Minerals Co. sold its talc mines and mills to RTZ PLC, a London-based international mining company. The Vermont mines and mills are being operated under the name of Luzenac America Inc. The company operated three mines (Windham, Troy Deposit, and Ludlow Area Mines) and four mills in the State. Both production and value decreased from those of 1991. Major uses for the talc were for roofing, cosmetics, and as fillers for plastic and paper. Most of the talc was sold domestically; some was exported.

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[1]Regional Minerals Specialist, U.S. Department of the Interior, Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related experience and has covered the mineral activities in Vermont for 8 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]State Geologist, Agency of Natural Resources, Division of Geology and Mineral Resources, Waterbury, VT.

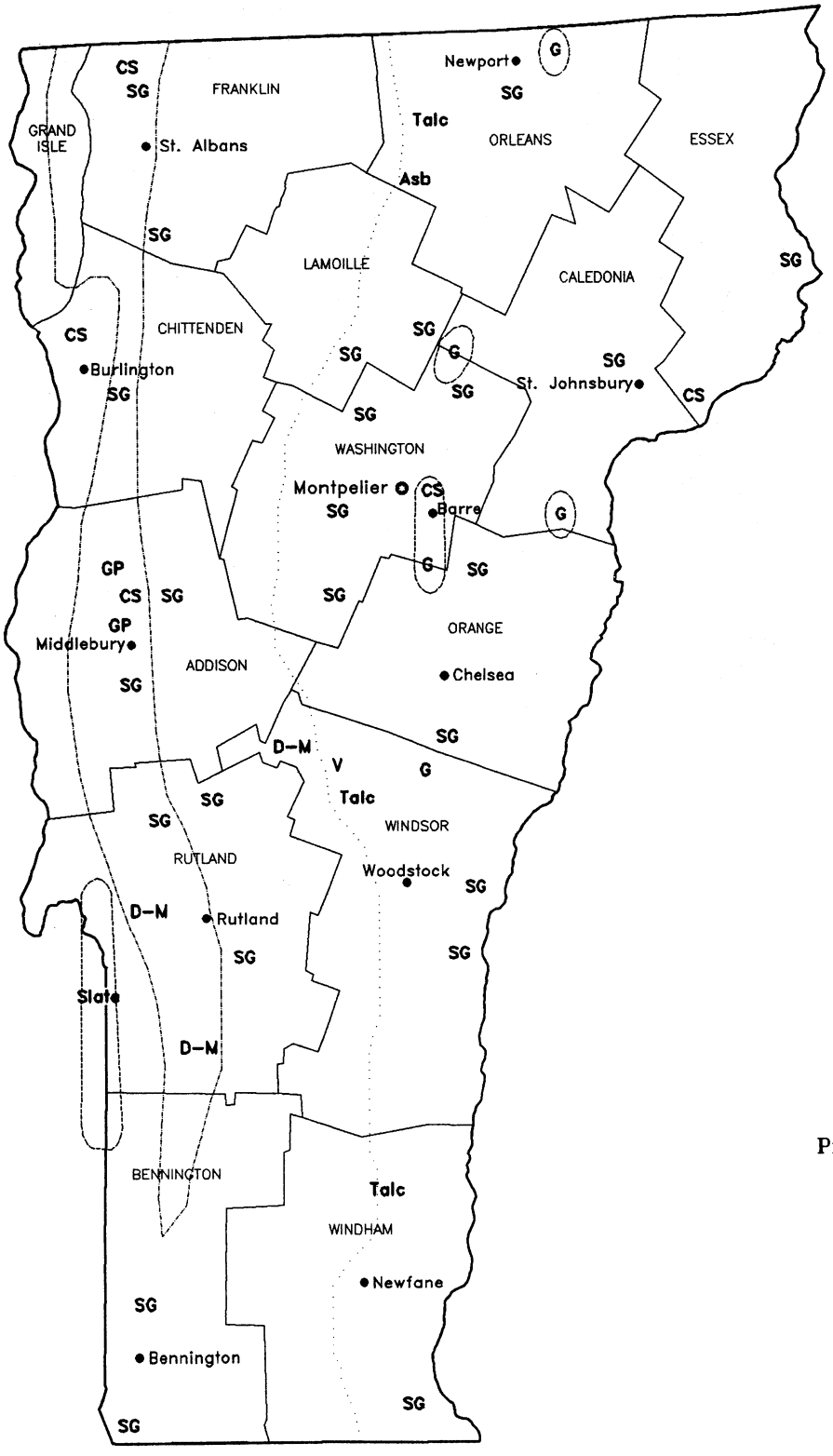
[3]"Average number of workers" is a summary of the average number of persons working at individual mining establishments during periods (not necessarily continuous) of active operations.

[4]U.S. Department of Labor, Mine Safety and Health. Mine Injuries and Worktime Quarterly, Jan.-Dec. 1992, 32 pp.

[5]Peper, J. D., and E. A. Downie. Geology, Geochemistry, and Mineral Resource Assessment of the Big Branch and Peru Peak Wildernesses and the Wilder Mountain Roadless Area, Rutland and Bennington Counties, VT, 1992, 26 pp., 4 plates in pocket.

[6]Rutland Daily Herald. Slate Quarry Is Set To Reopen Despite Neighbors Qualms. Dec. 21, 1992.

VERMONT



LEGEND

- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Asb	Asbestos
CS	Crushed Stone
D–M	Dimension Marble
G	Dimension Granite
GP	Finely Ground Products
SG	Sand and Gravel
Slate	VT/NY Slate District
Talc	Talc minerals
V	Verde Antique

- Concentration of mineral operations
- VT Limestone – Marble Belt
- Ultramafic Trend – includes Asbestos, Talc and Verde Antique operations

Principal Mineral–Producing Localities

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Asbestos:			
Vermont Asbestos Group Inc.[1]	Box 54B Morrisville, VT 05661	Pit	Orleans.
Sand and gravel (construction):			
Calkins Sand & Gravel Inc.	Box 82 Lyndonville, VT 05851	Pits and plant	Caledonia and Orleans.
Joseph P. Carrara & Sons Inc.	R. D. #3, Box 1000 Middlebury, VT 05753	Pits	Addison and Rutland.
William E. Daily Inc.	R.R. #1, Box 51 Shaftsbury, VT 05262	do.	Bennington.
Hinesburg Sand & Gravel Co.	R.R. #1, Box 2300 Hinesburg, VT 05461	Pit	Chittenden.
Stone (1991):			
Crushed:			
L. F. Carter Inc.	Box 224 Pittsford, VT 05763	Quarry	Rutland.
L. A. Demers Co.	Box 359 Essex Junction, VT 05453	do.	Addison.
Pike Industries Inc., a subsidiary of Oldcastle Inc.[2]	Route 3, Box 91 Tilton, NH 03276	Quarries	Addison, Caledonia, Rutland, Washington.
Swanton Limestone Corp., a subsidiary of Shelburne Limestone Corp.	Box 359 Essex Junction, VT 05453	do.	Chittenden and Franklin.
Frank W. Whitcomb Construction Corp.[2]	Box 1000 Walpole, NH 03608	do.	Caledonia, Chittenden, Rutland.
Dimension:			
Hilltop Slate Inc.	Main St. Mid-Granville, NY 12849	do.	Rutland.
Rock of Ages Corp., a subsidiary of John Swenson Co. Inc.	Box 482 Barre, VT 05641	do.	Washington and Windsor.
Vermont Marble Co.	Box 240 Danby, VT 05739	do.	Rutland and Windsor.
Vermont Structural Slate Co. Inc.	3 Prospect St. Fairhaven, VT 05743	Quarry	Do.
Talc:			
Luzenac America Inc.	Box 680 Windsor, VT 05089	Mines and mills	Lamoille, Windham, Windsor.

[1]Also crushed stone.
[2]Also sand and gravel.

THE MINERAL INDUSTRY OF VIRGINIA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Virginia Division of Mineral Resources for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.,[1] and Palmer C. Sweet[2]

The value of nonfuel mineral production in Virginia in 1992 was about $462 million. Output of most minerals remained about the same as that of 1991. The increase in value of about $34 million primarily reflected a significantly higher price reported for portland cement. A slowdown in construction during the past 2 years resulted in declining production of sand and gravel and crushed stone.

Nationally, Virginia ranked 24th in value of nonfuel mineral production, accounting for about 1.5% of the U.S. total. Virginia was again the only State that mined kyanite and one of only three that produced vermiculite. In coal, the State ranked seventh in output, producing almost 43 million short tons in 1992.

TRENDS AND DEVELOPMENTS

The construction industry was the primary economic drive affecting demand for the State's nonfuel minerals. During the past 2 years, Virginia's nonfuel mineral production and value declined. Two commodities used extensively in construction are sand and gravel and crushed stone. From 1987 through 1990, the State produced about 300 million short tons of these commodities or an average of about 75 million tons per year. In 1991-92, the combined production of sand and gravel and crushed stone dropped to an average of about 58 million tons per year. Correspondingly, Virginia's value of nonfuel mineral production, which averaged $493 million from 1987-90, fell to $428 million in 1991 and $462 million in 1992.

However, despite the dropoff in demand during the past 2 years, some producers expected demand to increase. Federal highway funding for Virginia in 1993 was projected to increase and overall conditions in the construction industry were expected to improve. During the year, at least three companies were in the process of attempting to open new quarries. These attempts were opposed by local residents. Because of this type of opposition, companies seeking to expand operations were instead considering purchasing existing operations.

EMPLOYMENT

The Virginia Department of Mines, Minerals, and Energy (DMME), Division of Mineral Mining, reported 2,296 plant

TABLE 1
NONFUEL MINERAL PRODUCTION IN VIRGINIA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2]	metric tons	882,383	$3,741	723,495	$3,248	753,504	$3,367
Gemstones		NA	34	NA	70	NA	W
Lime	thousand short tons	846	39,784	825	39,612	842	40,271
Sand and gravel (construction)	do.	13,096	48,950	r9,700	r36,900	9,545	37,336
Stone:							
Crushed	do.	r59,400	r320,000	48,861	260,966	r47,500	r261,300
Dimension	short tons	W	W	11,046	3,061	W	W
Combined value of aplite[3] (1990-91), cement, clays [bentonite (1992), fuller's earth], feldspar,[3] gypsum (crude), iron oxide pigments (crude), kyanite, sand and gravel (industrial), talc and pyrophyllite, vermiculite, and values indicated by symbol W		XX	r94,057	XX	84,188	XX	119,589
Total		XX	r506,566	XX	428,045	XX	461,863

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" figure.
[3]Beginning in 1992 aplite is combined with feldspar.

workers and 1,727 quarry workers were employed in the nonfuels mining industry in 1992. Compared with that of 1991, employment of plant workers increased by 10 and quarry workers by 80. Overall, in 1992, the limestone industry employed the most workers, with a total of 1,414 employees.

The State's coal industry employed about 8,750 workers, according to the U.S. Mine Safety and Health Administration. Of that total, about 82% was underground coal miners and 18% worked at surface mine operations. Compared with that of 1991, coal industry employment declined by about 4% while production increased by about 7%.

EXPLORATION ACTIVITIES

The continued slowdown in the economy again slowed exploration and development plans of titanium sand mineralization in southeastern Virginia. Weak demand for titanium dioxide resulted in mining companies indefinitely delaying plans for mine development from acreage leased from landowners in parts of Dinwiddie, Sussex, and Greensville Counties.

A special-use permit was approved for a small gold mining operation at a 200- by 1,000-foot area near Danville. The Pittsylvania County Zoning Administration approved the project with provisions excluding the use of explosives or chemicals for the work. The area, once known as the "Kentuck Prospect," was first explored in the 1800's. A mining license and reclamation permit were issued for the Kentuck Mine by the Division of Mineral Mining. A license was also issued to Southern Piedmont Mining Corp. for a site adjacent to the old Moss gold mine in western Goochland County.

LEGISLATION AND GOVERNMENT PROGRAMS

The Virginia General Assembly enacted legislation authorizing the reorganization of the State's environmental agencies. The new Department of Environmental Quality will be responsible for the functions of the State Water Control Board, Department of Waste Management, Department of Air Pollution Control, and Council on the Environment effective April 1, 1993.

The DMME, Division of Mineral Resources (DMR), was the primary State agency investigating the economic, environmental, and geologic impact of mineral resources in Virginia. Virginia produces in excess of 100 million tons of mineral commodities annually. As a result, investigations, research, and regulation of the mining and minerals-related industries by the division and the department were essential to the State in land use planning policies and decisions.

In 1992, the DMR updated a directory of nonfuel mineral producers in the State.[3] A map that accompanies the directory showed that producers and processors of rock and mineral materials existed in every county in the State except Allegheny, Bath, Cumberland, Floyd, Lunenburg, Page, Rappahannock, and James City. The DMR also provided an in-depth review of the dimension stone structures and uses throughout the State.[4]

The Division of Mineral Mining, DMME, continued reclamation work at two abandoned mines. In Rockbridge County, a silica mine in the Goshen Wildlife Management Area was in the final phase of a 3-year reclamation project. The project included regrading and revegetation on an 87-acre site that was mined for silica sand from 1900 to 1968. Stream degradation from sedimentation and other public health and safety hazards because of unstable highwalls were reduced. Total reclamation costs of the project were about $320,000.

In Bedford County, a 4-acre feldspar mine abandoned in the late 1950's was stabilized by regrading. The mine was being used as an illegal dump, thus creating an environmental problem. Cost of reclamation at this site was about $14,500.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

In 1992, industrial minerals were produced in the State at about 212 operations, according to data reported to the U.S. Bureau of Mines and listed in table 1. Crushed stone was produced at 105 quarries; sand and gravel at 73 pits; common clay and shale at 12 pits; lime at 5 plants; cement at 3 plants; dimension stone at 4 quarries; kyanite and iron oxide pigments at 2 operations each; and fuller's earth, feldspar, gypsum, industrial sand, soapstone, and vermiculite at 1 mine each. Output from these operations accounted for the State's value of mineral production of $462 million in 1992.

In addition, the following mineral commodities were processed in Virginia: calcined gypsum, expanded perlite, sulfur (recovered), and exfoliated vermiculite. The combined value of these commodities as reported to the U.S. Bureau of Mines was about $15 million.

Cement.—In 1992, portland cement production increased by about 7% and Virginia ranked 23d among the 37 States producing cement. However, the reported value of production increased 85% and the State ranked 15th in value. This aberration was attributed to a significant increase in the value reported for production of calcium aluminate cement, which is included with portland cement production.

During the year, Tarmac Roanoke Cement, which operated a plant near Cloverdale in Botetourt County, formed a joint venture with Titan Cement Co. of Athens, Greece. The agreement continued a trend in which foreign ownership of U.S. cement operations was approaching 70%.

Clays and Shale.—In 1992, output of common clay and shale increased slightly. Most of the production from 12 pits was used in manufacture of face brick and concrete block. Fuller's earth was

TABLE 2
VIRGINIA: LIME SOLD OR USED BY PRODUCERS, BY USE

Use	1991		1992	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Acid water neutralization	42,417	$2,283	47,145	$2,393
Steel, basic oxygen	76,145	3,559	79,800	3,681
Steel, electric	58,012	2,674	64,222	2,974
Utility powerplant	W	W	26,113	1,275
Water purification	W	W	39,071	2,062
Other[1]	648,676	31,096	585,453	27,886
Total	825,250	39,612	841,804	40,271

W Withheld to avoid disclosing company proprietary data; included with "other."
[1]Includes, agriculture, ladle desulfurization, mason's lime, ore concentration, other chemical and industrial, chemical and industrial, other environmental, paper and pulp, precipitated calcium carbonate, road stabilization, sewage treatment, tanning, and uses indicated by symbol W.

produced at one operation in King and Queen County. These specialty clays were used as absorbents of oil, grease, and pet waste.

Feldspar.—Virginia ranked second among seven States that produced feldspar in the United States in 1992. Nationwide, about 725,000 metric tons of feldspar was produced. Feldspar produced in Virginia in Hanover County was used primarily for glassmaking.

Gypsum.—Crude gypsum was mined at one operation in Smyth County. Output from this underground mine ranked Virginia 14th of 19 States that produced crude gypsum. The gypsum was processed and calcined for wallboard manufacture at a plant in Smyth County. Gypsum was also calcined by the same company at a plant in Norfolk County. This gypsum was imported from Canada. Apparently it was less costly to transport crude gypsum by waterway from Canada to Norfolk than truck gypsum from the Smyth County mine to Norfolk, a distance of about 350 miles.

Iron Oxide Pigments (Crude).—Virginia was one of five States that mined crude iron oxide pigments. Brown and yellow pigments were produced from mines in Pulaski and Wythe Counties. Output from these operations was part of the U.S. total production in 1992 of about 39,000 metric tons.

Kyanite.—The only U.S. and the world's largest kyanite operation continued at Willis Mountain, Buckingham County. The area has a mining history that includes minor copper mining during the Civil War. Operations began for kyanite at the Willis Mountain Mine in 1955 and have since expanded to include the East Ridge Mine. Kyanite typically expands when heated, making it useful to counteract shrinkage of other materials in ceramic products. Kyanite also has application in the U.S. space program as an insulating material and was used in jet aircraft engines.

Lime.—Nationally, Virginia ranked eighth in lime production in 1992. Output from five plants of 842,000 short tons accounted for about 5% of the Nation's production.

During the year, Mississippi Lime Co., the Nation's second leading lime-producing company, purchased the underground mine and lime plant of Virginia Lime Co. in Giles County. The operation was renamed Eastern Ridge Lime Co.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Virginia construction sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 4 presents end-use statistics for Virginia's three districts.

Output in 1992 of 9.5 million short tons was the lowest since 1984 and the second year in a row that production was below 10 million tons. Production of sand and gravel in 1990 of 13.1 million tons had been the highest in Virginia in 16 years.

Despite the decline in output during the past 2 years, the State's industry has remained relatively stable. In 1992, 42 companies operated 73 pits; in 1990, only 3 more companies and 5 more pits were in operation. In 1984, Virginia produced about 8.9 million tons of sand and gravel with 51 companies operating 64 pits. A comparison of production per pit ratios showed in 1992 an average output of 130,100 tons per pit versus 139,000 tons per pit in 1984.

Stone (Crushed).—Crushed stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed stone was the leading mineral commodity produced in Virginia, accounting for about 57% of the State's value of nonfuel mineral production. In 1992, the State ranked ninth nationally in output.

By 1992, crushed stone production had declined by 18.5 million short tons from the State's record output of 66 million tons in 1988. However, some producers expected demand to increase based on estimated Federal highway funding allocations of $350 million for the State in 1993.

During the year, plans to open quarries in Nokesville in Prince William County, Danville in Pittsylvania County, and Lexington in Rockbridge County were denied or delayed by local government, primarily because of

TABLE 3

VIRGINIA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,736	$17,059	$4.57
Plaster and gunite sands	61	384	6.30
Concrete products (blocks, brick, pipe, decorative, etc.)	340	1,854	5.45
Asphaltic concrete aggregates and other bituminous mixtures	768	3,083	4.01
Road base and coverings[1]	1,443	4,043	2.80
Fill	1,015	1,967	1.94
Snow and ice control	8	18	2.25
Railroad ballast	W	W	3.00
Other miscellaneous uses[2]	213	558	2.62
Unspecified:[3]			
Actual	1,610	7,032	4.37
Estimated	352	1,338	3.80
Total	[4]9,545	37,336	3.91
Total[5 6]	8,659	37,336	4.31

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

opposition by area residents. Because of this type of opposition, some producers have purchased existing operations to avoid, in some cases, up to 5 years of work in attempting to open a quarry. In 1992, Chantilly Stone Co. purchased the Mecklenburg Rock Quarry near Boydton, which had started up in 1988. Martin Marietta Aggregates Corp. purchased the Culpeper Stone Quarry (sandstone) and the Spotsylvania Quarry (granite) from the Culpeper Stone Co. Inc. Also during the year, Vulcan Materials Co. opened a quarry in Mechlenburg County and resumed crushing operations at a sandstone quarry in Chatham, Pittsylvania County.

Vermiculite.—Virginia remained second among three States in the Nation in production of crude vermiculite. Late in the year, Virginia Vermiculite Ltd. sought a conditional-use permit from Louisa County to expand operations onto an adjoining 15-acre site. The permit is necessary for the company to maintain its current level of production. The company began mining vermiculite in 1978 at a site near Boswell Tavern.

Other Industrial Minerals.—The mining of soapstone, industrial sand, and dimension stone also contributed to the unique and varied mineral industries of Virginia. Commercial-scale soapstone production resumed in Virginia in 1987 after a 20-year hiatus. The heat-retention characteristics of soapstone were first utilized on this continent by the American Indians in making pots, bowls, and cooking stoves. In 1992, soapstone was mined only in Virginia and Oregon. One company in Frederick County continued to produce industrial sand for use in glass manufacture. Dolomite, granite, sandstone, and slate were quarried for dimension stone at one quarry each by four companies. Rough blocks, veneer, flagging, roofing, flooring, and structural products were among the end products produced from this industry.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 18 years of mineral-related and government experience and has covered the mineral activities in Virginia for 7 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Head geologist, Economic Geology Section, Virginia Division of Mineral Resources.

[3]Sweet, P. C. Directory of the Mineral Industry in Virginia–1993. VA Div. of Miner. Resour., Publication 129, 1993, 29 pp.

[4]Webb, H. W., and P. C. Sweet. Interesting Uses of Stone in Virginia, Part I. VA Minerals, v. 38, No. 4, pp. 29-36 and Part II, v. 39, Nos. 1-2, pp. 1-12.

TABLE 4

VIRGINIA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1[1]		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[2]	—	—	262	1,639	3,875	17,658
Asphaltic concrete aggregates and other bituminous mixtures	—	—	175	765	593	2,318
Road base and coverings[3]	—	—	200	972	1,243	3,071
Fill	—	—	9	48	1,006	1,919
Snow and ice control	—	—	W	W	W	W
Railroad ballast	—	—	—	—	W	W
Other miscellaneous uses[4]	—	—	21	85	199	491
Unspecified:[5]						
Actual	—	—	74	388	1,536	6,644
Estimated	—	—	352	1,338	—	—
Total[6]	—	—	1,093	5,234	8,452	32,102
Total[7 8]	—	—	992	5,234	7,668	32,102

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."

[1]Withheld to avoid disclosing company proprietary data; included with District 2.

[2]Includes plaster and gunite sands.

[3]Includes road and other stabilization (cement).

[4]Includes filtration.

[5]Includes production reported without a breakdown by end use and estimates for nonrespondents.

[6]Data may not add to totals shown because of independent rounding.

[7]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.

[8]Total quantity and total value in thousand metric tons and thousand dollars.

VIRGINIA

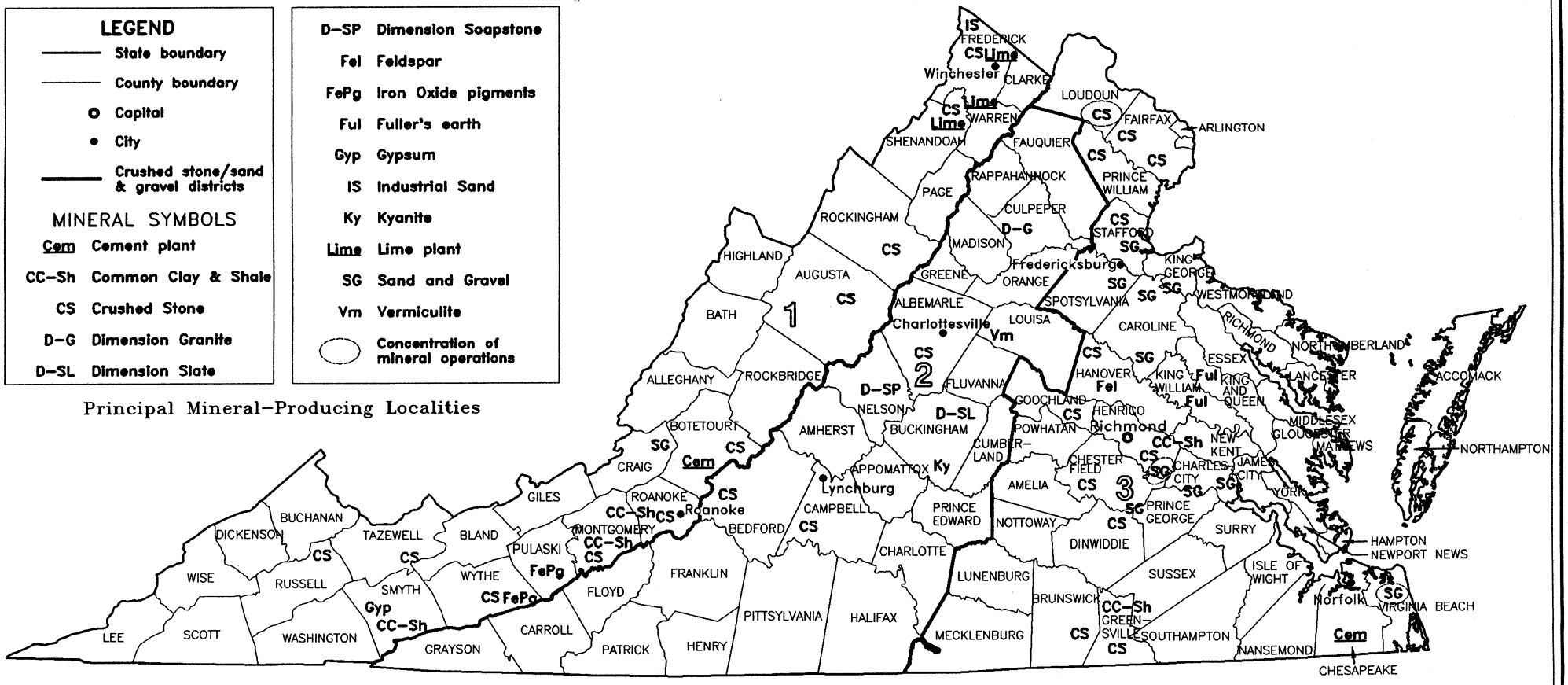
LEGEND
State boundary
County boundary
Capital
City
Crushed stone/sand & gravel districts
MINERAL SYMBOLS
Cem Cement plant
CC–Sh Common Clay & Shale
CS Crushed Stone
D–G Dimension Granite
D–SL Dimension Slate
D–SP Dimension Soapstone
Fel Feldspar
FePg Iron Oxide pigments
Ful Fuller's earth
Gyp Gypsum
IS Industrial Sand
Ky Kyanite
Lime Lime plant
SG Sand and Gravel
Vm Vermiculite
Concentration of mineral operations
Principal Mineral–Producing Localities
1
2
3
FREDERICK
Winchester
CLARKE
WARREN
SHENANDOAH
LOUDOUN
FAIRFAX
ARLINGTON
FAUQUIER
PRINCE WILLIAM
RAPPAHANNOCK
PAGE
CULPEPER
STAFFORD
ROCKINGHAM
MADISON
Fredericksburg
KING GEORGE
HIGHLAND
AUGUSTA
GREENE
ORANGE
WESTMORELAND
ALBEMARLE
SPOTSYLVANIA
BATH
Charlottesville
LOUISA
CAROLINE
RICHMOND
NORTHUMBERLAND
ESSEX
ALLEGHANY
ROCKBRIDGE
FLUVANNA
HANOVER
KING WILLIAM
KING AND QUEEN
LANCASTER
ACCOMACK
GOOCHLAND
NELSON
BUCKINGHAM
HENRICO
Richmond
MIDDLESEX
GLOUCESTER
BOTETOURT
AMHERST
POWHATAN
NEW KENT
MATHEWS
NORTHAMPTON
CRAIG
CUMBERLAND
CHESTER FIELD
CHARLES CITY
JAMES CITY
APPOMATTOX
Lynchburg
AMELIA
YORK
GILES
ROANOKE
Roanoke
CAMPBELL
PRINCE EDWARD
PRINCE GEORGE
BUCHANAN
MONTGOMERY
BEDFORD
NOTTOWAY
SURRY
HAMPTON
NEWPORT NEWS
DICKENSON
TAZEWELL
BLAND
PULASKI
CHARLOTTE
DINWIDDIE
WISE
RUSSELL
WYTHE
FRANKLIN
LUNENBURG
SUSSEX
ISLE OF WIGHT
SMYTH
FLOYD
BRUNSWICK
Norfolk
VIRGINIA BEACH
LEE
SCOTT
WASHINGTON
GRAYSON
CARROLL
PATRICK
HENRY
PITTSYLVANIA
HALIFAX
MECKLENBURG
GREENSVILLE
SOUTHAMPTON
NANSEMOND
CHESAPEAKE

TABLE 5
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Masonry:			
Riverton Corp.	Box 4004 Front Royal, VA 22630	Quarry and plant	Warren.
Portland:			
Tarmac Roanoke Cement[1]	Box 34527 Richmond, VA 23234	do.	Botetourt.
Clays and shale:			
Common:			
Brick & Tile Corp.	Box 45 Lawrenceville, VA 23868	Pits and plant	Brunswick and Greensville.
General Shale Products Corp.	Route 4, Box 127 Marion, VA 24354	do.	Rockbridge and Smyth.
General Shale-Webster Inc.	Box 306 Blue Ridge, VA 22064	do.	Botetourt and Orange.
Fuller's earth:			
Bennett Mineral Co.	Box 28 Walkerton, VA 23177	do.	King and Queen.
Virginia Clay Co. Inc.	Route 1, Box 215 King William, VA 23086	do.	King William.
Feldspar:			
The Feldspar Corp.	Route 1, Box 305 Montpelier, VA 23192	Quarry and plant	Hanover.
Gypsum:			
USG Corp.	Route 1 Saltville, VA 24370	Mine and plant	Smyth.
Iron oxide pigments (crude):			
Hoover Color Corp.	Box 218 Hiwassee, VA 24347	Mines and plant	Pulaski.
Virginia Earth Pigments Co.	Box 1866 Pulaski, VA 24301	Mine	Wythe.
Kyanite:			
Kyanite Mining Corp.	Box 486 Dillwyn, PA 23936	Mines and plant	Buckingham.
Lime:			
APG Lime Corp.	Route 635 Ripplemead, VA 24150	Underground mine and plant	Giles.
Chemstone Corp.	Route 629, Box 71 Strasburg, VA 22657	Quarry and plant	Shenandoah.
Eastern Ridge Lime Co.	Route 635 Ripplemead, VA 24150	Underground mine	Giles.
Sand and gravel:			
Construction:			
Henry S. Branscome Inc.	Drawer 260 Williamsburg, VA 23187	Pits and plant	Charles City and James City.
Culpepper Stone Co. Inc.	Box 1318 Culpepper, VA 22701	do.	Caroline, King George, Stafford.
Isle of Wight Material Co. Inc.	Box 216 Carrollton, VA 23314	Pits and plants	Isle of Wight.
Solite Corp.[2]	Box 883 Fredericksburg, VA 22404	Pit and plant	King George.
Tarmac Mid-Atlantic Inc.	Box 34527 Richmond, VA 23234	Pits and plants	Botetourt, Chesterfield, Henrico, Prince George.

See footnotes at end of table.

TABLE 5—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued:			
Construction—Continued:			
West Sand & Gravel Co. Inc.	Box 15480 Richmond, VA 23227	Pits and plants	Henrico and Rockingham.
Williams Corp. of Virginia	Box 938 Norfolk, VA 23501	Pits and plant	Suffolk and Virginia Beach.
Industrial:			
Unimin Corp.	Box 38 Gore, VA 22637	Mine and plant	Frederick.
Soapstone:			
New Alberene Stone Co. Inc.	Box 300 Schuyler, VA 22969	Pit and plant	Nelson.
Stone:			
Crushed:			
W. W. Boxley Co.	Box 13527 Roanoke, VA 24035	Quarries and plants	Augusta, Bedford, Campbell, Henry, Nelson.
Luck Stone Corp.	Box 29682 Richmond, VA 23229	do.	Albemarle, Augusta, Fairfax, Fauquier, Goochland, Greene, Loudoun, Louisa, Nottoway, Powhatan, Rockingham.
Tarmac Mid-Atlantic Inc.	Box 34527 Richmond, VA 23234	do.	Botetourt, Chesterfield, Dinwiddie, Henrico.
Vulcan Materials Co., Mideast Div.	Box 1590 Manassas, VA 22110	do.	Brunswick, Fairfax, Fauquier, Goochland, Greensville, Halifax, Prince William, Stafford, Wise.
Dimension:			
LeSueur-Richmond Slate Corp.	Box 8 Arvonia, VA 23004	Quarries	Buckingham.
Vermiculite:			
Virginia Vermiculite Ltd.	Box 70 Louisa, VA 23093	Mine and plant	Louisa.

[1]Also masonry cement.
[2]Also lightweight aggregate.

THE MINERAL INDUSTRY OF WASHINGTON

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines (USBM), U.S. Department of the Interior, and the Washington Division of Geology and Earth Resources for collecting information on all nonfuel minerals.

By R. J. Minarik,[1] R. E. Derkey,[2] and C. W. Gulick[3]

The total value of nonfuel minerals produced in Washington fell to $469 million in 1992, a decrease of almost 3% from that of 1991. Increases in the production values for portland cement, lime, and crushed stone were more than offset by decreases in the value of gold and magnesium metal. Construction sand and gravel was the leading commodity in terms of value, followed in order by gold, magnesium metal, crushed stone, and portland cement.

Washington ranked 23d in the Nation in the value of nonfuel minerals production, down from a 22d ranking in 1991.

TRENDS AND DEVELOPMENTS

Led by increases in the values for portland cement, lime, and crushed stone, the 1992 value of industrial minerals produced in Washington increased more than 9% from that of 1991. Aggregate production—construction sand and gravel and crushed stone—accounted for almost 44% of the State's total nonfuel mineral production. The combined value for all industrial minerals accounted for 64% of the State's total nonfuel mineral production value, compared with 57% in 1991 and 54% in 1990.

The production value of Washington's metallic minerals—gold, lead, magnesium metal, silver, and zinc—dropped 19% from that of 1991. Decreases in production were responsible largely for the drop in value—a magnesium plant curtailed sales on the open market and reduced production accordingly; a gold mine reduced production because of dwindling reserves; and a lead-zinc property operated only late in the year, a result of low prices. Although not included in USBM's mineral production table, Washington was the Nation's largest producer of aluminum, accounting for almost one-third of total production nationwide.

EMPLOYMENT

The State's mining industry employment decreased almost 11% from that of 1991. According to the State of Washington Employment Security Department, average mining and

TABLE 1
NONFUEL MINERAL PRODUCTION IN WASHINGTON[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	158,257	$1,357	263,374	$2,633	306,267	[2]$1,889
Gemstones		NA	281	NA	85	NA	379
Gold[3]	kilograms	9,620	119,671	9,954	116,260	8,802	97,619
Sand and gravel (construction)	thousand short tons	r40,032	r132,921	40,200	140,700	40,933	140,994
Stone (crushed)	do.	e12,700	e41,900	13,126	59,588	e13,500	e63,200
Combined value of cement, clays [fire (1992)], diatomite, gypsum [crude (1990-91)], lead (1991-92), lime, magnesium metal, olivine, peat, sand and gravel (industrial), silver, stone (dimension), zinc (1991-92), and values indicated by symbol W		XX	r176,929	XX	r163,395	XX	164,958
Total		XX	r473,059	XX	r482,661	XX	469,039

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" figure.
[3]Recoverable content of ores, etc.

quarrying employment dropped to 3,329 workers from the 3,730 reported in 1991. The largest segment employed in mining was in the production of industrial minerals, which accounted for 52% of the total. Employment in the State's primary metals industry fell to 11,658 workers in 1992, a decrease of 627 workers from that of 1991. An almost 3% decrease in persons employed in the primary production of aluminum, which averaged 5,855 during 1992, reflected the continued weakness in that market.

ENVIRONMENTAL ISSUES

Structures at ASARCO Incorporated's former copper smelter at Ruston, Pierce County, including the landmark 171-meter-tall smokestack, were demolished or set to be demolished following final approval from the U.S. Environmental Protection Agency. The old smelter property, often referred to as the Tacoma smelter, was contaminated with arsenic and heavy metals and was on the national Superfund list. At yearend, demolition of the smokestack had become a little more complicated. Endangered peregrine falcons were perching on top of the chimney, using the vantage point for spotting prey. When the stack is ultimately razed, demolition experts first will have to lure the birds from their perch. Also, efforts continued on the multimillion-dollar cleanup of heavy metals detected in several Tacoma-area log yards. Arsenic and other metals reportedly were leached from slag generated at the smelter and marketed by Asarco as an inexpensive alternative to gravel. The slag was used in paving the log yards.

EXPLORATION ACTIVITIES

Exploration continued at a relatively active pace, especially in the northeastern and north-central part of the State. Precious metals continued to be the primary target.

The joint venture of Battle Mountain Gold Co. and Crown Resources Corp. continued exploration and permitting of the Crown Jewel gold project. Sited east of Chesaw, the skarn-type deposit covers about 60 acres on and adjacent to Buckhorn Mountain in Okanogan County. The deposit contains two main zones, the Gold Bowl and the Gold Axe. Battle Mountain, which will manage the project for the joint venture, did geologic mapping, condemnation drilling, and engineering studies in preparation for mining. A draft environmental impact statement (EIS) was being prepared.

Also in Okanogan County, Crown Resources, in a joint venture with Lac Minerals (USA) Inc., did geochemistry, geophysics, and drilled at the Ida and Molson Gold properties. The joint venture of Crown Resources and Teck Exploration Ltd. drilled and mapped the Strawberry Lake prospect west of Chesaw. On the Colville Indian Reservation, Santa Fe Pacific Mining Inc. explored the Wasco Ridge property, Echo Bay Exploration Inc. mapped Agency Butte, and the Parmenter Creek property was being offered by the Colville Confederated Tribes. Centurion Mines Corp. conducted geologic mapping and extensive computer analysis of the Mazama porphyry copper deposit, 18 miles northwest of Winthrop; Strongbow Resources Corp., a subsidiary of Consolidated Ramrod Corp., explored the Crystal Butte project, a property optioned from Keystone Gold Inc.; Hunter Mines Inc., a subsidiary of Waseco Resources Ltd., did underground development at the Say Energy property; and Weaco Resources Ltd. drilled the Kelsey property. Other companies or individuals reporting exploration activities in the county included Wilbur Hallauer, R.E. Kucera, Magill and Associates, Northwest Minerals Inc., Pacific Northwest Resources Inc., and Sunshine Valley Minerals Inc.

In Ferry County, Santa Fe Pacific and Pathfinder Gold Corp. drilled and mapped the Golden Harvest and Franson Peak properties; Equinox Resources Ltd. explored its Wardlaw property, adjacent to the Lamefoot gold deposit; Phelps Dodge Mining Co. drilled the Copper Mountain and Toroda properties; Orvana Resources Corp. did exploration work on the Goosmus Creek, Kelly Camp, Long Alec Creek, and O'Brien Creek properties; Westmont Gold Inc. mapped and sampled the Manhattan Mountain property; Johnson Explosive performed geological and geochemical exploration at its Irish project; Morse Brothers' Morning Star Mines Inc. drilled and sampled the Morning Star property; and the Gold Mountain Mine south of Danville, a joint venture of Gold Express Corp. and N.A. Degerstrom Inc., was permitted and put on hold, with startup dependent on gold prices. Other companies and individuals conducting exploration in Ferry County included Wilbur Hallauer, Hecla Mining Co., and Sutton Resources Inc.

In Stevens County, Homestake Mining Co. and Pathfinder Gold drilled and mapped the Big Iron-McNally gold property; David Robbins and Associates did shaft reclamation on the Cleta Group; the Vanhorn and Watson Mining Co. drilled and drifted underground on the Copper Penny project; and Pathfinder Gold, in a joint venture with Billiton Minerals U.S.A. Inc., explored at the First Thought Mine. Other companies maintaining a presence in the county included Bitterroot Resources Ltd., Hope Mountain Mining Ltd., Leadpoint Consolidated Mines Co., Lovejoy Mining Inc., Silver Hill Mines Inc., State Mining Co., and Lester Willmann.

In Pend Oreille County, Raven Hill Mining Co. explored its Cooks Copper silver-copper prospect near Newport and performed preliminary mine development work at its Glass Mountain Mine. N.A. Degerstrom explored a property on Harvey Creek.

In Chelan County, Asamera Minerals (U.S.) Inc. drilled at its Simon-Cumbo and Wallace sites. Others maintaining a presence in the county included Gold Bond Mining Co., Wilbur Hallauer, Montana d'Oro Inc., and Raven Hill Mining. In agreement with Island-Arc Resources and Formosa Resources Corp., Kennecott Exploration Co. drilled then later dropped its option on the Lockwood massive sulfide project near Everett, Snohomish County. Base and precious metal mineralization in the largely pyrite-rich deposit has been identified. In

Whatcom County, exploration was done by Double Dragon Exploration Inc. at its Azurite prospect, Seattle-St. Louis Mining Co. did mapping and maintenance at its Minnesota property, Jackpine Mining Co. investigated the South Pass nickel property, and Cannon Minerals assessed its Loomis Mountain property.

In Skamania County, Plexus Resources Corp. drilled, mapped, and conducted baseline studies at its Silver Star base metal property, Champion International Corp. drilled the Polar Star project, and Teck Exploration was seeking a prospecting permit for its Margaret deposit. CSS Management Corp. did development work at the Apex-Damon project in King County, and Weyerhaeuser Co. inventoried and evaluated the mineral potential of its company-owned forest lands. In Yakima County, Ardic Exploration and Development Inc. drilled the Morse Creek property.

LEGISLATION AND GOVERNMENT PROGRAMS

According to the Washington Department of Natural Resources, Division of Lands and Minerals, total revenue to the State from prospecting, mining, and quarrying on State lands was $834,000 for the fiscal year ending June 30, 1992. Additional revenues of $187,000 were received from mineral activity on Washington's aquatic lands in fiscal year 1992.

The USBM Spokane Research Center continued its work in both the environmental technology area and the health, safety, and mining technology area. Mine waste management projects included work on contaminant fate, dissolution mechanisms, hydrologic disposal of tailings drainage, and subaqueous disposal of mine waste. Environmental impacts of backfill used in metal mines, as well as clay grouting to reduce acid drainage from abandoned mines, were investigated. Impact of mining on fragile arctic, subarctic, and alpine environments was an ongoing project.

In the health and safety area, several ground control projects were funded, including minewide monitoring, rock burst hazard assessment, and innovative methods for rock burst control. Computer technology was used to investigate such areas as expert systems for mine support selection, noninvasive geophysics for detecting hazards in active mining, and using fractals to characterize rock. In situ projects continued, as did those looking at advanced methods for mining deep and shallow ore bodies. One project was funded with technology transfer funds, using lightweight concrete materials for heat abatement in deep mines.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Barite.—After completing the refurbishment of its mill, Mountain Minerals Northwest, a subsidiary of Mountain Minerals Co. Ltd. of Lethbridge, Alberta, Canada, processed a limited amount of barite at its property on Sheep Creek near Northport. The barite was mined from a bedded deposit on Flagstaff Mountain in Stevens County and was marketed as drilling mud. The mill then was shut down, and the project placed on hold pending a turnaround in the depressed market for drilling mud.

Lovejoy Mining Co. shipped two truckloads of barite from the Eagle Mountain deposit near Chewelah, Stevens County, to Missoula, MT, where it was ground for ceramic glass. The company continued assessment work.

Calcium Chloride.—Occidental Chemical Corp. in Tacoma, Pierce County, manufactured synthetic calcium chloride using hydrochloric acid and limestone barged in from British Columbia, Canada. Washington was one of two States reporting production. Output remained essentially unchanged in both quantity and value from that of 1991.

Cement.—The production of portland cement in Washington increased 43% in quantity from that estimated in 1991 and more than 24% from that reported in 1990. Value increased 45% from that estimated in 1991 and by almost 27% from that reported in 1990. The State total included a modest amount of masonry cement production, which also increased in quantity and value.

In King County, Ash Grove Cement West Inc. completed construction of its new $65 million state-of-the-art cement manufacturing facility in Seattle. At full production, the plant would be the largest in the State, with an estimated capacity of 680,000 metric tons per year. After demolishing an old, antiquated portland cement facility, including removal of the clinkering plant (kilns), Ash Grove built the new dry-process facility on the same site, on the Duwamish River near its outlet on Elliott Bay. This site affords access to barges that transport raw limestone from the company's quarry on Texada Island, British Columbia. Also, the company maintained a bulk cement distribution center. Ash Grove processed silica from the Superior quarry and reopened the Castle Rock clay pit in Cowlitz County. The high-alumina clays were blended with clay produced by the Pacific Coast Coal Co. at its John Henry No.1 Mine near Black Diamond, King County. Pacific Coast Coal mined clay for cement production for both Ash Grove and Holnam Inc. In Spokane, Ash Grove completed expansion of its cement distribution plant. The expansion nearly doubled the plant's storage capacity and gives the company the ability to load two trucks simultaneously.

Holnam produced portland cement at its wet-process facility in Seattle, King County. According to the State's Division of Geology and Earth Resources (DGER), the 25-year-old facility has a capacity of 453,500 metric tons per year. The company barged limestone to the plant from Texada Island, British Columbia, and clay from its Twin River quarry along the Strait of Juan de Fuca, west of Port Angeles, Clallam County. At Bellingham, in Whatcom County, Tilbury Cement Co. operated a grinding

facility using imported clinker from the company's portland cement plant at Delta, British Columbia.

The bulk of Washington's cement production was general use, moderate-heat, Types I and II gray portland cement, with lesser amounts of high-early-strength Type III and high-sulfate-resistant Type V; oil well and pozzolanic cements also were produced. The cement plants used a mix of fossil fuels, including natural gas, fuel oil, and bituminous and anthracite coal for fuel; electricity also was purchased for energy. Raw materials used to produce the different grades of portland cement included aluminum dross, clay, gypsum, iron ore, limestone, and sand.

Portland cement was used by ready-mixed concrete companies, building material dealers, other contractors, concrete products manufacturers, highway contractors, and government agencies.

Clays.—Clay production, excluding fire clay, increased more than 16% in quantity but dropped more than 28% in value from that of 1991. Common clay production was reported to USBM by three companies from seven pits in four counties. Fire clay production was reported at three pits in two counties.

Mutual Materials Co. was the State's largest clay producer. A large part of the company's clay and shale production came from two pits in King County, with lesser amounts from Pierce and Thurston Counties. In Spokane County, Mutual Materials mined clay and operated a brickmaking plant at Mica. The company blended clay from the Mica pit with clay from pits in Idaho. In anticipation of future production, Mutual Materials constructed a stockpile pad and creek crossing at its Fruin deposit, southeast of Mica.

Holnam mined the Twin River quarry, the largest clay pit in the State; the high-alumina, low-alkali clay was barged from the quarry along the Strait of Juan de Fuca to Holnam's cement plant at Seattle for the production of portland cement. Quarry Tile Co. of Spokane County removed red and white clays from existing stockpiles at the Somers pit; the clay was used in the production of ceramic floor tiles.

North American Refractories Co. reported fire clay production at three pits in King and Stevens Counties.

In the Columbia Basin, Basic Resources Corp. continued to explore for bentonite clays interbedded in the Columbia River basalt. The company evaluated the Rock Top property, Grant County, and Coulee Chief in Douglas County.

Diatomite.—Washington's diatomite production increased more than 5% in quantity and almost 8% in value from that of 1991. The State was the Nation's third-ranked producer in value of production. Celite Corp., a subsidiary of The Allegheny Corp., was the State's sole producer of diatomite. Celite was mined from two pits and hauled from stockpiles at a third pit in the Frenchman Hills in Grant County. The company processed and calcined the diatomaceous earth at its plant in Quincy. The bulk of the diatomite was used for filtration, with a modest quantity consumed as paint filler. Markets were both domestic and international.

Gemstones.—Gemstone production in Washington included petrified wood and picture rock by Rock Hanger Minerals, Lee & Sons, and others. Quartz and pyrite crystals were mined from breccia pipes in the Snoqualmie batholith near North Bend, King County. Other Washington gemstones included agate, garnet, jasper, common opal, and realgar crystals.

Gypsum.—Agro Minerals Inc. operated the Poison Lake Mine near Tonasket, Okanogan County, the only gypsite mine in the State. Agro Minerals has mined gypsite from small, saline lake bottoms since 1948; the dried and sized product was used as a soil conditioner. Calcined gypsum was produced by James Hardie Gypsum in Seattle and by Domtar Gypsum America Inc. at Tacoma. These wallboard manufacturers import raw gypsum by barge from Mexico.

Lime.—Lime production in Washington increased 25% in quantity and more than 31% in value from that of 1991. The State's largest producer, Northwest Alloys Inc., produced quicklime as a byproduct of magnesium metal production at a plant in Addy, Stevens County. The Tacoma Lime Div. of Continental Lime Inc., a wholly owned subsidiary of Graymont Ltd., produced both quicklime and hydrated lime at its Tacoma plant in Pierce County.

Olivine.—Washington was one of two States to produce olivine in 1992. The value of production dropped more than 7% from that of 1991. In Whatcom County, Olivine Corp. mined and milled fresh, unaltered olivine from the Swen Larsen quarry in the Twin Sisters dunite. A small portion of the production was used in fabrication of modular olivine refractory slabs for wood- and municipal-waste incinerators. For the most part, Olivine Corp. sold its crude production to Applied Industrial Minerals Corp. (AIMCOR), which processed the material at its plant near Hamilton, Skagit County. AIMCOR made a variety of refractory products, including foundry and blasting sands used both domestically and for export to South America and Pacific Rim countries.

Peat.—Washington's peat production dropped both in quantity and value from that of 1991. Companies producing peat included Asbury's Topsoil at its Newberry Hill property, Kitsap County; Bonaparte Peat Co. at its Bonaparte Meadows property, Okanogan County; Maple Valley Humus near Renton, King County; and Ocean Farms and Soils (Chrystel Soils) at its North Bay property, Grays Harbor County. All reported production was sold in bulk.

Sand and Gravel.—Construction.—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains estimates for 1991 and actual data for

TABLE 2

WASHINGTON: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	11,370	$44,535	$3.92
Plaster and gunite sands	106	558	5.26
Concrete products (blocks, brick, pipe, decorative, etc.)	340	1,307	3.84
Asphaltic concrete aggregates and other bituminous mixtures	6,030	21,121	3.50
Road base and coverings[1]	10,036	36,258	3.61
Fill	7,415	15,777	2.13
Other miscellaneous uses[2]	168	761	4.53
Snow and ice control	305	921	3.02
Railroad ballast	120	523	4.36
Unspecified:[3]			
Actual	1,341	5,380	4.01
Estimated	3,702	13,852	3.74
Total	40,933	[4]140,994	3.44
Total[5 6]	37,134	140,994	3.80

[1]Includes road and other stabilization (cement).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

1990 and 1992.

The quantity of construction sand and gravel produced in Washington remained essentially unchanged from that estimated in 1991 and what was reported in 1990. The value of production was essentially unchanged from that estimated in 1991, but rose 6% from that reported in 1990. The State was the fifth largest producer of construction sand and gravel in the Nation. The bulk of the production came from the aggregate-rich, ice-margin deposits in the Puget Sound region of Clark, King, Pierce, and Snohomish Counties and from Lake Missoula flood deposits near Spokane. Of Washington's 39 counties, 33 reported production.

Washington's construction sand and gravel statistics are compiled by geographical districts, as depicted on the State map. District 1, representing the western part of the State, accounted for 76% of the surveyed output. Major uses included concrete aggregates, concrete sand, fill, and road base and coverings.

Industrial.—The quantity of industrial sand and gravel produced fell slightly, but value rose more than 6% from that of 1991. Lane Mountain Silica Co., a division of Hemphill Brothers Inc., was the State's largest producer of industrial sand. The company operated a mine and plant near Addy in Stevens County. In King County, silica was mined by Reserve Silica Corp. from the Ravensdale pit. The bulk of the silica from both companies was used in the manufacture of glass containers. From its Superior quarry, Ash Grove Cement shipped silica from stockpiled inventory. The bulk of the material was used in-house at the company's new portland cement plant in Seattle.

Other uses for industrial sand and gravel included fiberglass, flat-glass manufacture, golf course sand traps, and sandblasting.

Stone.—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates made before yearend. This chapter contains actual data for 1991 and estimates for 1990 and 1992.

Crushed.—The estimated volume of crushed stone produced in 1992 increased slightly and the value rose 6% from that surveyed in 1991. In the most recent survey, production was reported in 35 of the State's 39 counties. The counties of Clark, Cowlitz, Franklin, Snohomish, and Spokane were among the leading producers. Reflecting the widespread occurrence of volcanic rocks in Washington, andesite and basalt accounted for the bulk of production. Other stone produced included limestone and granite.

Dimension.—The estimated production of dimension stone decreased both in quantity and value from that of 1991. Decorative stone was quarried from andesite, basalt, dolomite, feldsite, marble, and quartzite. Counties with production included Clark, Ferry, King, Pierce, Skagit, Snohomish, Stevens, and Yakima. Products included ashlar, flagstone, rubble, and veneers.

Sulfur (Recovered).—All of the State's sulfur production was recovered as byproduct from petroleum refining in the Puget Sound area. Companies reporting production were Shell Oil Co. and Texaco Inc. from their Skagit County refineries, and Atlantic Richfield Co. and British Petroleum Oil Co. from refinery operations at Cherry Point and Ferndale in Whatcom County.

Metals

Aluminum.—Aluminum production in Washington remained essentially unchanged, but value dropped almost 3% from that of 1991. The State's seven aluminum smelters produced a total of 1,263,000 metric tons of aluminum ingot, slightly above total annual rated capacity. Washington was the Nation's largest aluminum producer. Production was

TABLE 3

WASHINGTON:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	9,302	$38,303	793	$2,408	1,274	$3,823
Plaster and gunite sands	24	179	W	W	W	W
Concrete products (blocks, brick, etc.)	W	W	W	W	321	1,214
Asphaltic concrete aggregates and other bituminous mixtures	4,627	16,097	1,166	4,250	237	774
Road base and coverings[2]	6,017	22,158	2,173	6,599	1,846	7,502
Fill	6,966	14,502	234	530	214	745
Snow and ice control	147	424	W	W	W	W
Railroad ballast	70	352	50	171	—	—
Other miscellaneous uses[3]	151	684	55	268	221	779
Unspecified:[4]						
Actual	574	2,862	457	1,447	238	830
Estimated	3,186	12,147	256	799	260	907
Total[5]	31,065	107,708	5,185	16,471	4,610	16,573
Total[6 7]	28,182	107,708	4,704	16,471	4,183	16,573

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Excludes 72,261 short tons valued at $241,352, not reported by county.
[2]Includes road and other stabilization (cement).
[3]Includes filtration.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value in thousand metric tons and thousand dollars.

more than three times that of any other State and accounted for 31% of total domestic output. At an average $0.58 per pound, prices leveled off after falling from an average $1.10 per pound in 1988 to $0.59 per pound in 1991.

With a rated annual capacity of 272,000 metric tons, Intalco Aluminum Corp., a subsidiary of Alumax Inc., operated Washington's largest single plant in Ferndale, Whatcom County. Alumax owned 75% of the plant, with three Japanese companies controlling the remaining interest. Kaiser Aluminum & Chemical Corp., with a total rated annual capacity of 274,000 metric tons, and Intalco were the State's leading aluminum ingot producers.

Kaiser, a division of MAXXAM Inc., operated a smelter and rolling mill in Mead and Trentwood in Spokane County and a smelter in Tacoma, Pierce County. Kaiser's smelter at Mead produced molten aluminum, ingot, and aluminum shot. It has a rated capacity of 200,000 metric tons per year. At its Trentwood rolling mill, Kaiser produced plate and sheet, including coil stock for the beverage, aerospace, transportation, and other industries.

Washington's other aluminum smelters, by order of annual rated capacity, were Aluminum Co. of America's (Alcoa) plant in Wenatchee, Chelan County; the Reynolds Metals Co. operation in Longview, Cowlitz County; a plant in Goldendale, Klickitat County, owned by Columbia Aluminum Co.; and a smelter in Vancouver, Clark County, operated by Vanalco Inc.

Gold and Silver.—Gold production in Washington decreased almost 12% in quantity and 16% in value from that of 1991. The State was the sixth-ranked gold producer in the Nation in 1992. Two companies reported silver produced as a byproduct of lode gold production. The quantity of silver production remained essentially unchanged, but the value dropped 9% from that of 1991.

In 1992, the Cannon Mine, an epithermal deposit at Wenatchee, Chelan County, was the largest gold operation in the State and the second largest underground gold mine in the Nation; silver also was produced. Owing to dwindling reserves, the company cut back production and reduced output. The mine continued to operate 7 days per week; however, the mill operated only 5 days per week. According to DGER, 1992 production was 4,192 kilograms of gold and 7,574 kilograms of silver from 449,100 metric tons of ore. The mine is a joint venture of Asamera Minerals (U.S.) Inc., a subsidiary of Gulf Canada Resources Ltd., and Breakwater Resources Ltd. The mine ranked 20th nationally in terms of value of gold production in 1992. Asamera closed its Wenatchee exploration office in late 1992 after completing exploration on properties in the region.

Echo Bay Minerals Co. continued to operate its Kettle River project in Ferry County. Echo Bay's joint-venture partner, Crown Resources, which had maintained a 30% interest, withdrew from the project. Production was curtailed at the Overlook, one of the original underground mines, because of low grades and high development costs, and ore at the Kettle Mine was exhausted. The Overlook, a replacement-type deposit, was sited just north of the Key mill, northeast of Republic. When in production, a modified room-and-pillar mining method and a decline ramp system that accommodated rubber-tired vehicles were used at the Overlook. The Kettle Mine, an epithermal gold deposit, was west of Curlew, about 23 miles to the north of the mill. According to DGER, total gold production for the life of the Kettle Mine was about 2,000 kilograms. At yearend, ore production was coming exclusively from the Key East and Key West surface mines, which began production late in the year. The surface mines are about one-quarter of a mile apart and about 1 mile northeast of the Overlook Mine. Ore was trucked to the nearby Key mill, which used a carbon-in-pulp vat-leach system and zinc precipitation (Merrill-Crowe process) to recover the precious metals. Throughput at the mill, which processed ore from all four mines, ranged from 1,500 to 1,800 metric tons per day. According to Echo Bay's 1992 annual report, total production during the year from the Kettle River project, including all four mines, was 2,800 kilograms of gold.

Echo Bay was developing a production drift on the Lamefoot property, east of Curlew Lake, about 3 miles from the Key mill. As the underground ramp was being driven, the company continued to test the validity of the drill indicated reserves. Ore removed during development was stockpiled and will be hauled to the mill when mining commences. Assuming the timely receipt of necessary permits, the company hopes Lamefoot will be the principal source of mill feed in 1994. In addition, preliminary exploration drilling continued at the K-2 prospect, 2 miles west-southwest of the mined-out Kettle deposit.

Hecla Mining Co.'s Republic Unit (Knob Hill Mine), at Republic, Ferry County, was the State's top-ranked silver producer. The company employed a cut-and-fill mining method and continued to remove ore primarily from the Golden Promise vein system. It consists of a large, main vein, referred to as the No. 2 vein, and several smaller or secondary veins. A decline ramp provides direct access to the Golden Promise ore bodies and permits the use of rubber-tired, diesel vehicles for ore loading and haulage to the surface. In the past, ore was trammed almost 2 kilometers to the Knob Hill No. 2 shaft and hoisted to the surface. Once there, it was hauled by truck to the Republic mill. After installing closed circuit crushing, mill capacity was expanded from 245 to 295 metric tons per day. This enabled the Republic Unit to set a production record in 1992 by milling nearly 93,400 metric tons of ore, compared with the previous record in 1991 of about 88,000 metric tons. According to Hecla's 1992 annual report, the mine produced 1,815 kilograms of gold and 9,330 kilograms of silver in 1992. Hecla also operated an on-site refinery where ore was processed into gold and silver bullion consisting of about 90% precious metals. Gold was then shipped as doré for further refinement into gold and silver bars. During 1992, Hecla remapped its surface holdings throughout the district and, utilizing the new production decline, continued its underground exploration and development program.

Magnesium Metal.—Magnesium metal production in 1992 decreased more than 19% in quantity and more than 23% in value from that of 1991. The State ranked third nationally in production of the metal.

Northwest Alloys, a wholly owned subsidiary of Alcoa, produced magnesium metal from locally mined dolomite at its plant at Addy, Stevens County. The plant employed a silicothermic process using ferrosilicon imported from Norway and aluminum-quartzite flux. Owing to low magnesium prices worldwide and a decrease in demand, Northwest Alloys reduced plant production. At the reduced production level, the majority of the magnesium metal was used by the parent company, Alcoa, as a strengthening agent in aluminum alloy products; the remainder was offered for outside sales. According to DGER, the anticipated 50% cutback in the total work force was not fully instituted, and the company was able to bring approximately 50 people back to work during the year.

After laying off 52 workers in 1991 and temporarily closing its magnesium processing plant near Chewelah, Stevens County, L-Bar Products Inc. subsequently entered into chapter 11 bankruptcy. The company had manufactured fertilizer and magnesium granules by extracting the metal from sludge bars residue obtained from the nearby Northwest Alloys magnesium plant.

Silicon.—Silicon Metaltech Inc. operated a silicon plant at Rock Island, Douglas County; the plant obtained raw material from quartzite mining operations in Golden, British Columbia, Canada. The plant produced silicon metal for the domestic aluminum industry and the manufacturers of adhesives and caulks. Silica fume, a byproduct of silicon metal and ferrosilicon production, was sold as a strengthener for concrete products. Although both Silicon Metaltech and Northwest Alloys are capable of producing ferrosilicon, prohibitively expensive electric rates and other considerations precluded production.

Advanced Silicon Materials Inc., a subsidiary of Komatsu Electronic Metals Co. Ltd. (KEM) of Japan, operated polysilicon plants in Moses Lake, Grant County, and Washougal, Clark County. Reportedly, KEM was the company's largest polysilicon customer and marketed the product in India, Japan, Republic of South Korea, and Taiwan, where it was used in the manufacture of silicon wafers for computer chips and other electronics.

Zinc and Lead.—In August, Equinox Resources Ltd. reopened the Van Stone zinc-lead mine near Onion Creek, north

of Colville, Stevens County. After purchasing the property from Callahan Mining Co., U.S. Borax and Chemical Corp., and Brinco Ltd. in 1990, Equinox operated the mine from March to October 1991, when it suspended production because of low prices. The mill has a capacity of 1,100 tons per day. According to DGER, in 1992, Equinox produced 7,815 metric tons of zinc concentrates that averaged 55% zinc and 1,986 metric tons of lead concentrates that averaged 70.5% lead. The Van Stone Mine ranked 13th in the Nation in lead production and 21st in zinc production in 1992. The company shipped concentrates by truck to be smelted at Cominco Ltd.'s zinc smelter at Trail, British Columbia, about 40 kilometers to the north of the operation. Plans are to mine the property as an open pit for 2 to 3 years, then begin underground mining using room-and-pillar mining methods.

Resource Finance Corp. (RFC) with Minnova Inc., both subsidiaries of Kerr Addison Mines Ltd., continued an exploration program at the Pend Oreille zinc-lead property 4 miles north of Metaline Falls, Pend Oreille County. Later, Minnova exercised an option and bought a controlling interest in the mine by purchasing a stake of RFC from Kerr Addison. The underground exploratory drilling was directed at further delineating the Yellowhead zone, the lower of two mineralized zones previously mined. RFC continued to work on acquiring permits necessary to reopen the property.

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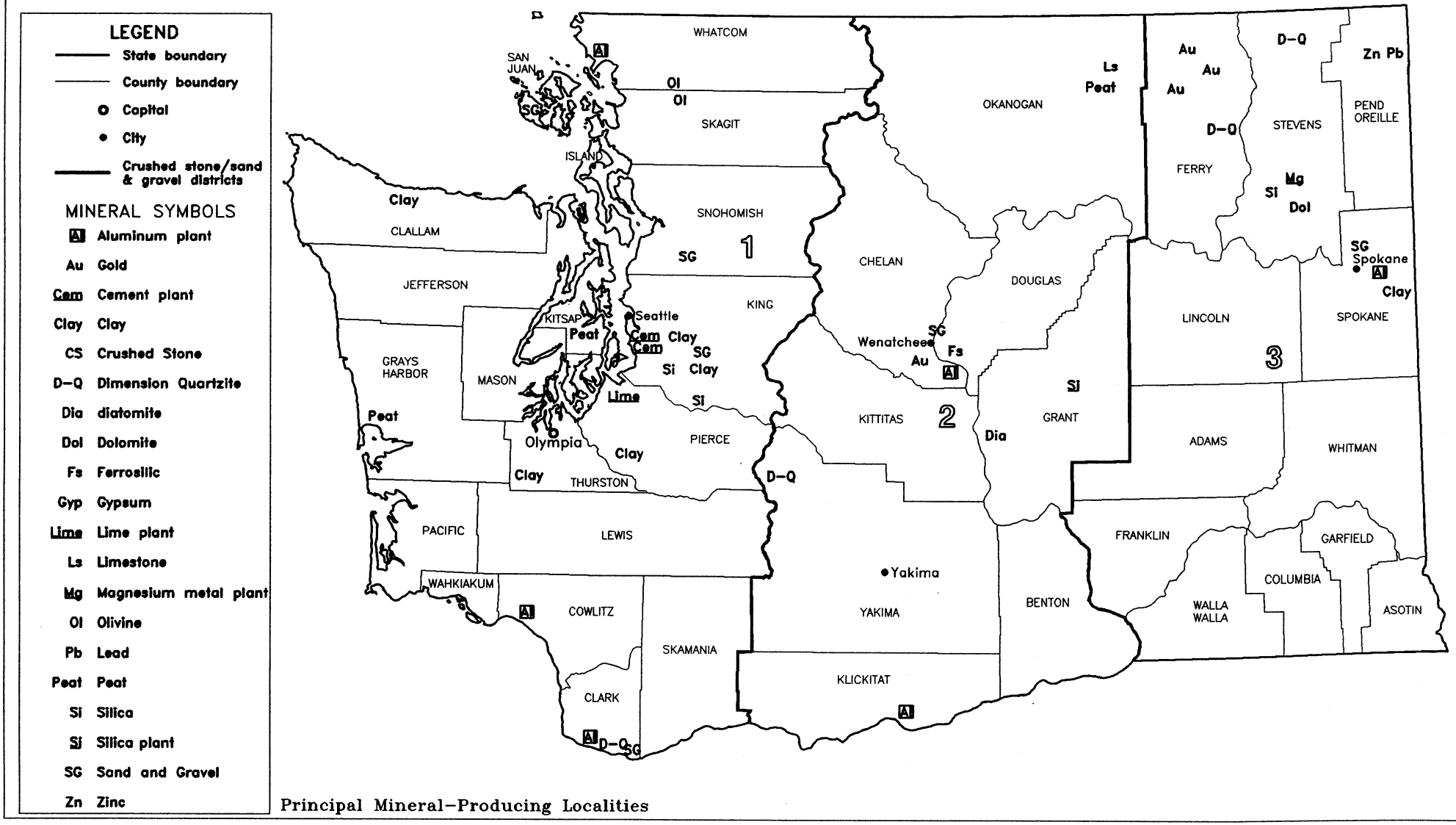
[1]State Mineral Officer, U.S. Bureau of Mines, Spokane, WA. He has 18 years of mineral-related experience in industry and government and has covered the mineral activities in Washington since 1989. Assistance in preparation of the chapter was given by W. A. Lyons, editorial assistant.

[2]Geologist, Metals, Washington Division of Geology and Earth Resources, Spokane, WA.

[3]Geologist, Industrial Minerals, Washington Division of Geology and Earth Resources, Spokane, WA.

WASHINGTON



Principal Mineral–Producing Localities

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Aluminum:			
Aluminum Co. of America	Box 221 Wenatchee, WA 98801	Plant	Chelan.
Columbia Aluminum Co.	Star Route 667, Box 46 Goldendale, WA 98620	do.	Klickitat.
Intalco Aluminum Corp.	Box 937 Ferndale, WA 98248	do.	Whatcom.
Kaiser Aluminum and Chemical Corp.	Box 6217 Spokane, WA 99207	do.	Spokane.
Do.	3400 Taylor Way Tacoma, WA 98421	do.	Pierce.
Reynolds Metals Co.	Box 999 Longview, WA 98632	do.	Cowlitz.
Vanalco Inc.	Box 120 Vancouver, WA 98660	do.	Clark.
Cement:			
Ash Grove Cement West Inc.	6720 SW Macadam Ave. Suite 300 Portland, OR 97219	do.	King.
Holnam Inc.	Box 8789 Denver, CO 80201	do.	Do.
Clays:			
Holnam Inc.	Box 8789 Denver, CO 80201	Pit	Clallam.
Mutual Materials Co.	Box 2009 Bellevue, WA 98009	Pits and plant	King, Pierce, Spokane.
Diatomite:			
Celite Corp.	Box 636 Quincy, WA 98848	Mine and plant	Grant.
Gold:			
Asamera Minerals (U.S.) Inc.	1001 Circle St. Wenatchee, WA 98801	Underground mine and mill	Chelan.
Echo Bay Minerals Co.	921 Fish Hatchery Rd. Republic, WA 99166	Surface mines and mill	Ferry.
Hecla Mining Co.	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	Underground mine and mill	Do.
Lime:			
Continental Lime Inc.	1220 Alexander Ave. Tacoma, WA 98421	Plant	Pierce.
Northwest Alloys Inc.	Box 115 Addy, WA 99101	Mine and plant	Stevens.
Magnesium metal:			
Northwest Alloys Inc.	Box 138A, Route 1 Addy, WA 99101	do.	Stevens.
Olivine:			
Applied Industrial Minerals Corp.	Box 58 Hamilton, WA 98225	do.	Skagit.
Peat:			
Asbury's Topsoil	7051 NW Newberry Hill Rd. Silverdale, WA 98383	Bog	Kitsap.
Ocean Farms and Soils	Rt. 4, Box 2324 Hoquiam, WA 98550	Bog	Grays Harbor.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Construction:			
Associated Sand & Gravel Co., a division of CSR Corp.	Box 2037 Everett, WA 98203	Pits	Skagit and Snohomish.
Central Pre-Mix Concrete Co.	Box 3366 Spokane, WA 99220	do.	Franklin.
Lakeside Industries	Box 1379 Bellevue, WA 98009	do.	King, Lewis, Snohomish, Thurston.
Lone Star Northwest Inc.	Box 1730 Seattle, WA 98111	do.	King and Pierce.
Miles Sand and Gravel Co.	Box 1637 Auburn, WA 98002	do.	Various.
Sand and gravel:			
Industrial:			
Lane Mountain Silica Co.	Box 236 Valley, WA 99181	Quarry and plant	Stevens.
Reserve Silica Inc.	Box 95 Ravensdale, WA 98051	do.	King.
Silver:			
Hecla Mining Co.	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	Underground mine and mill	Ferry.
Zinc:			
Equinox Resources Inc.	Box 32 Colville, WA 99114	Mine and mill	Stevens.

THE MINERAL INDUSTRY OF WEST VIRGINIA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the West Virginia Geological and Economic Survey for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.,[1] and Claudette M. Simard[2]

The value of nonfuel mineral production in West Virginia in 1992 was about $112 million. Demand for industrial minerals increased slightly, primarily the result of improved conditions in the construction industry.

Coal remained the dominant mineral industry affecting the State's economy. West Virginia again ranked second nationally in output, accounting for about 17% of the U.S. total. Production in 1992 decreased slightly.

TRENDS AND DEVELOPMENTS

One indication of the socioeconomic significance of coal to West Virginia is the per capita production ratio. An average of 91 short tons of coal was produced for every person in West Virginia based on a 1992 output of 165 million tons. Nationally, the average was about 4 tons per person. The West Virginia average was the highest in the United States, except for Wyoming, which led the Nation in coal production with an output of 190 million tons and had a per capita ratio of about 409:1.

However, a comparison of size, employment, and the number of mines illustrates how much more the coal industry impacts West Virginians. West Virginia is approximately one-fourth the size of Wyoming, about 24,000 coal miners or four times as many as in Wyoming are employed in the coal industry, and all of Wyoming's coal is mined at 32 operations versus 1,600 in West Virginia. Also, in West Virginia, about 600 other facilities such as preparation plants, stockpiles, loading areas, refuse disposal areas, and haulageways support these mining operations.[3]

Another trend in the State's mineral industry is the shipment of minerals out of State and, in some instances, overseas. The movement of mineral commodities in the State was detailed in a guidebook compiled by the West Virginia Geologic and Economic Survey for the 28th Forum on the Geology of Industrial Minerals. The guidebook highlighted mineral operations in the State's eastern panhandle in Berkeley, Jefferson, and Morgan Counties. This area accounted for all of the State's brickmaking capacity, industrial sand production, cement manufacture, as well as the leading quarry in output. About one-third of the State's brick production was sold to markets in the Washington, DC, area. The Washington, DC, area was also the recipient of about 75% of the limestone mined at the State's leading quarry, which had an annual production capacity of about 3 million tons. Glass sand produced in Berkeley County was shipped by rail to Baltimore with final destinations including countries in Europe and the Pacific Rim. An estimated 70% of the production went to these markets. Much of the cement produced in West Virginia was shipped by rail to terminals in Baltimore. The general market for the cement was within a 100-mile radius of the plant, which is just outside of

TABLE 1
NONFUEL MINERAL PRODUCTION IN WEST VIRGINIA[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	164,257	$384	134,262	$322	79,573	$221
Gemstones		NA	1	NA	2	NA	1
Sand and gravel (construction)	thousand short tons	r2,456	r12,040	e3,100	e14,300	1,385	5,730
Stone (crushed)	do.	e r2[2],000	e r45,200	10,255	50,505	e11,400	e57,800
Combined value of cement, lime, peat, salt, sand and gravel (industrial), stone [crushed granite (1990)], and values indicated by symbol W		XX	75,803	XX	51,802	XX	47,846
Total		XX	r33,428	XX	116,931	XX	111,598

eEstimated. rRevised. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, or marketable production (including consumption by producers).
[2]Excludes certain stones; kind and value included with "Combined value" data.

Martinsburg.

EMPLOYMENT

Similar to the nationwide trend, employment in West Virginia has shifted and continues to shift from the goods-producing to the service-producing sector. In 1992, about 141,000 workers were employed in manufacturing, construction, and mining, down from 226,000 in 1976. The 95,000 job losses in that sector have been more than offset by increased employment in services and retail trade. Those two industries have reported an increase in employment to about 280,000 workers in 1992 from 172,000 in 1976.

In 1992, mining employment in West Virginia declined to 31,000 from 33,000 a year earlier. About 84% of the jobs was in coal mining, 13% in the oil and gas industry, and 3% in nonfuel minerals, according to the West Virginia Bureau of Employment Programs.

LEGISLATION AND GOVERNMENT PROGRAMS

The West Virginia Legislature in 1992 enacted Senate bill 362, the Abandoned Mine Lands and Reclamation Act. This legislation provided additional funding for reclamation work and increased from 15% to 30% the amount of Federal funding under certain provisions to be used at facilities such as water-treatment plants and water suppliers affected by surface coal mining.

The legislature also enacted House bill 4643, the Air Pollution Control Act. This act was designed to bring the State into compliance with previously enacted amendments to the Federal Clean Air Act.

On March 13, 1992, the West Virginia Department of Environmental Protection (WVDEP) and the U.S. Office of Surface Mining (OSM) signed an Implementation Plan outlining the concepts for rebuilding and improving the State's surface coal mining regulatory program. The Implementation Plan called for nearly doubling the regulatory program staff and provided a guide for the development of procedures and the organizational structure necessary for attaining those goals. According to the State, the staffing level for the regulatory program increased to 251 workers. About 28% of the State's coal production was mined at the surface.

The U.S. Bureau of Mines (USBM) abandoned mined land reclamation program focused on environmental problems associated with abandoned coal mines. In Logan County, the USBM, in cooperation with the WVDEP, demonstrated the use of foam concrete as a low-cost material for sealing an abandoned coal mine opening. The completed mine seal was estimated to have a service life in excess of 100 years.

The USBM, through its Intermountain Field Operations Center in Denver, continued studies on coal recoverability and costs. Initial assessments from studies of four quadrangles in southern West Virginia, Kentucky, and Virginia showed that only about 30% of the original coal resources are recoverable under existing regulations and technology. These studies also have indicated that economically recoverable coal resources in some regions are in the range of 15% or less for coal at a price of $25 per short ton. This work is being done in cooperation with the State Geological Surveys in West Virginia, Kentucky, and Virginia, as well as the U.S. Geological Survey.

Also in 1992, the National Technology Transfer Center (NTTC) began operations in Wheeling. The NTTC was created to provide U.S. businesses and industry with access to research and technology developed by the Federal Government. The center utilizes a computerized data base system to provide information on government research nationwide.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Excluding coal and crushed stone, the mineral industry in West Virginia reporting production to the USBM consisted of 16 operations. Generally, these operations have been in existence for decades and are likely to continue production through resource depletion.

The State's lime and limestone industries appeared to be in the best position to expand during the 1990's. Environmental applications for limestone products have increased and were expected to continue to increase as amendments to the Clean Air Act of 1990 that require reduction in sulfur-dioxide emissions take effect in 1995 and 2000.

Clays and Shale.—Production in 1992 remained about the same as that of 1991. Three companies, of which two were in Berkeley County and one in Lincoln County, accounted for all of the output. The clay and shale produced at these operations was used to manufacture bricks, in cementmaking, and as stemming for coal mine explosives.

Lime.—In 1992, lime production in West Virginia increased by about 22% over that of the previous year. Germany Valley Limestone Co., Pendleton County, was the State's only producer.

Consumption of lime and limestone was expected to increase in West Virginia because of an expanding market for these commodities in environmental applications. Construction of a $726 million sulfur dioxide scrubber system at a powerplant in Shinnston by Allegheny Power Systems Inc. continued during the year. The plant, scheduled to be completed in 1995, was expected to require approximately 500,000 tons of lime per year to remove sulfur during coal burning at the powerplant.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the USBM for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

In 1992, seven companies operating seven pits and one dredge produced about 1.4 million short tons of sand and gravel.

TABLE 2
WEST VIRGINIA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	834	$3,543	$4.25
Plaster and gunite sands	W	W	7.42
Road base and coverings	472	1,873	3.97
Fill	W	W	2.51
Snow and ice control	W	W	6.20
Other miscellaneous uses	75	279	3.72
Unspecified:[1]			
Actual	4	35	8.75
Total	1,385	5,730	4.14
Total[2 3]	1,256	5,730	4.56

W Withheld to avoid disclosing company proprietary data; included in "Other miscellaneous uses."
[1]Includes production reported without a breakdown by end use.
[2]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[3]Total quantity and total value in thousand metric tons and thousand dollars.

Most of the State's output was concentrated in three counties—Hancock, Mason, and Wetzel. Sand and gravel pits in Mason County that operated as E.T.&S. Inc. and Jesco Corp. in 1991 were renamed The Letart Corp.

Stone (Crushed).—Stone production is surveyed by the USBM for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed stone was again the leading nonfuel mineral commodity produced in West Virginia, accounting for about 52% of the State's nonfuel mineral value.

In 1990, because of the continuing growth and development in the Baltimore and Washington areas, Francis O. Day Co. Inc. proposed developing a quarry on a 310-acre site in Kearneysville, Jefferson County. In December 1991, the WVDEP denied the company permission to open the quarry. Francis O. Day Co. Inc. appealed that decision to the State Reclamation Board of Review, which ruled by a 3-to-2 vote to overturn the WVDEP's denial of the permit. However, in December, the West Virginia Supreme Court ruled that the seven-member Reclamation Board was one vote short of the four required to overrule the WVDEP decision and returned the case to Kanawha Circuit Court.

Metals

Primary and fabricated metals industries in West Virginia provided employment for about 19,200 workers in 1992 or about 23% of the State's manufacturing employment, according to the West Virginia Bureau of Employment Programs.

Metals discussed in this section were processed from materials received from both foreign and domestic sources; no metals were mined in West Virginia in 1992. Production and value data for these commodities, which are not included in table 1, are given, if available.

Aluminum.—Ratification of a 3-year labor contract on June 29 ended a 20-month dispute at the State's sole producer of primary aluminum. During the dispute, the company hired replacement workers to operate the State's only primary aluminum smelter. With the settlement, a total of 1,700 union workers regained their jobs. It was expected that this dispute could prompt demands by organized labor for Federal legislation banning the employment of replacement workers.

Later in the year, Ravenswood Aluminum Corp. increased its plant output rate by about 20,000 metric tons to 165,000 tons per year.[4]

Iron and Steel.—Weirton Steel Corp., West Virginia's leading steel producer, reported an 8.4% increase in steel shipments, to about 2.1 million short tons, in 1992. The increase resulted primarily from improved demand for coated steel sheet products, in particular, galvanized products.

Weirton continued a research and development project aimed at expanding the market for tin mill products such as beverage containers. The project is a joint effort of Weirton, La Fer Blanc (Sollac Div.) of Usinor Sacilor in France and Nippon Steel Corp. of Japan. Development of a lighter weight, higher tensile strength steel can is sought in an effort to be more competitive with aluminum.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 19 years of mineral-related industry and government experience and has covered the mineral activities in West Virginia for 7 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Economic geologist, West Virginia Geological and Economic Survey, Morgantown, WV.

[3]Office of Surface Mining Reclamation and Enforcement, Charleston Field Office. 1992 West Virginia Annual Evaluation Report, July 1992, p. 4.

[4]American Metal Market. Ravenswood Throttles Up. V. 100, No. 183, Sept. 21, 1992, p. 1.

WEST VIRGINIA

Principal Mineral–Producing Localities

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Capitol Cement Corp.[1]	Box 885 Martinsburg, WV 25401	Quarry and plant	Berkeley.
Clays:			
Continental Brick Co.	1441 Charles Town Rd. Martinsburg, WV 25401	Pit and plant	Do.
Sanders Dummy Co.	Box 146 Midkiff, WV 25540	Pit	Lincoln.
Lime:			
Germany Valley Limestone Co.	Box 302 Riverton, WV 26814	Quarry and plant	Pendleton.
Peat:			
Thompson Enterprises	Route 1, Box 133 Davis, WV 26260	Bog	Tucker.
Salt:			
PPG Industries Inc.	Box 191 New Martinsville, WV 26155	Brine wells and plant	Marshall.
Sand and gravel:			
Construction:			
Dravo Natural Resources Co.	5253 Wooster Rd. Cincinnati, OH 45226	Dredge	Wetzel.
Letart Corp.	Box 430 Gallipolis Ferry, WV 25515	Pits	Mason.
Lafarge Corp.	Drawer A Newell, WV 26050	Pit and plant	Hancock.
Industrial:			
U.S. Silica Co.	Box 187 Berkeley Springs, WV 25411	Quarry and plant	Morgan.
Steel:			
Weirton Steel Corp.	400 Three Springs Dr. Weirton, WV 26062-4989	Plant	Hancock.
Stone:			
J. F. Allen Co.	Box 49 Clarksburg, WV 26302	Quarry	Randolph.
Beckley Stone Co.	Box 1284 Beckley, WV 25801	Quarries	Raleigh.
Evered Bardon USA Inc. (Millville Quarry Inc.)	Box 166 Millville, WV 25432	do.	Jefferson.
Fairfax Sand & Crushed Stone Inc.[2] (Laurel Sand & Gravel Inc.)	Box 719 Laurel, MD 20705	do.	Grant, Mineral, Tucker.
Greer Limestone Co.	Box 844 Morgantown, WV 26505	do.	Monongalia.
Pounding Mill Quarry Corp. (Mercer Crushed Stone Inc.)	Box 5368 Princeton, WV 24740	Quarry	Mercer.

[1]Also clays and crushed stone.
[2]Also sand and gravel.

THE MINERAL INDUSTRY OF WISCONSIN

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Wisconsin Geological and Natural History Survey for collecting information on all nonfuel minerals.

By Robert H. Wood II[1] and Thomas J. Evans[2]

Wisconsin ranked 37th nationally in value of nonfuel mineral production and contributed about 0.7% of the U.S. total. The State's total mineral production was valued at more than $222 million, a 3% increase over the previous year's record value. Total value increases were reported for three of the State's four principal mineral commodities. Only the value of construction sand and gravel showed a slight decrease from data estimated for 1991; however, the value of construction sand and gravel produced in 1992 increased 5% over actual data collected in 1990. Total value decreases also were reported for dimension stone, gemstones, and recovered sulfur.

In order of value, crushed stone, construction sand and gravel, lime, and industrial sand and gravel continued to be the State's leading mineral commodities. Crushed stone accounted for more than 40% of the State's total mineral value. Construction sand and gravel accounted for about 35% of the State's total mineral value.

TRENDS AND DEVELOPMENTS

Mineral industry activities in Wisconsin during the year were characterized by record nonfuel mineral production, resumption of Flambeau Mine construction, decreased metallic mineral leasing activity, new legislation affecting metallic minerals and oil and gas, northern Wisconsin oil and gas exploration, and the resolution of several legal issues affecting the Flambeau Mine and Crandon project.

In May, construction resumed at the Flambeau Mining Co's. (a wholly owned subsidiary of Kennecott Corp.) copper, gold, and silver mine near Ladysmith, Rusk County. The company had been granted a permit to mine in January 1991 and started construction in May 1991. In August 1991, a Dane County judge stopped mining activities until 30 days after the release of a Supplemental Environmental Impact Statement (SEIS) addressing the affects of mining on endangered species found near the mine site. Production is anticipated in May 1993. As a result of the SEIS, more stringent wastewater restrictions were required.

Expected to be mined over a 6-year period, the Flambeau Mine will be the

TABLE 1
NONFUEL MINERAL PRODUCTION IN WISCONSIN[1]

Mineral		1990		1991		1992	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	W	NA	$542	NA	$5
Lime	thousand short tons	461	$24,608	536	23,225	521	26,579
Peat	do.	12	256	9	227	62	553
Sand and gravel:							
Construction	do.	r,e29,553	r73,676	e29,600	e77,500	29,118	77,066
Industrial	do.	W	W	W	W	1,374	24,639
Stone:							
Crushed	do.	e26,600	e91,000	2,e23,676	2,e80,475	e,2 25,500	e,2 89,300
Dimension	short tons	2,r,e57,525	2,r,e7,191	r,2 60,890	r,2 6,221	e36,166	e4,227
Combined value of other industrial minerals and values indicated by symbol W		XX	r18,727	XX	r27,534	XX	(3)
Total		XX	r215,458	XX	r215,724	XX	4222,369

eEstimated. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes certain stones; value included with "Combined value" figure.

[3]Value excluded to avoid disclosing company proprietary data.

[4]Partial total, excludes values that must be concealed to avoid disclosing company proprietary data.

first metal mining operation to operate in the State since 1982, and the first to initiate production since the mid-1970's. The massive sulfide deposit, to be developed in a 13-hectare (32-acre) open pit mine, was reported to contain approximately 1.7 million metric tons (1.9 million short tons) of ore, grading about 10.5% copper, 59 grams of silver per metric ton (2.1 troy ounces per short ton), and 2.82 grams of gold per metric ton (0.1 troy ounce per short ton).

Noranda Exploration Inc. filed a Notification of Intent (the first step toward obtaining a mining permit in Wisconsin) for its Lynne project in Oneida County west of Rhinelander. Noranda's proposed 152-meter-deep (500-foot-deep) open pit mine would include an area up to 32 hectares (80 acres). The 5.3-million-metric-ton (5.8-million-short-ton) massive sulfide deposit averages 8.94% zinc, 1.66% lead, 65 grams of silver per metric ton (2.3 troy ounces per ton), 0.42% copper, and 0.56 gram of gold per metric ton (0.02 troy ounce per ton).[3] In August, Noranda announced it was reevaluating the economics of its Lynne deposit because the economics were being affected by the prolonged permitting process and regulatory concerns regarding the extent of lake beds and wetlands in the area. Later in the year, Noranda suspended all environmental baseline studies on the Lynne project owing to the controversy over the legal definition of a lake or stream in Wisconsin. Several small lakes and streams were identified on the site. Noranda indicated it intends to continue its 10-year lease with the county.

Exxon Coal & Minerals Co. and Phelps Dodge Mining Co. agreed to conduct a joint evaluation of the Crandon deposit. The Crandon deposit is a 61-million-metric-ton (67-million-short-ton) zinc-copper massive sulfide ore body south of Crandon in Forest County. Despite determining that mining the Crandon ore body was environmentally and financially feasible, Phelps Dodge has dropped any continuing interest in the property. Exxon was seeking a new partner at yearend.

Jump River Joint Venture's Bend project in Taylor County received little attention during the year. Seven drill holes were completed, and additional financial participation was sought. The 3.3-million-metric-ton (3.6-million-short-ton) copper-gold massive sulfide deposit is in the Chequamegon National Forest.

EMPLOYMENT

As reported by the Wisconsin Department of Industry, Labor and Human Relations, the State's civilian labor force averaged 2.7 million, an increase of about 2.6% over the 1991 level. The State's unemployment rate decreased from 5.4% to 5.1%. Wisconsin's mining industry employed an average of 2,280 workers during the year, an increase of about 5% compared with the 1991 work force. The average annual wage for all mine workers increased about 8% to $32,711 over that of the previous year.

According to 1992 statistics released by the U.S. Department of Labor, no fatalities, 108 injuries resulting in lost workdays, and 59 injuries with no workdays lost were reported during the 3.1 million employee-hours worked at surface mining operations in the State. Eight employees at underground mines worked a collective total of 21,475 hours with three injuries resulting in lost workdays. At mills and preparation plants associated with mining operations, an additional 36 injuries occurred to workers resulting in lost workdays and 35 injuries occurred with no lost workdays. A total of 940,738 employee-hours were worked at mills and plants during the year.

Mining activities at the Flambeau Mining Co's. mine currently under development near Ladysmith accounted for up to about 185 employees during the peak of the construction phase. Upon completion of the construction phase next year, when the mine comes on-stream, Flambeau's operational work force is expected to be between 65 and 70 workers.

ENVIRONMENTAL ISSUES

Mining companies continued having conflicts with environmental and Native American groups over metallic mineral mining in Wisconsin. Site preparation for the Flambeau Mine was allowed to resume after release of an SEIS that addressed impacts of mining on endangered species identified in the area. Noranda stopped environmental baseline studies on the Lynne project owing to controversy over legal definitions of lakebeds, lakes, and streams identified on the site. Exxon Corp. won a legal decision on treaty-related rights within the Crandon ore body.

A Native American group attempted legal intervention to stop Terra Energy, Ltd. from drilling an exploratory hole for oil and gas in Bayfield County. Terra Energy was permitted to continue exploratory drilling during the court proceedings and completed drilling before the court issued a decision.

Governor Thompson approved funding for the consolidation and capping of roaster (toxic) and flotation (nontoxic) tailings piles south of Mineral Point in Iowa County. The toxic waste piles were generated between 1840 and 1930 from zinc roaster operations.

The Private Water Section of the Wisconsin Department of Natural Resources (DNR) initiated a program to eliminate hazards of open and caved mine shafts, vents, and drill holes. The mine workings, some dating back to the late 1800's, were associated with lead and zinc mining in the State.

Two gravel pits in New Berlin (Waukesha County) were listed as potential Superfund sites. The Bodus Gravel Pit and the abandoned Jaeger Sand and Gravel Pit will undergo extensive water testing in 1993. Mercury contamination was feared in the Bodus Gravel Pit.

EXPLORATION ACTIVITIES

Exploration activity in the northern part of the State has been intense over the past several years as massive sulfide

deposits containing copper, gold, lead, silver, and zinc had been discovered. Exploratory drilling for metallic minerals in Wisconsin decreased 81% from last year's alltime record high of 128 completed drill holes. Of the 24 holes drilled in 1992, 7 were considered as development drilling designed to establish the quantity of ore for Jump River Joint Venture's Bend project. Phelps Dodge Exploration East Inc. drilled in Lincoln County near Harrison and Pine River, and south of Merrill in Marathon County. E.K. Lehman & Associates conducted mineral exploration north of Prentice in Price County, near Enterprise in Oneida County, at the Bend project in the Chequamegon National Forest in Taylor County, and at the Horseshoe project west of Tomahawk in Lincoln County. Cominco American conducted mineral exploration north of Mercer in Iron County. BHP Minerals International exploration efforts centered in the Marinette County area south of Goodman. Noranda Exploration Inc. explored areas in the vicinity of its Lynne deposit in Oneida and Price Counties, southwest of Florence in Florence County, and south of Phelps in Vilas County. In September, Noranda announced it will halt mineral exploration efforts in Wisconsin and focus its exploration activities in States that encourage mineral development.

Total footage drilled in 1992 decreased 76% from 1991's record-high level. Of the 6,884 meters (22,585 feet) drilled in 1992, 305 meters (1,000 feet) was drilled in Forest County, 743 meters (2,438 feet) in Iron County, 1,293 meters (4,242 feet) in Lincoln County, 123 meters (403 feet) in Marinette County, 252 meters (827 feet) in Oneida County, 814 meters (2,670 feet) in Price County, and 3,354 meters (11,005 feet) in Taylor County.[4]

The total number of new acres (55,605) leased for metallic mineral exploration was at near-record levels in 1992. However, the large amount of newly leased acreage did not reflect a widespread interest in new areas of the State for mineral exploration. A single transaction, by M & W Minerals Co. for 16,865 hectares (41,675 acres) in Forest County, accounted for about 75% of new acreage leased; existing leases on about 12,000 hectares (30,000 acres) were terminated. Six other companies active in leasing metallic mineral in 1992 included BHP-Utah International Inc., 523 hectares (1,293 acres); Cominco American Resources, 1,878 hectares (4,640 acres); E. K. Lehmann & Associates of Wisconsin Inc., 176 hectares (436 acres); Jump River Joint Venture, 97 hectares (240 acres); Noranda Exploration Inc., 3,128 hectares (7,730 acres); and Phelps Dodge Exploration East, 77 hectares (190 acres). Leasing occurred in 10 northern Wisconsin counties: Clark, Forest, Iron, Langlade, Lincoln, Marathon, Marinette, Price, Rusk, and Taylor.[5]

Oil and gas leasing occurred in three counties: Bayfield, Door, and Kewaunee. Terra Energy Ltd. was unsuccessful in drilling for oil and gas west of Ashland in Bayfield County. The drill hole was completed to a depth of 1,433 meters (4,700 feet) in the Copper Harbor Conglomerate in March.

LEGISLATION AND GOVERNMENT PROGRAMS

Environmental concerns over the current high level of mineral exploration activity and potential mineral development led to the passage of three bills dealing with metallic mineral regulation and oil and gas production. The new legislation will affect the mineral industry and future oil and gas industry. Act 259 (Assembly bill 661) requires mining companies to pay up to $150,000, through the State Mining Impact Board, to cover costs associated with negotiation of local agreements between eligible communities and mining companies. Act 260 (Senate bill 240) prohibits companies guilty of environmental violations in other States from obtaining a permit to mine in Wisconsin. Act 262 (Assembly bill 701) gave the Department of Natural Resources (DNR) authority to regulate oil and gas exploration and production.

Work continued on the new Wisconsin Information Center in Hurley near the intersection of U.S. 2 and Highway 51. Emphasis at the center is on the mining heritage of the area. Displays will include a life-size statue of an early miner, 5.5-foot-diameter drill core from the Care Mine, photographs, and assorted memorabilia from area iron mines.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Lime.—Lime produced in Wisconsin accounted for about 12% of the State's mineral value in 1992. Wisconsin ranked 12th among the 32 States with reported lime production. Lime produced in Wisconsin decreased 3% in output and increased 14% in attendant value in 1992. Quicklime and hydrated lime were produced by Western Lime & Cement Co. at plants in Brown and Fond du Lac Counties, by CLM Corp. in Douglas County, and by Rockwell Lime Co. in Manitowoc County.

Installation of a second preheater rotary kiln was in progress during the year at Western Lime & Cement Co.'s Green Bay facility. Installation is expected to be completed in 1993.

Peat.—Peat production increased nearly 590% in quantity and 145% in value compared with data reported in 1991. Peat sales and production were affected by end-of-year stock changes; increased sales of packaged peat, which commanded a much higher price; and increased sales of peat varieties that command lower prices (sphagnum commanded the highest price). Three companies (Certified Peat & Sod Inc., Liphatech Inc., and Zellner Enterprises Inc.) reported peat production from bogs in Kewaunee and Waukesha Counties. Bogda's Top Soil & Excavating Co. did not report peat production during the year. Sphagnum was the dominant type of peat harvested in Waukesha County. Hypnum peat was produced in Kewaunee County. Peat was mainly used for soil improvement and as a seed inoculant. Most of the State's peat production was sold as a packaged product.

TABLE 2

WISCONSIN: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	6,406	$21,505	$3.36
Plaster and gunite sands	49	251	5.12
Concrete products (blocks, brick, pipe, decorative, etc.)	253	962	3.80
Asphaltic concrete aggregates and other bituminous mixtures	2,111	5,567	2.64
Road base and coverings[1]	8,393	19,541	2.33
Fill	1,987	2,929	1.47
Snow and ice control	202	519	2.57
Railroad ballast	W	W	1.85
Other miscellaneous uses[2]	69	161	2.33
Unspecified:[3]			
Actual	6,993	19,005	2.72
Estimated	2,653	6,627	2.50
Total[4]	29,118	77,066	2.65
Total[5 6]	26,415	77,066	2.92

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement and lime).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.
[5]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[6]Total quantity and total value in thousand metric tons and thousand dollars.

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Construction sand and gravel was Wisconsin's second leading mineral commodity produced in 1992. The material accounted for about 35% of the State's mineral value. Both output and value decreased about 1% from the record-high production estimated in 1991. Average unit value of the State's construction sand and gravel mined in 1992 increased $0.03 per short ton, to $2.65 per short ton during the year. Construction sand and gravel was produced by 232 operators from 358 pits in 60 of the State's 72 counties.

Lembezeder Sand and Gravel of Hartland, WI, was purchased by Cretex Sand and Gravel, a subsidiary of the Cretex Co. of Elk River, MN. The portable crushing equipment acquired will be used to provide custom-crushing services for customers in eastern Wisconsin and northern Illinois.

Permits were approved for construction sand and gravel operations in Chippewa, Door, Green Lake, Kenosha, Portage, Sheboygan, and Waukesha Counties. Permits were denied in Racine, Sawyer, and Walworth Counties.

Industrial.—Nationally, Wisconsin ranked eighth in output and sixth in attendant value among the 38 States with reported industrial sand and gravel production in 1992. Industrial sand production accounted for more than 11% of the State's mineral value during the year. Wisconsin's reported industrial sand production increased slightly over the 10-year low established last year. Four companies, with operations in Columbia, Green Lake, Jackson, and Waupaca Counties, reported industrial sand production in 1992. Foundry moldings continued as the largest use of industrial sand produced in the State, followed by uses in hydraulic fracturing and for the manufacture of glass containers.

Construction of a 4-kilometer (2.5-mile) rail spur between the Badger Mining Corp.'s (BMC) production facility and the Green Bay and Western Rail Line in the village of Taylor was dedicated in October. The $2 million project was a joint venture between Green Bay and Western, the Wisconsin Department of Transportation, Jackson County, and BMC. The new rail spur, which will improve BMC's shipping capability and reduce shipping costs, was expected to create 12 additional jobs and save the 83 existing jobs at BMC. Sands produced were from the Jordan Sandstone at BMC's Taylor facility and were used for oil and gas well stimulation, as foundry molds, as abrasives, as filtration media, and for other specialty sand markets. Reserves on BMC's site are expected to supply the industrial sand market for the next 70 years.[6]

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimates for 1990 and 1992 and actual data for 1991.

Crushed.—Crushed stone production accounted for more than 40% of Wisconsin's mineral value in 1992. Estimated crushed stone production (excluding certain stones such as traprock to avoid disclosing company proprietary data) increased about 8% in output and 11% in value over data collected in 1991. In 1991, crushed stone production was reported by 85 companies from about 180 quarries. Estimates for 1992 were calculated using data obtained from nine companies that represented about 45% coverage. Crushed stone produced in Wisconsin included dolomite, granite, limestone, sandstone, and traprock.

TABLE 3

WISCONSIN:[1] CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	721	2,297	3,616	11,576	704	1,850	250	1,412
Plaster and gunite sands	11	62	W	W	—	—	W	W
Concrete products (blocks, brick, etc.)	65	262	70	371	73	144	—	—
Asphaltic concrete aggregates and other bituminous mixtures	271	741	501	1,363	576	1,174	W	W
Road base and coverings[2]	862	2,182	3,351	8,780	1,519	2,917	377	1,183
Fill	357	641	1,200	1,611	116	180	151	162
Snow and ice control	36	93	71	240	26	63	—	—
Railroad ballast	—	—	—	—	—	—	—	—
Other miscellaneous uses[3]	—	—	76	278	—	—	84	172
Unspecified:[4]								
Actual	1,486	4,413	3,969	10,661	368	875	372	744
Estimated	81	175	481	1,401	477	1,024	222	530
Total[5]	3,889	10,865	13,335	36,281	3,860	8,227	1,456	4,203
Total[6 7]	3,528	10,865	12,097	36,281	3,502	8,227	1,321	4,203

	District 5		District 6		District 7		District 8	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	236	1,114	612	2,453	20	54	247	748
Plaster and gunite sands	—	—	W	W	—	—	—	—
Concrete products (blocks, brick, etc.)	—	—	W	W	W	W	2	6
Asphaltic concrete aggregates and other bituminous mixtures	—	—	W	W	180	405	136	800
Road base and coverings[2]	—	—	802	1,802	455	929	948	1,606
Fill	6	6	76	219	W	W	(8)	(8)
Snow and ice control	30	45	W	15	18	47	(8)	16
Railroad ballast	—	—	—	—	—	—	(8)	(8)
Other miscellaneous uses[3]	—	—	152	350	51	109	5	13
Unspecified:[4]								
Actual	—	—	5	20	41	132	—	—
Estimated	—	—	642	1,747	467	1,008	283	743
Total[5]	272	1,165	2,290	6,606	1,232	2,682	1,705	4,046
Total[6 7]	247	1,165	2,077	6,606	1,118	2,682	1,547	4,046

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Excludes 1,079,176 short tons valued at $2,991,579, not reported by county.
[2]Includes road and other stabilization (cement and lime).
[3]Includes filtration.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value in thousand metric tons and thousand dollars.
[8]Withheld to avoid disclosing company proprietary data; included with "Total."

Owing to much local opposition, three quarry expansion requests and two new quarries were denied. Quarry expansion was approved for two companies, and a new quarry site was approved for one company. Daanen and Janssen's request was approved for a 58-acre quarry expansion by the town of Glenmore, Brown County. Halquist Stone Co. was given permission by the Lisben Town Board to expand its quarry operation onto 80 acres that borders the town of Pewaukee in Waukesha County. Payne and Dolan was approved for a 185-acre quarry operation by the town of Saukville in Ozaukee County. A lawsuit was filed late in the year by Saukville residents opposed to the proposed quarry.

Dimension.—Estimated dimension stone production in Wisconsin decreased 41% in output and 32% in value from data collected in 1991. In 1991, 9 companies reported dimension stone production from 12 quarries in 7 counties. Granite, limestone, and dolomite were the principal types of dimension stone quarried in the State.

Valders Stone & Marble was acquired by Mankato-Kasota Stone Inc. of Mankato, MN, after the former owners filed for bankruptcy. The acquisition included a quarry and stone finishing facilities. Mankato plans no major changes other than possible equipment purchases. The company hopes to boost the work force and financial health of the operation.

Other Industrial Minerals.—Raw materials for producing expanded perlite, exfoliated vermiculite, iron oxide pigments, and sulfur produced in Wisconsin were obtained from out-of-State sources. Perlite was expanded by Midwest Perlite Co. at its plant in Outagamie County and was used as concrete aggregate, in acoustic tile, as fillers, for cavity fill insulation, and for horticultural purposes. Vermiculite was exfoliated by Koos Inc. at its Kenosha plant. The exfoliated material, which increased significantly in quantity and value compared with 1991 figures, was used for concrete and plaster aggregates, insulation, horticultural purposes, and numerous other uses. DCS Color & Supply Co. Inc. of Milwaukee processed black magnetite, red iron oxide, and burnt red sienna varieties of iron oxide pigments. Murphy Oil USA Inc. continued to recover sulfur at the company refinery in Superior, Douglas County.

Reported gemstone production in Wisconsin continued to be erratic. American Shell Co. of Hermitage, TN, and U.S. Shell Co. of Hollywood, AL, reported freshwater pearl production, and a private citizen reported gem and specimen beryl production. No precise value is known for gem material that rock hounds, mineral collectors, and other hobbyists collected. Lapidary materials found in the State include quartzite, granite, chalcedony, catlinite, moonstone, and Lake Superior agates in addition to a variety of mineral and fossil specimens. Diamonds have been found in the glacial deposits of northern Wisconsin.

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[1]State Mineral Officer, U.S. Bureau of Mines, Denver, CO. He has 16 years of mineral-related work with the government.

[2]Associate professor, Mineral Information, Wisconsin Geological and Natural History Survey, Madison, WI.

[3]Evans, T. J. Selected Developments in Wisconsin's Mineral Industry in 1992. Wisconsin Geol. and Nat. Hist. Surv. Educational Series 34, 1992, 8 pp.

[4]Work cited in footnote 3.

[5]Work cited in footnote 3.

[6]Skillings Mining Review. Wisc. Rail Spur Will Boost Area Economy, Efficiency. Sept. 5, 1992, p. 17.

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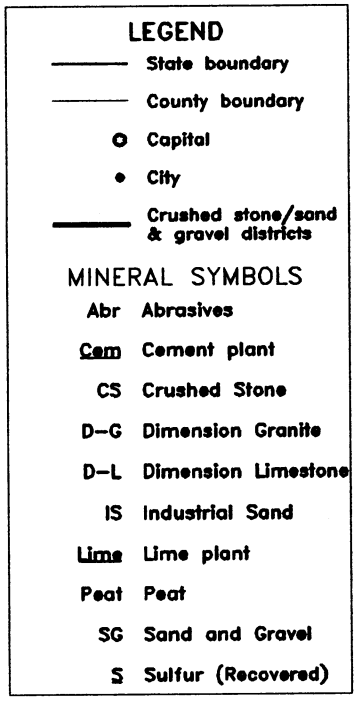

Principal Mineral–Producing Localities

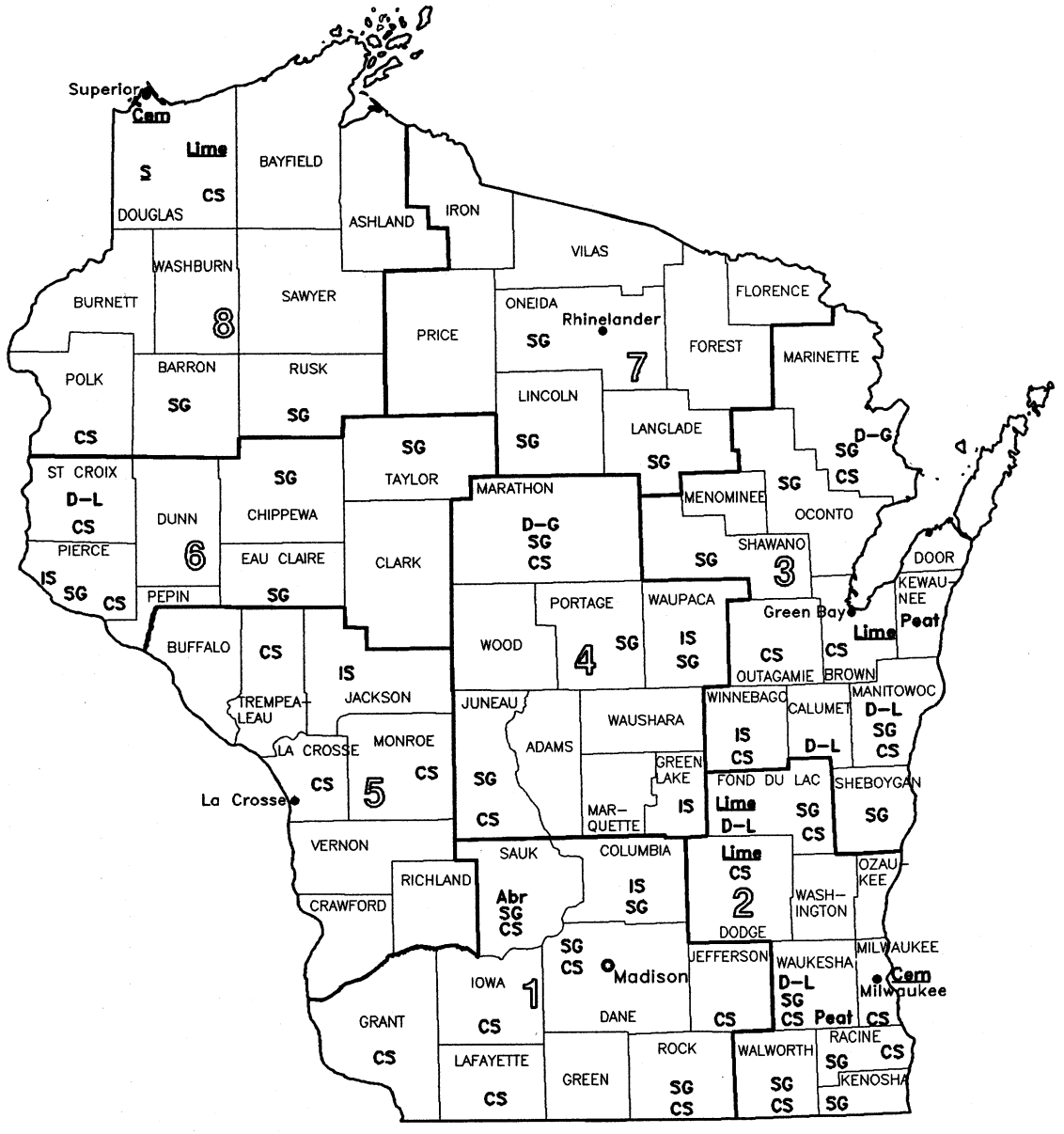

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Abrasives (natural):			
Edward Kraemer & Sons Inc.	1 Plainview Rd. Plain, WI 53577	Quarry and plant	Sauk.
Iron oxide pigments (finished):			
DCS Color & Supply Co. Inc.	2011 South Allis St. Milwaukee, WI 53207	Plant	Milwaukee.
Lime:			
CLM Corp.	Box 16807 Duluth, MN 55816	do.	Douglas.
Rockwell Lime Co.	4223 Rockwood Rd. Manitowoc, WI 54220	do.	Manitowoc.
Western Lime & Cement Co.	Box 57 West Bend, WI 53095	Plants	Brown and Fond du Lac.
Peat:			
Certified Peat & Sod Inc.	19000 W. Lincoln Ave. New Berlin, WI 53151	do.	Do.
Liphatech Inc.	3101 W. Custer Ave. Milwaukee, WI 53209	do.	Do.
Zellner Enterprises Inc.	North 8548 Highway M Algoma, WI 54201	Bog	Kewaunee.
Perlite (expanded):			
Midwest Perlite Co.	4280 Parkway Blvd. Appleton, WI 54915	Plant	Outagamie.
Sand and gravel:			
Construction:			
B. R. Amon & Sons Co.	Route 3, Box 37 Elkhorn, WI 53121	Pits and plants	Walworth.
Janesville Sand & Gravel Co., Lycon Inc.	Box 427 Janesville, WI 53545	do.	Columbia, Dane, Rock.
Lannon Stone Products Inc.	Box 314 Lannon, WI 53046	do.	Washington and Waukesha.
Mann Bros. Inc.	Box 48 Elkhorn, WI 53121	do.	Dane, Kenosha, Rock, Walworth, Waukesha.
Tews Co. Inc.	Box 67 Colgate, WI 53017	do.	Racine and Waukesha.
Johnson Sand & Gravel Inc.	N8 W 22590 Johnson Dr. Waukesha, WI 53186	do.	Waukesha.
Industrial:			
Badger Mining Corp.	Box 97 Fairwater, WI 53931	do.	Green Lake and Jackson.
Faulks Brothers Construction Inc.	East 2481 Hwys 22 and 54 Waupaca, WI 53931	Pit and plant	Waupaca.
UNIMIN Corp.	258 Elm St. New Canaan, CT 06840	do.	Columbia.
Stone:			
Crushed:			
Granite:			
Roehl Granite Inc.	220 South Hwys 107 Mosinee, WI 54445	Quarry and plant	Marathon.
Wimmer Granite & Supply Co.	1204 Starling Lane Wausau, WI 54401	Quarries and plant	Do.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone—Continued			
Crushed—Continued:			
Limestone and dolomite:			
C. C. Linck Inc.	1226 North Center St. Beaver Dam, WI 53916	Quarries and plants	Various.
Mathy Construction Co., Patterson Quarries Div.	Box 18 Onalaska, WI 54650	do.	Do.
Vulcan Materials Co., Midwest Div.	Box 6 Countryside, IL 60525	do.	Milwaukee, Racine, Waukesha, Winnebago.
Wilber Lime Products Inc.	544 East 6th St. Trempealeau, WI 54661	do.	Buffalo, Pepin, Trempealeau.
Sandstone and quartzite:			
Martin Marietta Aggregates, Central Div.	Box 30013 Raleigh, NC 27622	Quarry and plant	Sauk.
Minnesota Mining & Manufacturing Co.	3M Center St. Paul, MN 55101	do.	Marathon.
Traprock (basalt):			
Dresser Traprock Inc.	Box 517 Dresser, WI 54009	do.	Polk.
GAF Chemicals Corp.	Box 630 Pembine, WI 54156	do.	Marinette.
Dimension:			
Granite:			
Anderson Bros. & Johnson Co.	Box 26 Wausau, WI 54401	Quarries and plant	Marathon, Marinette, Wausau.
Cold Spring Granite Co.	202 South 3d Ave. Cold Spring, MN 56320	Quarry	Marathon.
Lake Wausau Granite Co.	Box 397 Wausau, WI 54401	Quarry and plant	Do.
Limestone and dolomite:			
Buechel Stone Corp.	West 3639 Highway H Chilton, WI 53014	Quarries and plant	Calumet and Fond du lac.
Fond du Lac Stone Co. Inc.	Box 148 Fond du Lac, WI 54935	Quarry and plant	Fond du Lac.
Mankato-Kasota Stone Inc.	Valders, WI 54245	Quarries and plant	Manitowoc.
R. & T. Quality Stone Inc.	Box 182 Lannon, WI 53046	do.	Waukesha.
Sulfur (recovered):			
Murphy Oil USA Inc.	Box 2066 Superior, WI 54880	Byproduct sulfur recovery plant	Douglas.
Vermiculite (exfoliated):			
Koos Inc.	4500 13th Court Kenosha, WI 53140	Plant	Kenosha.

THE MINERAL INDUSTRY OF WYOMING

This chapter has been prepared under a Memorandum of Understanding between the U.S. Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Wyoming for collecting information on all nonfuel minerals.

By Eileen K. Peterson,[1] W. D. Hausel,[2] and R. E. Harris[3]

Wyoming nonfuel mineral producers reported a 1992 value of production of $951 million, a 2% increase from that of 1991. Gains in the production value of portland cement, bentonite clay, gypsum, soda ash, and crushed stone more than offset declines in the value of common clay, gemstones, Grade-A helium, lime, and construction sand and gravel. Clays, crushed stone, Grade-A helium, sand and gravel, and soda ash continued as the leading contributors to the State's nonfuel mineral production value. No metal production was reported to the U.S. Bureau of Mines (USBM).

Nonfuel minerals production came from 19 of the State's 23 counties. Sweetwater County continued to be the leading county in terms of value, followed by Lincoln and Crook Counties.

Nationally, Wyoming ranked 10th in nonfuel mineral production value, accounting for about 3% of the U.S. total. Wyoming continued to be the Nation's leading producer of bentonite clay and soda ash, and the second largest producer of total clays and Grade-A helium.

TRENDS AND DEVELOPMENTS

According to the Wyoming Department of Commerce, Economic & Community Development Div., the minerals industry in Wyoming continued to be the single largest contributor to the economy of Wyoming. Mineral taxes are the third leading source of revenue for the State's general fund, totaling more than $700 million in 1992 although down nearly $100 million from that of 1991.

The 1992 valuation on minerals produced in 1991 represented 60% of the State's total assessed valuation, down from 71% in 1991. Production of both bentonite and trona, two major mineral resources produced in the State, increased slightly during the year. An oversupply of soda ash produced from the trona, however, dropped the unit price despite the increase in production. A recent change in methods of determining severance taxes led to most of the decrease in severance tax collections.

In 1992, bentonite producers continued efforts to diversify markets away from a dependence on oil drilling muds. Most Wyoming producers have been operating at less than one-half rated plant capacities since 1982 when oil and gas drilling declined dramatically. Successful efforts at reorientation of markets has turned the industry around in Wyoming, with most producers reporting some increase in production levels in 1992.

Construction of business and residential buildings continued to be a large consumer of construction aggregate,

TABLE 1
NONFUEL MINERAL PRODUCTION IN WYOMING[1]

Mineral		1990 Quantity	1990 Value (thousands)	1991 Quantity	1991 Value (thousands)	1992 Quantity	1992 Value (thousands)
Cement (portland)	thousand short tons	W	W	W	W	483	$30,182
Clays[2]	metric tons	2,523,573	$76,082	2,496,361	$81,573	2,534,550	83,094
Gemstones		NA	151	NA	61	NA	12
Lime	thousand short tons	W	W	37	2,729	W	W
Sand and gravel (construction)	do.	4,329	14,446	e3,500	e11,900	3,147	11,438
Stone (crushed)	do.	e2,200	e14,000	2,946	12,645	e4,500	e19,900
Combined value of cement (masonry), clay (common), gypsum (crude), helium (Grade-A), soda ash, and values indicated by symbol W		XX	806,169	XX	820,268	XX	806,131
Total		XX	910,848	XX	929,176	XX	950,757

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; kind and value included with "Combined value" figure.
[3]Less than 1/2 unit.

such as sand and gravel and crushed stone. During 1992, 958 permitted residential units were valued at more than $102 million and nonresidential units were valued at nearly $43 million for 417 newly permitted buildings.

Despite the high level of building construction, decreased spending for highway projects in Wyoming resulted in a decline in production of sand and gravel. The Wyoming Department of Transportation projected spending in both 1992, about $132 million, and 1993 would be less than that in 1991. Production of construction aggregate is expected to continue to closely reflect downward trends in highway construction funding in future years.

Recent attempts by producers to increase the size of existing operations, or start new aggregate operations, has met with stiff opposition. Despite the necessity of construction aggregate for building and maintaining roads and buildings, most people do not want to see or hear the operations they have gotten service from. Attempts to push aggregate operations away from population centers will result in increased costs to the consumer. Some environmental groups also have protested movement away from human population centers because that would disturb plant and animal populations. A compromise will be necessary between producers and opponents to continue the standard of living contributed to by ready sources of low-cost aggregate. Plans by Federal officials to raise trona royalty rates prompted soda ash producers to rally against the moves, successfully for 1992. Federal officials are still evaluating a plan to raise the trona royalty rate in 1993.

In a move to counterbalance environmental movements in Wyoming, a "Wise Use" movement was being organized in the State to advocate multiple use of public lands. Several county organizations worked with local industries in bringing political pressure to bear on public land issues. The strongest argument in the Wise Use movement's favor is the State's economy. Most of the State's traditional commodity-based industries (ranching, logging, mining, and oil production) are in a downward economic cycle, and all depend to a large degree on access to federally managed land and resources.[4] The group's ability to convince State residents that environmental movements are wrecking the State's economy will, to a large extent, determine the success of the groups in maintaining multiple land use in the State.

The Wyoming Heritage Society announced in December that it had elected 13 representatives from businesses and trade groups for its steering committee, called the Associations Partnership. The partnership will work on business concerns about the economy, with an emphasis on legislative, regulatory, and tax issues facing businesses operating in Wyoming. Mining and petroleum groups in Wyoming are among the members of the organization.

EMPLOYMENT

Wyoming Department of Employment information indicates that mining employment continued to be an important sector of the total employment in the State, accounting for about 8.5% of total nonagricultural employment. Wyoming's unemployment rate for 1992 was 5.6%, up from 5.1% in 1991.

The Department of Employment reported that Statewide, nonfuel mining employment dropped from about 4,400 in 1991 to 4,000 in 1992. Trona production and processing accounted for about 3,130 of that total, and bentonite mines and mills employed about 570, up 14 from that in 1991. Coal mines employed about 4,650 people in 1992, down slightly from that of 1991. Oil and gas extraction accounted for about 8,200 employees, down 7.1% from that in 1991. Total mining-related employment was down 5.3% in 1992 as compared to that in 1991.

From 1980 to 1990, mining employment in Wyoming fell 48.5%. In 1980 about 35,500 were employed and in 1990 about 18,300 were employed. Mining employment fell an additional 4.4% from 1990 to about 17,460 in 1992, according to Wyoming Department of Employment statistics.

Employment in the mineral dependent construction industries was down 5% from that in 1991 with a total employment of 11,300 for all construction sectors in 1992.

The Research & Planning Div. of the Wyoming Department of Employment reported average weekly earnings in mining in 1992 were about $716. Wyoming Department of Employment & Planning statistics indicated the Wyoming average weekly mining earnings in 1992 were $780 and average annual mining pay rose to $40,562 in 1992, up 4.4% from that of 1991. In Wyoming, average weekly hours worked in all mining categories was 44.6, down slightly from 45.1 in 1991. Average annual pay for all State employment sectors in 1992 was $21,216.

According to the U.S. Department of Labor, 1992 injuries reported from Wyoming nonfuel surface and underground mines totaled 62 injuries resulting in lost workdays and 51 injuries with no lost workdays during 3.4 million employee-hours worked. Coal mines reported 67 injuries with lost workdays and 72 injuries with no workdays lost during 8.1 million employee-hours worked. During the 4.7 million employee-hours worked at all surface mills and preparation plants, 73 injuries occurred to workers resulting in lost workdays and 51 injuries occurred with no workdays lost.

ENVIRONMENTAL ISSUES

Ongoing litigation between the State and Universal Equipment Co., Ohio, delayed reclamation activities at the abandoned Atlantic City iron ore mine in Fremont County for most of the year. Late in the year, the Wyoming Supreme Court upheld a lower court decision that Universal Equipment must post a $4 million reclamation bond as declared in 1991 by a Fremont County District Court judge. The court also declared that reclamation of the iron ore mine is subject to newer, more stringent reclamation standards regardless of the

fact that the mine was constructed before the laws took effect. Following the court decision, the Wyoming Department of Environmental Quality sent a "demand letter" to Universal Equipment to post the $4 million bond.

Universal Equipment purchased the mine site and buildings from U.S. Steel in 1985. Universal has been fighting an order to demolish or remove all buildings from the site, hoping to find a use or a buyer for the mill buildings.

In December it was announced that Oregon Steel, Portland, OR, had funded a study to determine if a new method of processing could be used to refine iron ore from the Atlantic City site into powdered iron carbide. Mineral rights at the site are held by J.R. Simplot of Idaho.[5]

Officials of Mountain Cement Co. were still considering a plan to burn hazardous waste as fuel at the company's Laramie cement plant. The plan was stymied last year by strong public opposition and a permit denial by the U.S. Environmental Protection Agency (EPA) on the basis that the company could not apply for a fast-track permit. Permitting under the full process could take up to 5 years. Mountain Cement's Illinois cement plant has been granted interim status that will allow hazardous waste burning at that facility. Successful operations at that plant might convince local opposition that the company can burn such wastes safely in Wyoming.

The Wyoming Department of Environmental Quality filed an unrelated complaint in Albany County District Court charging Mountain Cement with violations of numerous State air quality and waste regulations. The company denied all allegations.

The State's Governor stopped a study for a Monitored Retrievable Storage (MRS) facility in Fremont County for nuclear waste disposal. Fremont County Commissioners, hoping such a project would provide economic help to the county, had voted to proceed with the second phase of the study, designed to educate the public about the project. The Governor's primary reason for killing the study was distrust of the Federal Government, which would be in charge of the project, to keep MRS rules unchanged after the project was under way.

Chem-Nuclear Systems Inc., of Columbia, SC, dropped plans to try to locate a low-level radioactive waste site in the State. The company was one of three companies that had expressed interest in building such a facility in Wyoming. Economic reasons were cited by the company as the reason for dropping plans for a facility.

UMETCO Minerals Corp., American Nuclear, Pathfinder Mines Corp., and Western Nuclear have licensed uranium mill tailings repositories in the Gas Hills area.

A study conducted by Eastern Washington University warned cavers in Wyoming against exploring in abandoned uranium mines in the State because of the danger of high radon levels. Although caves in the northwestern part of Wyoming, in the Bighorn Basin, also contain high levels of radon, the study did not recommend closing any caves. Many of the 16 caves sampled had radon concentrations at least two orders of magnitude higher than the maximum exposure recommended by EPA for homes. Most mines with high levels of radon have been placed off limits by the Bureau of Land Management (BLM); however, plans to reclaim the mines are being delayed because of active mining claims on the sites.

The most serious problems associated with abandoned mines in Wyoming comes from uranium and bentonite mined lands; abandoned hardrock mines present a less serious reclamation challenge. From 1987 through 1992 about 541 sites were evaluated and 470 were reclaimed at a cost of about $125 million. At the end of 1992, 14 sites were still in need of reclamation work, expected to cost $42 million. The State has begun plugging exploration drill holes, most of which were in uranium mining districts.

EXPLORATION ACTIVITIES

Significant exploration activity for bentonite, construction aggregate, decorative stone, diamonds, limestone, precious metals, trona, and zeolites was reported in the State in 1992. Limited exploration was reported for common clay, leonardite, mica, peat, and silica sand.

About 1,600 mineral claims were filed in southern Wyoming during the year. Carbon and Sweetwater Counties were the focus of most of the activity. Recent publications by the Geological Survey of Wyoming (GSW), including Open-File Report (OFR) 92-5 and Mineral Report 93-1, on mineral studies in southern Wyoming were credited for much of the interest in the two counties. Some companies were looking for diamonds and precious metals on the claims filed.

Noranda Exploration Inc. obtained U.S. Forest Service approval to conduct an eight-hole exploration drilling project in the Medicine Bow National Forest, including the Bear Mountain Roadless Area. Opposition from a local environmental group had temporarily stopped the project until the Forest Supervisor upheld the decision to allow the drilling. The company was looking for copper, gold, lead, silver, and zinc.

Other areas of exploration interest by various mining companies were the Bear Lodge Mountains, Hartville Uplift, Arlington and Cooper Hill areas in the Medicine Bow Mountains, Encampment district of the Sierra Madre Mountains, the greenstone belt in the Seminoe Mountains, Rattlesnake Hills in the Granite Mountains, the South Pass region of the Wind River Range, and the Kirwin and Sunlight Basin areas of the Absaroka Mountains.

During 1992, the GSW conducted mineral exploration studies in southern Wyoming. Areas studied include the Medicine Bow Mountains, Sierra Madre Mountains, Quaking Asp Mountain area of the Green River Basin, Rattlesnake Hills area of the Granite Mountains, and the Seminoe Mountains.

LEGISLATION AND GOVERNMENT PROGRAMS

Because of interest expressed by

several companies in siting low-level radioactive waste repositories in Wyoming, the State legislature passed and the Governor signed a bill establishing a permitting process and fee structure. State environmental agency officials had sought, and received, authority to regulate facilities handling such waste in the State.

The Governor also signed rules setting stricter mine reclamation standards as recommended by the State Environmental Quality Council. The new shrub density standard for reclaimed mine land, one shrub per square meter on 20% of the land, is different than that approved by the 1991 State legislature, one shrub per square meter on 10% of most postmined land. Because the new standard is at odds with the 1991 law, industry representatives will undoubtedly challenge the new standard.

State law was cited by the State Department of Environmental Quality when it refused to pay an environmental group's legal fees from a protested decision on a mining permit. State regulations state mining companies can be forced to pay legal fees when a group successfully challenges a permit; however, State officials deliberately wrote legislation against allowing the State to pay such fees. The group in question planned to appeal the decision.

The Wyoming Supreme Court ruled there was no statute of limitations for collecting unpaid mineral taxes. The court also ruled it was legal for the State to use "bounty hunters" to find unpaid taxes. In addition to unpaid taxes, delinquent mineral companies must pay 18% interest and a 25% penalty. The ruling was handed down in a lawsuit filed in 1991 by Union Pacific Resources Co. against the Wyoming Department of Revenue and Audit and eight Wyoming counties. The decision will not affect a law adopted by the 1991 State Legislature that set a 5-year statute of limitations on mineral tax audits beginning in 1994. That time limit affects only mineral audits, not assessments.

State legislators were informed by the Legislative Service Office that the new mineral valuation methods passed by the 1990 legislature would result in less tax income to the State rather than being revenue neutral as planned. The Consensus Revenue Estimating Group forecast the 1993-94 mineral severance tax at $455 million, down from $508 million collected in 1991-92. Some of the decline resulted from expiration of capital facilities taxes on coal and trona and the rest from lower production and more deductions taken by mining companies. Because the mining industry of the State appears to be in another downward cycle, revenues to the State may decline for several more years. In 1992, the severance tax rate on oil and natural gas was 6%; coal, 8.5%; trona, 5.5%; and on other nonfossil minerals, 2%.

The GSW completed work on, and published Open-File Reports on, a silica sand deposit in Big Horn County (GSW OFR 92-3), precious metals and stones in southern Wyoming (GSW OFR 92-5), the coal reserve base of Wyoming (GSW 92-4), and mineral pigments in the State (GSW OFR 92-6). By request the GSW reprinted reports (R) on the geology and mineralization of the South Pass region (R-49), industrial minerals and construction materials of Wyoming (R-50), and gold, platinum, palladium, and silver in Wyoming (R-51).

Field investigations by the GSW continued on copper, gold, lead, molybdenum, silver, titanium, and zinc occurrences in the Encampment district of the Sierra Madre Mountains, the Medicine Bow Mountains, Quaking Asp Mountain area, Rattlesnake Hills area of the Granite Mountains, and in the Seminoe Mountains. The GSW also continued work on publicizing the availability and quality of decorative stone deposits in the State.

The U.S. Forest Service was given a 3,844-acre tract of land in Kirwin by the Richard King Mellon Foundation. The Kirwin property, which included a historic mining area and the Sunshine Ranch, were purchased by the foundation from AMAX Exploration for $1.9 million.

The BLM proposed to designate an additional 240,307 acres of Federal land in Wyoming as wilderness. Of 42 sites recently studied, the Agency called for all or part of 21 sites to receive wilderness designation. The Secretary of the U.S. Department of the Interior is expected to make a decision on the areas sometime in 1993.

Announcement by the BLM of a new $100 per claim fee on mining claims, to replace the required $100 worth of yearly assessment work, was decried by mining officials as a means of driving exploration and mining companies off Federal lands. The BLM described the change as a means of reducing nuisance mining claims and unnecessary surface disturbance performed under the guise of being assessment work. Mining representatives suggested it was merely a means of taking money out of Wyoming and sending it to Washington, DC. Some company representatives saw this move as another incentive to move out of the United States, taking tax dollars and jobs with them. The $100 fee is expected to result in a significant decrease in the number of active mining claims in Wyoming. Enforcement of the fee is expected to result in forfeiture of many mining claims. Many claimholders able to conduct the $100 of assessment work on their own time may not be able to raise the money to pay rental fees. Mining companies that have held mining claims for future exploration will drop all but the most promising claims to lower costs.

The BLM also announced plans to publish bonding regulations that affect mining operations before the end of the year. The rulemaking on new bonding requirements is intended to ensure proper reclamation on all mining operations on public lands. The proposed rule was first published by BLM in 1991.

The USBM continued work on an interagency examination of the Greater Yellowstone Area (GYA), a 11.7-million-acre area contiguous to Yellowstone National Park. Mineral examinations continued on the Shoshone and Bridger-Teton National Forests. Both forests are within the GYA study area.

An allotment grant from the USBM was received by the Mining and Mineral

Resources Research Institute at the University of Wyoming in Laramie under provisions of Public Laws 98-409 and 100-483. The purpose of the institute is to coordinate and administer training and research in mining, mineral resources, minerals development, and mineral processing.

The university also received $17.9 million in abandoned mine lands reclamation money from the Department of the Interior in 1992. More than one-half of the grant money will be used for a new geology building on the campus in Laramie. About $4.9 million of the money will buy new equipment for the geology department.[6]

Wyoming received $179 million in Federal royalties in 1992 for minerals produced on Federal lands within State borders. Royalty payments were down from the $197 million received in 1991. The money represented the State's share of bonuses, rents, and royalties collected by the U.S. Department of the Interior's Minerals Management Service (MMS), about $334 million for 1992. Approximately 48% of the land area in Wyoming is public land.

The Wyoming Department of Commerce, Economic & Community Development Div., collects and reports annually on income to Wyoming from mineral production.[7] Wyoming mineral severance tax collections in 1992 totaled $237 million; an additional $244.6 million in ad valorem taxes were collected. Sales and use taxes amounting to $23.9 million were collected on minerals production, and State rents and royalties added another $29.5 million. Total income to the State of Wyoming in 1992 from mineral production was about $707 million (including Federal returns to State).

FUELS

For the fifth consecutive year, Wyoming led the Nation in coal production and remained third in total coal reserves. In 1992, there also was production of crude oil, natural gas, methane, carbon dioxide, and uranium.

The GSW reported[8] that despite a 2.3% drop from the 1991 historic high coal production rate of 176 million metric tons, or 194 million short tons, Wyoming was again the Nation's leading coal producer with 170.6 million metric tons (189.5 million short tons) of coal, about 20% of the Nation's total production. The drop in production was the first for the State since 1986. Because of intense competition among mines for coal sales, several companies were forced to lay off and/or reorganize to cut overall costs.

According to GSW data, coal was produced in seven counties; about 86% came from Campbell County with Converse and Sweetwater Counties being the other major production centers. About 87% of the coal was shipped out-of-State to 23 States, and 1% was shipped to foreign countries, all primarily for power generation. Eight of the ten largest producing surface coal mines in the Nation are in Wyoming. Only 4 of the State's 32 coal mines are underground operations and 1 of the underground mines did not operate the entire year pending an expected decision to permanently close the mine.

Wyoming has 63 billion metric tons (69.5 billion short tons) of proven coal reserves, 24.5 billion metric tons (27 billion short tons) of which can be surface mined. About 13.6 billion metric tons (15 billion short tons) is "compliance coal," meeting the Clean Air Act mandate of 0.54 kilogram (1.2 pounds) of sulfur dioxide per million British thermal unit. At current production rates, Wyoming miners can produce "compliance coal" from surface operations for another 77 years.

According to data compiled by the GSW, about 96.8 million barrels of oil and 1,012 billion cubic feet of gas (a record high) were produced in 1992. Gas production consisted of 871.5 billion cubic feet of natural gas, 139.2 billion cubic feet of carbon dioxide, and 1.05 billion cubic feet of helium. Wyoming ranked fifth among States with natural gas production and sixth for oil production.

Production from conventional surface uranium mining operations ceased in June, ending an era that began in Wyoming in 1957. In March Pathfinder Mines, a subsidiary of French-owned COGEMA, Inc., stopped mining in the Shirley Basin area of northern Carbon County. The last barrel of yellowcake was produced in June. Pathfinder Mines produced 134,179 pounds of U_3O_8 from the Shirley Basin open pit mine before its closure in June.

The new era of uranium production in Wyoming is based on in situ recovery. Power Resources Inc.'s had some production in 1992 from an in situ operation at the Highland Mine in Converse County. Pathfinder Mines, Rio Algom Mining Corp., and Total Minerals conducted production tests at in situ properties in the area but did not go into production in 1992.

In partnership with the Green Mountain Mining Venture (GMMV), Kennecott Minerals purchased the Sweetwater uranium mill in the Red Desert area of eastern Sweetwater County from Union Oil Co. of California. The mill, Wyoming's largest in 1982, closed in 1983. The partners plan to use the mill for processing uranium from an underground uranium mine currently undergoing developmental assessment by the partnership near Green Mountain, south of Jeffrey City, Fremont County.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Cement.—Cement production at Mountain Cement Co.'s plant south of Laramie, Albany County, was close to plant capacity (about 362,880 metric tons or 400,000 short tons) for most of the year, resulting in a significant increase in production. Cement from the plant was being used in the construction of the new Denver, CO, airport as well as for several Wyoming construction projects.

Major ingredients in the cement are limestone, gypsum, and silicic shale. Iron ore is used in certain types of cement produced at the plant. Tailings from an abandoned titaniferous magnetite mine at Iron Mountain, Laramie County, have been used in the cement in the past.

Because of the titanium in the iron ore, the plant is now using mill fines from a steel plant at Pueblo, CO.

Clays.—Wyoming continued to rank first in the Nation in bentonite production with about 66% of U.S. production, and ranked second, behind Georgia, in total clay produced with slightly more than 5% of total clay production.

In 1992 more than 2.5 million metric tons (2.79 million short tons) of bentonite was produced. Both quantity and value of production rose about 1% from that reported in 1991. The average unit value of all bentonite produced was $26.98 per metric tons ($29.74 per short ton).

Bentonite was produced by five companies in seven counties. American Colloid Co. was the State's largest producer; other producers, in descending order of production, were Bentonite Corp. (a subsidiary of Tremont Corp.), Wyo-Ben Inc., Black Hills Bentonite, Baroid Drilling Fluids Inc., and M-I Drilling Fluids Inc. Most bentonite production came from Crook, Big Horn, Weston, and Johnson Counties; other counties where bentonite was mined were Hot Springs, Natrona, and Washakie.

Because of a steep decline in domestic oil well drilling in the 1980's, production of bentonite in the State fell from almost 4.5 million metric tons (5 million short tons) in 1981 to less that 1.8 million metric tons (2 million short tons) in 1986. Since 1986, bentonite production has recovered slowly with new uses for the clay taking up more of the production tonnage.

Bentonite is now finding more use in barriers to isolate wastes, in containment structures, and as cleaning and absorbing agents for industrial chemicals. In 1992 major uses of Wyoming bentonite, in descending order of consumption, were in drilling mud, foundry sand, pelletizing iron ore, pet waste absorbent, and as a waterproof sealant.

American Colloid Co.'s Lovell Plant packaged the company's revolutionary new clumping cat litter under 17 different labels. Demand from mass merchandisers and pet store outlets escalated far beyond initial estimates. Though the plant also supplied clay to taconite processors for use in iron ore pelletizing, shipments of clumping cat litter alone increased at a rate of 30% to 50% in 1991 and continued to grow in 1992. Special properties of the bentonite at the American Colloid deposit make it the country's sole source of "clumping" kitty litter.

Bentonite Corp. started construction of a $1 million processing facility at the company's Colony bentonite plant. The project is scheduled for completion in early 1993 and will provide the company with a nominal capacity of 127,008 metric tons per year (140,000 short tons per year) of composite binder products, to be used in the metal casting industry. The company did not announce any plans for reopening a facility at Lovell that was closed in 1986 (formerly operated by N.L. Baroid).[9] Tremont Corp.'s 1992 Annual Report shows both the Colony and the Lovell facilities have a capacity of 326,590 metric tons (360,000 short tons) of crushed and dried bentonite per year and have milling capacities to pulverize 272,160 metric tons (300,000 short tons) per year.

Tremont Corp.'s annual report lists domestic and international foundry markets as the company's major markets, accounting for 60% of sales in each of the past 3 years. Bentonite products are used as binders in green sand casting methods in the production of iron, steel, and nonferrous components for transportation, construction, and petrochemical industries. Bentonite Corp. sells directly to large foundries with approximately 13% of sales exported outside the United States, including the Far East and Europe. Environmental and civil engineering markets account for less than 10% of the company's bentonite sales and only 14% of sales goes to the drilling fluids market.

Wyo-Ben Inc. reported that only 20% to 25% of company production went to the oil industry, down from 60% to 70% in the late 1970's and early 1980's. The company sells bentonite for more than 50 different products, including linings for land fills.

Wyo-Ben received the Wyoming Department of Environmental Quality award for outstanding environmental performance in 1991. Wyo-Ben, the first bentonite company in the State to receive the honor, was presented the award in 1992 for its overall reclamation efforts. Once mining is completed, the company reclaims disturbed ground by building wildlife habitats, including wetlands, ponds, and grasslands. A variety of topographic diversities provides feeding and nesting opportunities for birds and mammals.

Common clay was mined in Uinta County for use in brick manufacturing. Interstate Brick Co. produced clay at irregular intervals in Uinta County. The clay is trucked to Salt Lake City, UT, stockpiled, and used as needed to manufacture brick.

Gemstones.—The value of gemstone production fell about 80% from the 1991 value. Gemstones collected in Wyoming include nephrite jade (commonly called Wyoming jade), diamonds, sapphire, and some rubies and aquamarine.

Jade is found in Carbon, Fremont, Natrona, Sublette, and Sweetwater Counties and is collected for sale to gem and mineral collectors and tourists.

GSW reported in OFR 88-11 that exploration continued in the Colorado-Wyoming kimberlite province (where more than 100 kimberlites have been identified) as well as elsewhere in the Wyoming craton. Lamproites in the Leucite Hills have yielded some indicator minerals; however, no verified diamonds have been recovered from these rocks to date. South of the Leucite Hills, numerous indicator minerals have been identified in ant hills. The source of these minerals is unknown. Indicator minerals also have been identified in the central Laramie Range, Medicine Bow Mountains, and Seminoe Mountains.

Diamond Co., N.L., received a permit from the State to build a diamond extraction pilot plant in Wyoming. Several other companies were conducting exploration in the State Line diamond district as well as several other localities in southern Wyoming.

Gypsum.—Both Celotex Corp., at Cody, and Georgia-Pacific Corp., south of Lovell, continued to operate gypsum mines and calcining operations near capacity in 1992. Both production and value for crude and calcined gypsum were up slightly from that reported in 1991. Gypsum produced at the mines was pressed into wallboard at nearby plants operated by the two companies.

Mountain Cement has mined gypsum south of Laramie for use in the manufacture of cement at the company's Laramie cement plant. The company did not report production to the USBM for 1992. The company used stockpiled gypsum mined in previous years to met cement manufacturing needs during 1992.

Helium (Grade-A).—Wyoming continued to be the Nation's second largest producer of Grade-A helium, behind Kansas. Exxon Co. U.S.A. has produced helium in Wyoming since 1986 from natural gas produced at Shute Creek in the Riley Ridge gasfield, Lincoln County. Exxon's production of Grade-A helium decreased slightly in 1992. Helium has been Wyoming's third most important nonfuel mineral commodity, in terms of value, since 1987.

Leonardite.—Black Hills Lignite, a division of Black Hills Bentonite, produced leonardite near Glenrock, Converse County, and refined it at Casper, Natrona County, for use in drilling fluids and wood stains. Leonardite is produced by the oxidation of coal or lignite.

During 1992, the State decided leonardite produced from State leases would be subject to a royalty rate of $1.10 per short tons as long as the selling price remained below $43.10 per short tons. Black Hills Bentonite was billed $50,000 for leonardite extracted from State leases while a royalty rate was being established.[10]

Greenbelt Earth Sciences Inc., a Texas company, explored for additional sources of leonardite in the State.

Lime.—In 1992, Wyoming Lime Producers, a division of Dakota Coal Co. (a subsidiary of Basin Electric Power Cooperative) began construction of a lime plant at Frannie, Park County. By yearend, plant construction was 90% complete.

The $10 million facility will use up to 272,160 metric tons (300,000 short tons) of limestone and about 31,750 metric tons (35,000 short tons) of coal to produce between 54,430 and 63,500 metric tons (60,000 to 70,000 short tons) of lime annually at a rate of 363 metric tons (400 short tons) per day. Pete Lien & Sons Inc., of South Dakota, will operate the plant. Initially, limestone from the Big Horn Limestone Co. quarry in Montana, about 18 kilometers (11 miles) north of Frannie, will supply the lime plant. The company hopes to establish a limestone quarry east of the plant site, in Wyoming, sometime in the future. Basin Electric will use lime produced at the Frannie plant as a reagent to remove sulfur dioxide from exhaust gases at the company's coal-fired powerplants in Wyoming and North Dakota. The lime plant was expected to be operating in early 1993.[11]

Elsewhere in Wyoming, lime was produced by Western Sugar Co. in Lovell and by Holly Sugar Corp. in Worland and Torrington. Both production and value of lime produced by these two companies was slightly lower than that reported for 1991.

Perlite (Expanded).—The Harborlite perlite plant, west of Green River in Sweetwater County, expanded perlite mined in Arizona. The product was sold to soda ash plants in the county for use as a filter aid. As expected, expansions at Wyoming trona mines were reflected in increased expanded perlite production during 1992. Although the average unit value fell slightly, increased production resulted in a slightly higher total value.

Phosphate.—Although no phosphate was mined in Wyoming, it was slurried into the State from Simplot Soilbuilders (a joint venture between J.R. Simplot, Inc. and Farmland Industries) mine in Utah for use at the company's fertilizer plant at Rock Springs, Sweetwater County. Simplot completed purchase of the mine and plant from Chevron Chemical Co. in 1992.

The Rock Springs fertilizer plant produced phosphoric acid and diammonium phosphate from phosphate mined in Utah and sulfur recovered from natural gas produced in western Wyoming. The plant employs about 190 people and produces from 317,520 to 362,880 metric tons (350,000 to 400,000 short tons) of fertilizer annually.

Sand and Gravel (Construction).—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains actual data for 1990 and 1992 and estimates for 1991.

Sand and gravel production reported to the USBM for 1992 decreased by more than 0.9 metric ton (1 million short ton) from surveyed production data for 1990, and value fell by more than $3 million.

Wyoming construction sand and gravel statistics were compiled by geographical districts as depicted on the State map. Sand and gravel was produced in 20 of the State's 23 counties; Fremont, Natrona, Laramie, Teton, and Washakie were the leading counties. Production was reported by 46 companies and government agencies from 72 pits at 58 operations. Major producers in the State were Casper Concrete Co., Gilpartick Construction Co. Inc., McGarvin-Moberly Construction Co., Star Aggregate Inc., and Clarks Ready Mix & Construction Co. Those top five producers accounted for nearly 50% of the total output reported to the USBM.

Unit values for construction sand and gravel, shown on table 2, ranged from $2.22 for snow and ice control to $6.91 per short ton for plaster and gunite sands.

Table 3 presents end-use data for the State's two construction sand and gravel districts. Four major use categories—concrete aggregate, asphalt, road base, and fill—accounted for about two-thirds of the construction sand and gravel sold or used

TABLE 2
WYOMING: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1992, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	560	$2,408	$4.30
Plaster and gunite sands	W	W	6.91
Concrete products (blocks, brick, pipe, decorative, etc.)	14	55	3.93
Asphaltic concrete aggregates and other bituminous mixtures	461	2,537	5.50
Road base and coverings[1]	923	2,889	3.13
Fill	278	672	2.42
Snow and ice control	W	W	2.22
Other miscellaneous uses[2]	87	314	3.61
Unspecified:[3]			
Actual	372	1,389	3.73
Estimated	452	1,174	2.60
Total	3,147	11,438	3.63
Total[4 5]	2,855	11,438	4.01

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes road and other stabilization (cement).
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[5]Total quantity and total value in thousand metric tons and thousand dollars.

in 1992.

Rocky Mountain Pre-Mix Concrete of Lander received approval from the Wyoming Department of Environmental Quality to continue operations at the Jameson Gravel pit in Fremont County.

Riverton City Public Works Dept. confirmed that Foster Construction had a permit to mine gravel on a 22-acre parcel at the former Louisiana-Pacific mill site in the city.

In Sheridan County, county commissioners passed a resolution opening a closed road for use by contractors paving a runway at the Sheridan County Airport. Big Sky Asphalt of Bozeman, MT, will use the road to haul gravel and asphalt to the airport. The road was opened for use only by customers and employees of the gravel pit. Other proposed routes from the gravel pit to the airport had been opposed by residents of two subdivisions adjacent to the proposed haul routes.

Grand Teton National Park officials proposed to use 2.3 million cubic meters (3 million cubic yards) of gravel extracted from near the park to complete road improvements during the next 20 years. Because of public opposition to the proposal, officials also studied the possibility of trucking construction material about 144.8 kilometers (90 miles) from Sublette County.

The U.S. Army Corps of Engineers sought locations to mine aggregate for maintenance of levees in the Jackson Hole area. The Corps needs a supply of about 7,646 cubic meters (10,000 cubic yards) of riprap each year to maintain levees. Walton Quarry, the current source of riprap, has less than 5 years of reserves at the current rate of use. Three replacement sites were under consideration during the year, Curtis Canyon, Flat Creek, and Phillips Ridge, all near Jackson in Teton County.

Because all proposed quarry sites would be near Jackson Hole and Teton National Park, vocal opposition to all proposed sites can be expected in 1993.

Sodium Carbonate.—Wyoming continued to lead the Nation in soda ash production from the world's largest known trona resource, a natural sodium carbonate-bicarbonate. In 1992, soda ash production rose slightly from 1991 figures while value dropped slightly. The Wyoming Inspector of Mines reported that roughly 14.8 metric tons (16.3 million short tons) of trona was mined in Wyoming in 1992.[12] Trona mined in Wyoming was used to produce soda ash, caustic soda, sodium sulfite, sodium bicarbonate, and sodium cyanide.

Soda ash is sold primarily to glass manufacturing industries. Caustic soda is used in the pulp and paper industries, chemical manufacturing, and other industrial processes. Sodium sulfite is used in pulp processing, for water treatment in boilers, and as a scrubbing agent in textile manufacturing. Sodium bicarbonate goes into food and chemical applications. Sodium cyanide is used in leaching gold ores.

All trona production comes from the Green River Trona District in the southwestern part of the State. More than 40 individual beds of trona underlie an area of about 3,367 square kilometers (1,300 square miles).

Numerous challenges faced Wyoming's trona industry in 1992, including a tough European market where synthetic soda ash producers have filed antidumping complaints against U.S. producers. The prospect of a sixth trona production facility in Wyoming had some producers questioning the ability of the market to absorb increased production. Meanwhile, the BLM studied a plan to increase trona royalties paid on Federal leases to match those on private leases. Trona producers held discussions with the BLM and oil and gas producers, who also have leases in the trona basin, over who has first right to production. Some producers were concerned that trona lease areas could be removed from future production if contaminated by oil from drilling operations.

Five of the Nation's six major mines and soda ash processing facilities are within a few miles of Green River in Sweetwater County. FMC Wyoming Corp. continued to lead in production, followed by General Chemical Co.,

TABLE 3

WYOMING: CONSTRUCTION SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1992, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2	
	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products[1]	239	996	336	1,475
Asphaltic concrete aggregates and other bituminous mixtures	173	762	288	1,775
Road base and coverings[2]	454	1,697	470	1,192
Fill	130	317	148	355
Snow and ice control	W	W	W	W
Other miscellaneous uses[3]	70	254	15	53
Unspecified:[4]				
Actual	372	1,389	—	—
Estimated	258	473	194	701
Total[5]	1,697	5,887	1,450	5,550
Total[6 7]	1,539	5,887	1,315	5,550

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous uses."
[1]Includes plaster and gunite sands.
[2]Includes road and other stabilization (cement).
[3]Includes filtration.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[5]Data may not add to totals shown because of independent rounding.
[6]One metric ton is equal to 1,000 kilograms or 2,204.62 pounds. To convert short tons into metric tons, multiply short tons by 0.907185.
[7]Total quantity and total value in thousand metric tons and thousand dollars.

Rhône-Poulenc of Wyoming, Solvay Minerals Inc., and Tg Soda Ash Operations. Ownership of Wyoming's soda ash operations dropped to 50% held by U.S. companies in 1992, down from 60% in 1991.

In 1992 Wyoming trona producers employed 3,130 people, had a $183 million payroll, and paid $43 million in royalties to the State and $34 millon in taxes.[13]

FMC Wyoming proposed expansion of its soda ash production by more than one-fifth by adding about 544,320 metric tons (600,000 short tons) of capacity to the plant at a cost of $125 million. If approved by company management and State officials, the expansion would increase production from 2.54 million metric tons to 3.08 million metric tons (2.8 million short tons to 3.4 million short tons) per year. An additional 50 fulltime employees would be added to the current work force of 1,182.[14] Because the cost of building the plant would exceed $100 million, it must be reviewed and approved by the State Industrial Siting Council.

General Chemical Co., the State's second largest producer of soda ash, produced soda ash primarily for Church & Dwight Co. for its line of Arm & Hammer products. Church & Dwight announced plans to spend $1.3 million to expand its packaging facility in Green River.

During 1992, ownership of General Chemical changed with TOSOH Corp., a major Japanese chemical company, acquiring a 24% interest from ACI International for $82 million. ACI retained a 25% equity in the operation. The remaining 51% interest remains with General Chemical. The operation has a capacity of 2 million metric tons (2.2 million short tons) per year and employs 670.

Rhône-Poulenc of Wyoming Co., a joint venture of Rhône-Poulenc Basic Chemicals Co. and Union Pacific Resources Co. (49% interest), increased its soda ash production capacity to 2.09 million metric tons (2.3 million short tons) per year from 1.7 million metric tons (1.9 million short tons).[15] In April, the company marked the 30th year of continuous operation at the trona and soda ash operation (formerly operated by Stauffer Chemical).

In May, Solvay America, Inc. (subsidiary of Solvay S.A. of Belgium), acquired an 80% share of Tenneco Minerals Co.'s natural soda ash facility for $500 million. Asahi Glass of Japan continues to hold its 20% ownership of the operation.

Solvay acquired a 68,000-metric-tons-per-year (75,000-short-tons-per-year) chemical caustic soda plant, a 51,000-metric-tons-per-year (56,200-short-tons-per-year) sodium sulfite plant, and a 54,000-metric-tons-per-year (59,500-short-tons-per-year) ground trona unit. In April, Tenneco had completed installation of 635,000 metric tons (700,000 short tons) of new capacity, raising total production nameplate capacity to 1.91 million metric tons (2 million short tons). The company added 90 employees to run the $92 million expansion facility, bringing total employment at the complex to 430.

Tg Soda Ash Operations (a subsidiary of Societe National Elf Aquitaine Inc.) and Atochem North America started production of 136,080 metric tons per year (150,000 short tons per year) of caustic soda at their new joint-venture project at Granger, WY. Tg employs about 310 workers at all company operations in Wyoming.

Evergreen Enterprises decided not to pursue four Federal prospecting permits because testing suggested the proposed trona project would not be economically feasible. Two holes were drilled by the company but no minable trona was located. The company had planned to drill on 10,520 acres of Federal land northeast of Green River.

U.S. Borax also looked at the possibility of developing a new trona mine and soda ash processing facility west of Green River. The company obtained licenses to conduct exploratory drilling on about 8,600 acres of Federal land. The licenses were issued in

September but have been challenged by Church and Dwight.

Church and Dwight also has expressed interest in acquiring Federal trona leases. The company acquired trona resources by transfer of lease from General Chemical and the University of Wyoming and is applying for transfer of leases from Occidental Petroleum. The transfer is subject to BLM review and approval. GSW reported this lease package contains more demonstrated trona reserves than those of all present producers combined.

State and Federal officials examined the possibility of a land swap of State land in the Flaming George National Recreation Area for Federal land outside the area with trona resources. Wold Minerals has proposed a trona mine in the area of the Federal land. The proposed mine would produce about 0.97 million metric tons (1 million short tons) of trona per year for 25 to 30 years. At current trona prices, that level of production would generate up to $750,000 each year for Wyoming in royalties, and severance and ad valorem taxes.

During 1992, the BLM raised the Federal mineral royalty on trona from 5% to 8%, then put the increase on hold to study the economic impact of the increase.

Federal officials had cited the higher royalty rate charged by Union Pacific Resources as justification for the 60% increase. Union Pacific controls about 51% of the trona leases in the Known Sodium Leasing Area of the Green River Basin through its checkerboard land ownership along the railroad right-of-way. Trona company officials and State officials questioned the increase because of potential adverse economic impact to the industry. The BLM will review the proposed increase in 1993 and hold public meetings on the subject. The Agency also plans to add a diligence clause to all new trona leases that would require development within 10 years or forfeiture of the lease upon expiration. According to the BLM, the clause is intended to discourage speculation and encourage development and production from Federal leases.

Stone.—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; data for even-numbered years are based on annual company estimates. This chapter contains estimated data for 1990 and 1992 and actual data for 1991.

Crushed.—Both quantity and value of crushed stone produced increased significantly in 1992 from that reported in 1991. Estimated production, 4.08 million metric tons (4.5 million short tons), was up about 65% and value, $19 million, was up about 63%. Figures for 1992 are based on responses from four companies representing 89% of total production. Most of the increase in production was attributed to construction at the new Denver, CO, airport.

Production primarily came from Albany, Laramie, and Platte Counties. Major producers were Meridian Aggregate Co., Centex Corp. (Mountain Cement Co.), Peter Kiewit & Sons, and Frost Construction Co.

For more than a year, Rissler & McMurry Co. of Casper has encountered trouble with State officials and local citizens over a permit to expand a limestone quarry on Bessemer Mountain. The Wyoming Supreme Court threw out a private lawsuit alleging the State had violated the Environmental Quality Act when it approved mining plans submitted by the company.

Rissler & McMurry Co. had applied with the State to expand its 10-acre limestone quarry on Bessemer Mountain to a 40-acre mine on a 110.5-acre parcel. Quarries of less than 10 acres are exempt from the normal State permitting process. The planned expansion puts the permit into a public process for approval.

The Wyoming Environmental Quality Council designated parts of Bessemer Mountain as "rare or uncommon" in April, effectively stopping, or at least inhibiting, planned mining on the mountain. Rissler & McMurry immediately began investigating the possibility of appealing the action and in September filed an appeal with the district court. State officials expected the suit to go to the Wyoming Supreme Court early in 1993.

The Wyoming Board of Land Commissioners denied a permit to quarry construction aggregate north of Gillette, Campbell County, citing proximity to existing homes as a reason for denial.

In Yellowstone National Park, the National Park Service decided to reclaim three aggregate quarries. Park officials requested the Wyoming Abandoned Mine Lands (AML) Reclamation Program fund the reclamation work. The quarries had been used to supply aggregate for in-park construction.

At Georgia Marble's quarry and processing plant at Wheatland, production of white marble aggregate continued in 1992. Other producers quarried small amounts of scoria near Buffalo and Sheridan for landscape rock.

Dimension.—Work continued at Sunrise Stone's "Wyoming Raven" black granite quarry in northern Albany County. GSW reported that quarried blocks were shipped by truck to Fagan Marble and Granite in Mena, AR, for cutting and polishing into finished pieces, including interior and exterior building facing. GSW also reported that additional blocks of granite were shipped to two South Dakota stone fabricators. Sunrise Stone also shipped blocks of a pink, granitic migmatite to a facility in Illinois for processing into decorative stone facing and monuments.

Following up on a recent GSW publication, GSW Information Circular (IC) 31, five stone-producing companies from California, Colorado, Georgia, Maryland, and Tennessee were in Wyoming examining deposits of granite, quartzite, flagstone, and sandstone. Most of the interest centered on granite localities in the Granite Mountains of central Wyoming and in the northern Laramie Mountains, and on sandstone and orthoquartzite localities in the Hartville uplift.

Mesa Marble Co. quarried small amounts of brown marble near Tensleep, Washakie County. The decorative stone was used in trim, flagstone, and landscape rock. Some products have been shipped to the east coast.

Georgia Marble requested sample blocks of a black and a red marble described in a recent GSW publication on decorative stone of Wyoming, GSW IC 31.

Sulfur.—In Wyoming, all sulfur production was as a byproduct of natural gas and petroleum processing. Six companies produced sulfur in seven southwestern Wyoming counties. Amoco Production Co., Chevron U.S.A. Inc., and Exxon Co. U.S.A. were the largest producers.

Zeolites.—U.S. Zeolite, in partnership with Colorado Lien, tested a clinoptilolite deposit near Fort LaClede, in Sweetwater County, and is working to develop the deposit. Although minor production was reported to the USBM for 1992, no value was assigned to the production.

Zeolites act as molecular sieves and can remove selected ions, including toxic ions, from water. The firm is planning to market natural clinoptilolite for use in removing ammonia from aquaculture, agriculture, and as a wastewater treatment product.[16]

A South Dakota partnership located zeolites in the Washakie Basin in 1992. The BLM, however, denied the claims because the area is closed to mineral location under the terms of an oil shale withdrawal. The claimant has requested that the BLM review the withdrawal because oil shale development potential is low.

Because zeolites have been tested successfully by the USBM on the removal of heavy-metal cations from mine and metallurgical effluents, future markets for zeolites should grow substantially. Markets such as animal waste absorbent, aquaculture applications, odor control, and agricultural applications also are expected to expand.

Other Industrial Minerals.—A small amount of feldspar was produced from Casper Mountain. The material was used primarily for decorative aggregate.

Sweetwater Steatite, Inc. of Rock Springs applied for a mining permit for a small steatite (massive talc) quarry in southeastern Sublette County. Production from the quarry would be used to produce carved statuary. The permit was approved in July by the Department of Environmental Quality but requires approval by the State Environmental Quality Council. The deposit is in the Bridger-Teton National Forest. Issuance of the permit is in question because the site and the material may have religious significance to the Shoshone and Arapaho Tribes. The council is expected to reach a decision on the permit early in 1993.

Metals

No metal production has been reported to the USBM for Wyoming since 1986. In recent years, however, there has been a great deal of interest expressed in gold in the State.

The GSW has been examining metal occurrences throughout the State in recent years. In 1992, the GSW examined two deposits in the Encampment district in the Sierra Madre Mountains. GSW reported that 10 samples were collected southeast of Encampment from a 762- to 1,219-meter (2,500- to 4,000-foot) shear zone in Proterozoic granite on the Kurtz-Chatterton property. The samples averaged 4.43% copper, 5.96 grams per metric tons [0.17 troy ounce per short ton] gold and 2.1 grams per metric ton (0.061 troy ounce per short ton) silver. Six samples collected from a Proterozoic skarn on the Broadway property yielded 0.02% to 8.17% zinc, 0.3% to 5.6% lead, 0.05% to 1.82% copper, 0.1 to 3.28 grams per metric ton (0.0035 to 0.093 troy ounce per short ton) gold, and 6.7 to 418.0 grams per metric ton (0.0.23 to 14.81 ounce per short ton) silver.

Noranda Exploration Inc. also explored portions of the Encampment district within the Medicine Bow National Forest in 1992. The company planned to drill eight holes in an effort to locate copper, gold, lead, silver, and zinc.

Attempts by a small miner to develop a precious-metals project in the Sierra Madre area of the Medicine Bow National Forest met with innumerable difficulties during the year. The miner has invested about $1 million in the project but has not been able to do any mining. Late in the year, an environmental group got a court order to delay work into 1993.

Along the northern flank of the Medicine Bow Mountains, the GSW collected stream sediment samples that assayed up to 256 grams per metric ton (7.4 troy ounces per short ton) gold. Only 1 of the 37 samples collected did not yield anomalous gold and 20 samples yielded visible gold.

In the Lake Owen mafic complex in the Medicine Bow Mountains, a university study identified several zones containing elevated concentrations of gold, palladium, and platinum. GSW reported the mineralized zones were generally lenticular and include zones up to 4.8 meters (15 feet) thick with a strike length of more than 1.6 kilometers (1 mile).

In the Rattlesnake Hills area of the Granite Mountains, the GSW investigated targets in quartz breccia veins, metacherts, banded iron formations, jasperoids, breccias, and stockworks. One metachert examined yielded samples with 7.5 and 4.5 grams per metric ton (0.210 and 0.131 troy ounces per short ton) gold. Canyon Resources also was exploring in the area.

The Bear Lodge Mountains in northeastern Wyoming continue to be of exploration interest for some mining companies. In past years, drilling in the area outlined a 7.4 million metric tons (8.2 million short tons) disseminated gold deposit averaging 0.72 parts per million gold.

The GSW completed a study in the Seminoe Mountains of central Wyoming in 1992. Numerous samples were collected from banded iron formations with anomalous copper, gold, lead, silver, and zinc. Kimberlite indicator minerals also were identified in the greenstone belt.

Several companies continue to explore in the Hartville uplift in eastern Wyoming for copper, gold, silver, and zinc. Recent exploration work was done by Cominco American Inc., Doe Run, and Phelps Dodge. The district also has a

past history of iron, onyx, and uranium mining.

Gyorvay Mining Co. continued preparation work for mining at the Mary Ellen gold mine at South Pass. The first shipment of concentrate was sent to a Montana smelter during early summer. No gold recovery was reported to the USBM.

The Mary Ellen Mine was originally developed in the South Pass-Atlantic City district in 1868. Historic reports indicate the quartz vein, on which the mine is located, averaged 11 grams per metric tons (0.4 troy ounces per short tons) gold and may have produced as much as 194 kilograms (6,250 troy ounces) of gold prior to 1911.

Information released to the GSW on the Kirwin porphyry deposit, by AMAX Exploration, showed the Tertiary deposit in the southern Absaroka Mountains to contain minimum geologic reserves of 178 million metric tons (196 million short tons). The deposit reportedly averaged 0.505% copper. Recent data indicate the deposit could be in situ leached at an average cost of $0.30 per pound copper recovered. The property was sold by AMAX and is currently held in acquired land status by the U.S. Forest Service.

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[1]Mining engineer, U.S. Bureau of Mines, Denver, CO. She has 17 years of mineral-related experience with the Government.

[2]Senior Economic Geologist, Metals and Precious Stones, Geological Survey of Wyoming, Laramie, WY.

[3]Geologist, Industrial Minerals and Uranium, Geological Survey of Wyoming, Laramie, WY.

[4]Star Tribune (Casper, WY). Dec. 1, 1992.

[5]State Journal (Lander, WY). Dec. 14, 1992.

[6]Denver Post (Denver, CO). Apr. 21, 1992.

[7]Wyoming Department of Commerce, Economic & Community Development Division, Energy Section. 1992 Wyoming Mineral and Energy Yearbook. Jan. 1993, pp. 130.

[8]Hausel, W. D., R. E. Harris, and T. A. Moore. State Activities 1992—Wyoming. Min. Eng. May 1993, pp. 480-482.

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[12]Riverton Ranger (Riverton, WY). June 16, 1993.

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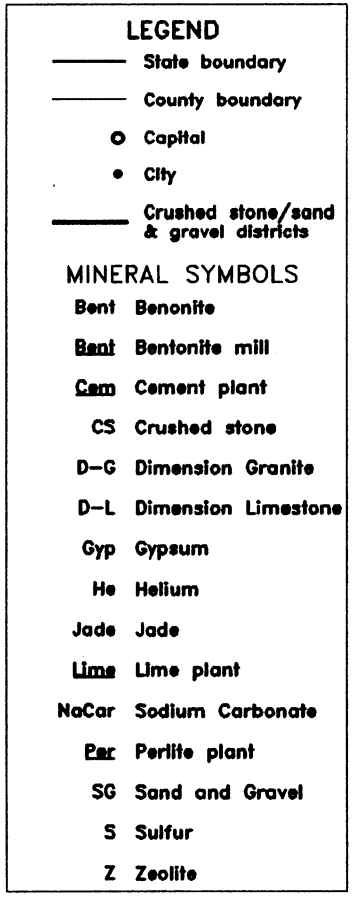
[14]Gazette (Kemmerer, WY). Dec. 17, 1992.

[15]Engineering & Mining Journal. Mar. 1993, p. 52.

[16]Work cited in footnote 7.

WYOMING



Principal Mineral–Producing Localities

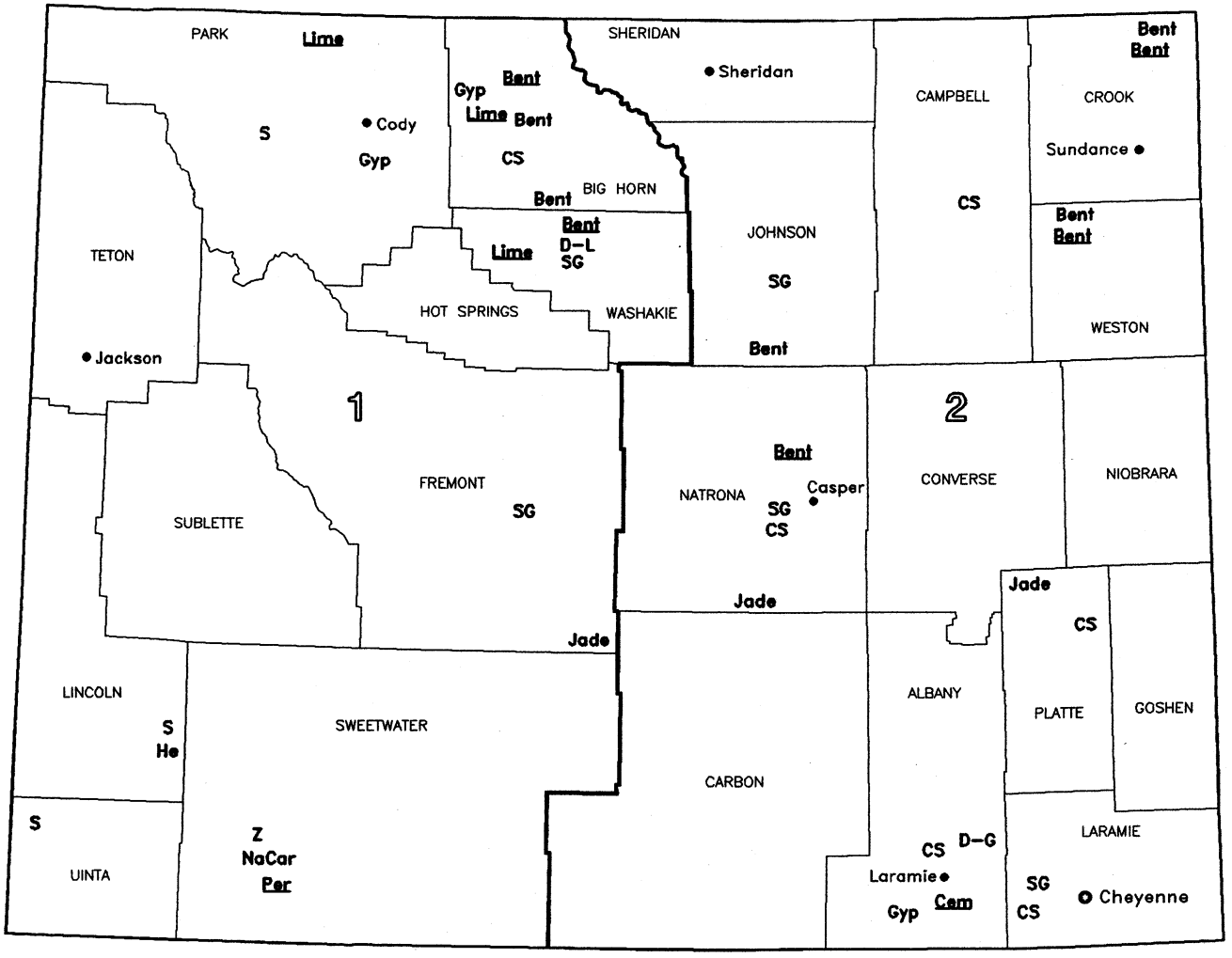


TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Mountain Cement Co.[1] (a subsidiary of Centex Corp.)	Box 40 Laramie, WY 82070	Plant	Albany.
Clays:			
American Colloid Co.	Box 130 Upton, WY 82730	Pits and plants	Big Horn, Crook, Weston.
Baroid Drilling Fluids Inc.	1999 Broadway 43d Floor Denver, CO 80202	do.	Crook.
Bentonite Corp. (subsidiary of Tremont Corp.)	HRC 69, Box 112 Belle Fourche, SD 57717	do.	Big Horn and Crook.
Black Hills Bentonite	Box 9 Mills, WY 82644	do.	Johnson, Natrona, Washakie.
M-I Drilling Fluids Co., Greybull Div.	Box 832 Greybull, WY 82426	Pits and plant	Big Horn.
Wyo-Ben Inc.	Box 1072 Greybull, WY 82426	do.	Do.
Gypsum:			
Celotex Corp.	Box 590 Cody, WY 82414	Surface mine and plant	Park.
Georgia-Pacific Corp.	Box 756 Lovell, WY 82431	do.	Big Horn.
Helium (Grade-A):			
Exxon Co. U.S.A.[2]	Box 98 Frontier, WY 83121	Plant	Lincoln.
Lime:			
The Great Western Sugar Co.	Box 5308 Denver, CO 80217	do.	Big Horn.
Holly Sugar Corp.	Holly Sugar Bldg. Colorado Springs, CO 80902	Plants	Goshen and Washakie.
Perlite (expanded):			
Harborlite Corp.	Box 1510 Green River, WY 82935	Plant	Sweetwater.
Sand and gravel:			
Casper Concrete Co.	Box 561 Casper, WY 82601	Pit and dredge	Natrona.
Clarks Ready Mix & Construction Co.	Box 1804 Jackson, WY 83001	Pit	Teton.
Gilpatrick Construction Co. Inc.	714 West Monroe Riverton, WY 82501	Pits	Fremont.
McGarvin-Moberly Construction Co.	Box 1166 Worland, WY 82401	Pit	Washakie.
Star Aggregates Inc.	Box 1437 Cheyenne, WY 82003	do.	Laramie.
Sodium carbonate:			
FMC Wyoming Corp.	Box 872 Green River, WY 82935	Underground mine and plant	Sweetwater.
General Chemical Co.	Box 551 Green River, WY 82935	do.	Do.
Rhône-Poulenc of Wyoming	Box 513 Green River, WY 82935	do.	Do.

See footnotes at end of the table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sodium carbonate—Continued:			
Solvay Minerals Inc.	Box 1167 Green River, WY 82935	Underground mine and plant	Sweetwater.
Tg Soda Ash Operations	Box 100 Granger, WY 82934	do.	Do.
Stone:			
Crushed:			
Frost Construction Co.	Box 457 Lovell, WY 82431	Pits and plants	Big Horn and Hot Springs.
Meridian Aggregate Co.	Box 155 Granite Canyon, WY 82059	Pit and plant	Laramie.
Peter Kiewit & Sons (Guernsey Stone Co.)	Box 339 Guernsey, WY 82214	do.	Platte.
Dimension:			
Sunrise Stone	2819 Eaton St. Wheat Ridge, CO 80214	Quarry.	Albany.
Sulfur (recovered):			
Amoco Production Co. (Standard Oil of Indiana)	Box 2520 Casper, WY 82602	Plant	Uinta.
Chevron USA Inc.	Box AA Evanston, WY 82930	do.	Do.
Exxon Co. USA	Box 4721 Houston, TX 77210	do.	Lincoln.

[1]Also gypsum and crushed stone.
[2]Also recovered sulfur.

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