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Minerals Yearbook

U.S.
DEPARTMENT
OF THE
INTERIOR

BUREAU OF
MINES

1990

UNITED STATES DEPARTMENT OF THE INTERIOR • Manual Lujan, Jr., Secretary

BUREAU OF MINES • T S Ary, Director

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 wisest use of our land and water resources, protecting our fish and wildlife, 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. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

U.S. GOVERNMENT PRINTING OFFICE

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Foreword

This edition of the Minerals Yearbook discusses the performance of the worldwide minerals industry during 1990 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. A chapter on organic materials also has been added to the Minerals Yearbook series beginning with the 1990 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, Area Reports: 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 review, Volume III 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 the U.S.S.R., and Minerals in the World Economy. This year's reports incorporate location maps, industry structure tables, and an outlook section previously incorporated in our Minerals 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.

T S Ary, *Director*

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.
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 and Energy Resources, 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: Conservation and Survey Division of the University of Nebraska (Nebraska Geological Survey).
Nevada: Nevada Bureau of Mines and Geology.
New Hampshire: New Hampshire Department of Environmental Services.
New Jersey: Geological Survey, Department of Water Resources, New Jersey Department of Environmental Protection.
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 and Mineral 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.

L. Michael Kaas, *Chief, Division of Resource Evaluation*

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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 5 years of Government experience, has been with the U.S. Bureau of Mines Branch of Statistics and Methods Development since 1990.

Mr. Smith, Mineral Data Assistant in the Branch of Data Collection and Coordination, was assisted in the preparation of the Statistical Summary by Sarah P. Guerrino, Chief, Section of Ferrous Metals Data; Imogene P. Bynum, Chief, Section of Nonferrous Metals Data; Barbara E. Gunn, Chief, Section of Industrial Minerals Data; and William L. Zajac, Chief, Section of International Data.

SURVEY METHODS

The U.S. Bureau of Mines 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 Bureau'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 U.S. Bureau of Mines 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 Bureau begins the collection of domestic nonfuel minerals and materials statistics by appraising the information requirements of Government and private organizations of the United States. Information needs that can be satisfied by data from the minerals industries are expressed as questions on U.S. Bureau of Mines survey forms. 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 169 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. U.S. Bureau of Mines 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 people 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

Approximately 26,000 establishments yield more than 50,000 responses to 169 surveys annually. Each completed survey form returned to the Bureau 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 U.S. Bureau of Mines 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.

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

FIGURE 1

A TYPICAL SURVEY FORM

Form 6-1066-M
Fer. (6-88)

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: 3/31/91

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, Office of Statistical Standards, 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)	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

percentage, and the method of estimating the production or consumption for nonrespondents.

To produce reliable aggregated data, the Bureau 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 Bureau 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 Bureau hopes 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 Bureau 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 U.S. Bureau of Mines relies on the cooperation of the U.S. minerals industry to provide the mineral data that are presented in this and other Bureau publications. Without a strong response to survey requests, the Bureau would not be able to present reliable statistics. The Bureau 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 Bureau 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 Bureau will not publish that 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 Bureau will publish the data as long as the data from other producers are protected from disclosure.

International Data

International data are collected by country specialists in the U.S. Bureau of Mines 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 Bureau country specialists based on historical trends and specialists' knowledge of current production capabilities in each country.

Publications

The U.S. Bureau of Mines 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, International Review. 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 presents the latest available mineral statistics for more than 160 countries with a summary review of the role of 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, up-to-date summaries 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 provides 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, which began monthly publishing on a trial basis in 1991, contains an index that measures the current and future short-term 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 Bureau 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.

To purchase Volumes I, II, and III of the Minerals Yearbook and Minerals Today, contact the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. For free copies of individual annual reports of the Minerals Yearbook, the Mineral Industry Surveys, the Mineral Commodity Summaries, the State Mineral Summaries, and Information Circulars, contact Publications Distribution, U.S. Bureau of Mines, Cochrans Mill Road, P.O. Box 18070, Pittsburgh, PA 15236. To receive a copy of the Metal Industry Indicators, contact the Branch of Statistics and Methods Development, U.S. Bureau of Mines, MS 9701, 810 7th Street, NW, Washington, DC 20241.

Electronic Data Dissemination

In addition to the Bureau's printed publications, current Mineral Industry Surveys for several commodities and selected annual reports from the Minerals Yearbook are now available through the Bureau'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) 501-9825 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) 501-9554.

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		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS							
Bauxite metric tons, dried equivalent		587,889	$10,566	W	W	W	W
Beryllium concentrates	metric tons	5,308	6	4,592	$5	4,548	e$5
Copper[2]	do.	1,416,928	3,764,353	r1,497,818	r4,323,965	1,587,191	4,309,693
Gold[2]	kilograms	200,914	2,831,281	r265,731	r3,268,548	290,202	3,609,954
Iron ore (includes byproduct material)	thousand metric tons	57,113	1,716,661	58,299	r1,839,873	57,010	1,740,925
Iron oxide pigments (crude	metric tons	39,711	3,815	r40,202	r4,561	37,071	4,615
Lead[2]	do.	384,983	315,222	410,915	356,477	473,992	480,917
Magnesium metal	do.	141,983	469,767	152,066	508,668	139,333	433,119
Molybdenum[3]	do.	45,941	271,039	r61,168	r427,477	61,580	346,262
Nickel[3]	short tons	—	—	382	r4,662	4,080	32,811
Palladium metal[4]	kilograms	3,730	14,750	4,850	22,454	5,930	21,735
Platinum metal[4]	do.	r1,240	r20,950	r1,430	r23,310	1,810	26,478
Silver[2]	metric tons	1,661	349,339	2,007	354,973	2,170	336,382
Zinc[2]	do.	244,314	324,249	275,883	499,103	515,355	847,485

See footnotes at end of table.

TABLE 1—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
Combined value of antimony, 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	$116,954	XX	r$233,783	XX	$237,523
Total metals[5]		XX	10,209,000	XX	11,868,000	XX	12,428,000
INDUSTRIAL MINERALS (EXCEPT FUELS)							
Abrasives[6]	metric tons	13,313	1,183	1,257	189	3,734	231
Asbestos	do.	W	W	17,427	W	W	W
Barite	thousand metric tons	404	15,512	290	12,625	439	15,554
Boron minerals[7]	metric tons	1,149,404	429,667	1,114,007	429,806	1,093,919	436,176
Bromine[e]	thousand kilograms	163,293	144,000	175,000	188,650	177,000	97,350
Cement:							
Masonry	thousand short tons	3,574	243,941	3,329	229,441	3,274	225,404
Portland	do.	74,074	3,575,906	74,202	3,592,255	75,596	3,683,400
Clays	metric tons	44,515,041	1,400,820	42,254,269	1,515,300	42,904,437	1,619,826
Diatomite	do.	628,680	143,774	617,164	136,754	631,062	137,982
Feldspar	do.	649,077	28,082	654,313	28,029	630,000	27,400
Fluorspar	do.	e63,500	W	e66,000	W	e63,500	W
Garnet (abrasive)	do.	42,506	4,707	42,604	4,408	47,009	6,937
Gem stones		NA	43,580	NA	42,901	NA	52,867
Gypsum (crude)	thousand short tons	16,390	109,205	17,624	128,448	16,406	99,567
Helium (Grade-A)	million cubic feet	2,574	95,238	2,879	106,523	3,059	113,183
Iodine	kilograms	998,000	W	1,508,000	23,947	1,972,84	930,486
Lime	thousand short tons	17,052	817,893	17,152	852,113	17,452	901,549
Mica (scrap)	thousand metric tons	130	6,793	119	6,273	109	5,841
Peat	thousand short tons	908	20,320	r775	17,636	795	19,200
Perlite	short tons	645,000	17,652	601,000	16,301	639,300	15,311
Phosphate rock	thousand metric tons	45,389	887,809	49,817	1,082,797	46,343	1,075,093
Potash (K_2O equivalent)	do.	1,521	240,300	1,595	271,515	1,716	303,337
Pumice	metric tons	352,895	4,129	424,000	8,213	442,848	10,687
Salt	thousand short tons	37,997	680,174	38,356	776,846	40,693	826,659
Sand and gravel:							
Construction	do.	923,400	3,126,000	e897,300	e3,249,100	910,600	3,249,400
Industrial	do.	28,480	388,000	29,205	410,200	28,406	436,200
Sodium compounds:							
Soda ash	thousand metric tons	8,738	644,973	8,995	764,146	9,156	836,188
Sodium sulfate (natural)	do.	361	31,377	340	31,104	349	33,748
Stone:[8]							
Crushed	thousand short tons	e1,247,800	e5,558,000	1,213,400	5,325,800	e1,222,000	e5,591,300
Dimension	short tons	e1,189,333	e196,289	1,206,995	208,311	e1,186,216	e209,691
Sulfur (Frasch)	thousand metric tons	4,341	430,814	3,780	378,712	3,676	335,189
Talc and pyrophillite	metric tons	1,233,716	31,185	1,253,128	W	W	W
Tripoli	do.	99,928	864	105,229	2,537	94,389	3,188

See footnotes at end of table.

TABLE 1—Continued

NONFUEL MINERAL PRODUCTION[1] IN THE UNITED STATES

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
INDUSTRIAL MINERALS (EXCEPT FUELS)—Continued							
Vermiculite	short tons	303,544	$33,948	293,320	$32,550	229,584	$19,075
Combined value of aplite, brucite, calcium chloride (natural), emery, graphite (natural, 1988-89), helium (crude), kyanite, lithium minerals, magnesite, magnesium compounds, marl (greensand), olivine, pyrites, staurolite, wollastonite, and values indicated by symbol W		XX	452,436	XX	483,672	XX	473,453
Total industrial minerals[5]		XX	19,805,000	XX	20,357,000	XX	20,891,000
Grand total[5]		XX	30,014,000	XX	32,225,000	XX	33,319,000

[e]Estimated. [r]Revised. 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]Recoverable content of ores, etc.
[3]Content of ore and concentrate.
[4]Revised due to the separation of palladium metal from platinum metal.
[5]Data may not add to totals shown because of independent rounding.
[6]Grindstones, pulpstones, and sharpening stones; excludes mill liners and grinding pebbles.
[7]Beginning with 1989 data reported in B_2O_3, 1988 data converted.
[8]Excludes abrasive stone and bituminous limestone and sandstone; all included elsewhere in table.

TABLE 2

NONFUEL MINERALS PRODUCED IN THE UNITED STATES AND PRINCIPAL PRODUCING STATES IN 1990

Mineral	Principal producing States, in order of quantity	Other producing States
Abrasives[1]	AR, WI, OH	
Antimony (content of ores, etc.)	ID	
Aplite	VA	
Asbestos	CA and VT	
Barite	GA, NV, MO, CA	IL and MT.
Bauxite	AR and AL	
Beryllium concentrate	UT	
Boron minerals	CA	
Bromine[e]	AR	
Brucite	NV	
Calcium chloride (natural)	MI and CA	
Cement:		
Masonry	IN, FL, MI, PA	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 CT, DE, LA, MA, MN, NH, NJ, NC, ND, RI, VT, WI.
Clays	GA, CA, WY, SC	All other States except AK, DE, HI, RI, VT, WI.
Copper (content of ores, etc.)	AZ, NM, UT, MT	CA, CO, ID, IL, MI, MO, NV, TN.
Diatomite	CA, NV, WA, OR	AZ.
Emery	OR	
Feldspar	NC, CA, CT, GA	ID, OK, SD.
Fluorspar	IL, UT, NV	
Garnet (abrasive)	ID and NY	
Gold (content of ores, etc.)	NV, CA, UT, SD	AK, AZ, CO, ID, MT, NM, OR, SC, WA.
Graphite (natural)	MT	

See footnotes at end of table.

TABLE 2—Continued

NONFUEL MINERALS PRODUCED IN THE UNITED STATES AND PRINCIPAL PRODUCING STATES IN 1990

Mineral	Principal producing States, in order of quantity	Other producing States
Gypsum (crude)	IA, MI, OK, NV	AR, AZ, CA, CO, IN, KS, LA, NM, NY, OH, SD,TX, UT, VA, WA, WY.
Helium	KS, WY, TX, NM	CO.
Iodine	OK	
Iron ore (includes byproduct)	MN, MI, MO, UT	CA, MT, NM, SD, TX.
Iron oxide pigments (crude)	GO, MO, VA, MI	AZ.
Kyanite	VA	
Lead (content of ores, etc.)	MO, AK, ID, CO	IL, KY, MT, NM, NV, NY, TN.
Lime	MO, OH, PA, KY	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, FL, DE	UT and TX.
Magnesium metal	TX, UT, WA	
Manganiferous ore	SC	
Marl (greensand)	NJ	
Mercury	NV, UT, CA	
Mica (scrap)	NC, GA, NM, SC	CT, PA, SD.
Molybdenum	CO, AZ, ID, MT	CA, NM, NV, UT.
Nickel	OR	
Olivine	NC and WA	
Palladium metal	MT	
Peat	MI, FL, MN, IL	CO, GA, IA, IN, MA, MD, ME, MT, NC, ND, NJ, NY, OH, PA, SC, WA, WI, WV.
Perlite	NM, AZ, CA, ID	CO and NV.
Phosphate rock	FL, NC, ID, TN	MT and UT.
Platinum metal	MT	
Potash	NM, UT, CA, MI	
Pumice	CA, OR, AZ, NM	HI, ID, KS.
Pyrites (ore and concentrate)	AZ	
Rare-earth metal concentrates	CA and FL	
Salt	NY, OH, LA, MI	AL, AZ, CA, KS, NM, NV, OK, TX, UT, WV.
Sand and gravel:		
Construction	CA, OH, TX, MI	All other States.
Industrial	IL, CA, TX, NJ	All other States except AK, DE, HI, IA, ME, NH, NM, ND, OR, SD, VT, WY.
Silver (content of ores, etc.)	NV, ID, AK, MT	AZ, CA, CO, IL, KY, MI, MO, NM, NY, OR, SC, SD, TN, UT, WA.
Sodium compounds:		
Soda ash	WY and CA	
Sodium sulfate (natural)	CA, TX, UT	
Staurolite	FL	
Stone:		
Crushed	PA, VA, FL, GA	All other States except DE.
Dimension	IN, VT, MN, SD	All other States except AL, AR, AZ, CA, CO, CT, GA, IA, ID, IL, IN, KS, MA, MD, ME, MI, MO, MT, NC, NH, NM, NY, OH, OK, PA, SC, TN, TX, VA, WA, WI.
Sulfur (Frasch)	TX and LA	
Talc and pyrophyllite	MT, TX, NC, VT	AL, AR, CA, GA, NY, OR, VA.
Tin	AK	
Titanium concentrates	FL and CA	

See footnotes at end of table.

TABLE 2—Continued

NONFUEL MINERALS PRODUCED IN THE UNITED STATES AND PRINCIPAL PRODUCING STATES IN 1990

Mineral	Principal producing States, in order of quantity	Other producing States
Tripoli	IL, AR, OK, PA	
Tungsten (content of ores, etc.)	CA	
Vanadium (content of ores, etc.)	CO, ID, AR, UT	
Vermiculite (crude)	SC, MT, VA	
Wollastonite	NY	
Zinc (content of ores, etc.)	AK, TN, NY, MO	CO, ID, IL, KY, MT, NM, NV.
Zircon concentrates	FL and NJ	

[e]Estimated.
[1]Grindstones, pulpstones, and sharpening stones; excludes mill liners and grinding pebbles.

TABLE 3

VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 1990

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$560,639	21	1.68	Stone (crushed and broken), cement (portland), lime, sand and gravel.
Arkansas	302,640	33	.91	Bromine, stone (crushed and broken), sand and gravel (industrial), cement (portland).
California	2,779,799	2	8.34	Sand and gravel (construction), cement (portland), boron, gold.
Colorado	386,192	27	1.16	Molybdenum, sand and gravel (construction), cement (portland), stone (crushed and broken).
Connecticut	117,893	41	.35	Stone (crushed and broken), sand and gravel (construction), feldspar, sand and gravel (industrial).
Delaware[1]	6,968	50	.02	Sand and gravel (construction), and gem stones.
Florida	1,564,204	4	4.69	Phosphate rock, stone (crushed and broken), cement (portland), sand and gravel (construction).
Georgia	1,495,124	5	4.49	Clays, stone (crushed and broken), cement (portland), sand and gravel (construction).
Hawaii[1]	106,095	43	32	Stone (crushed and broken), cement (portland), sand and gravel (construction), cement (masonry).
Idaho	399,761	26	1.20	Phosphate rock, silver, molybdenum, zinc.
Illinois	665,134	16	2.00	Stone (crushed and broken), cement (portland), sand and gravel (construction), sand and gravel (industrial).
Indiana	431,766	25	1.30	Stone (crushed and broken), cement (portland), sand and gravel (construction), stone (dimension).
Iowa	316,370	32	.95	Cement (portland), stone (crushed and broken), sand and gravel (construction), gypsum (crude).
Kansas	346,119	31	1.04	Salt, stone (crushed and broken), cement (portland), helium (Grade-A).
Kentucky	358,864	30	1.08	Stone (crushed and broken), lime, cement (portland), sand and gravel (construction).
Louisiana	367,918	29	1.10	Sulfur (Frasch), salt, sand and gravel (construction), stone (crushed and broken).
Maine	62,544	46	19	Sand and gravel (construction), cement (portland), stone (crushed and broken), stone (dimension).
Maryland	368,614	28	1.11	Stone (crushed and broken), sand and gravel (construction), cement (portland), cement (masonry).
Massachusetts	127,498	40	.38	Stone (crushed and broken), sand and gravel (construction), stone (dimension), lime.
Michigan	1,438,123	8	4.32	Iron ore (usable), cement (portland), sand and gravel (construction), stone (crushed and broken).

See footnote at end of table.

TABLE 3—Continued

VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 1990

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Minnesota	$1,469,922	6	4.41	Iron ore (usable), sand and gravel (construction), stone (crushed and broken), stone (dimension).
Mississippi	112,313	42	0.34	Sand and gravel (construction), clays, cement (portland), stone (crushed and broken).
Missouri	1,093,618	11	3.28	Lead, stone (crushed and broken), cement (portland), lime.
Montana	567,684	19	1.70	Gold, copper, molybdenum, silver.
Nebraska	90,329	44	.27	Cement (portland), sand and gravel (construction), stone (crushed and broken), clays.
Nevada	2,610,876	3	7.84	Gold, silver, sand and gravel (construction), cement (portland).
New Hampshire[1]	35,166	47	.11	Sand and gravel (construction), stone (dimension), stone (crushed and broken), gem stones.
New Jersey	229,470	37	.69	Stone (crushed and broken), sand and gravel (construction), sand and gravel (industrial), zircon concentrates.
New Mexico	1,097,550	10	3.29	Copper, potash, sand and gravel (construction), molybdenum.
New York	772,839	14	2.32	Stone (crushed and broken), salt, cement (portland), sand and gravel (construction).
North Carolina	564,591	20	1.69	Stone (crushed and broken), phosphate rock, lithium minerals, sand and gravel (construction).
North Dakota	26,568	48	.08	Sand and gravel (construction), lime, stone (crushed and broken), clays.
Ohio	728,840	15	2.19	Stone (crushed and broken), sand and gravel (construction), salt, lime.
Oklahoma	260,177	35	.78	Stone (crushed and broken), cement (portland), iodine (crude), sand and gravel (construction).
Oregon	237,406	36	.71	Stone (crushed and broken), sand and gravel (construction), cement (portland), nickel.
Pennsylvania	1,030,042	12	3.09	Stone (crushed and broken), cement (portland), sand and gravel (construction), lime.
Rhode Island[1]	17,844	49	.05	Sand and gravel (construction), stone (crushed and broken), gem stones.
South Carolina	449,853	24	1.35	Stone (crushed and broken), cement (portland), gold, clays.
South Dakota	298,452	34	.90	Gold, cement (portland), sand and gravel (construction), stone (crushed and broken).
Tennessee	662,560	17	1.99	Stone (crushed and broken), zinc, cement (portland), gem stones.
Texas	1,457,225	7	4.37	Cement (portland), stone (crushed and broken), magnesium metal, sulfur (Frasch).
Utah	1,334,010	9	4.00	Copper, gold, magnesium metal, cement (portland).
Vermont	81,954	45	.25	Stone (crushed and broken), stone (dimension), sand and gravel (construction), talc and pyrophyllite.
Virginia	507,275	22	1.52	Stone (crushed and broken), sand and gravel (construction), cement (portland), lime.
Washington	473,229	23	1.42	Sand and gravel (construction), gold, magnesium metal, cement (portland).
West Virginia	136,338	39	.41	Stone (crushed and broken), cement (portland), sand and gravel (construction), salt.
Wisconsin	212,047	38	.64	Stone (crushed and broken), sand and gravel (construction), lime, sand and grave (industrial).
Wyoming	910,848	13	2.73	Soda ash, clays, helium (Grade-A), sand and gravel (construction).
Undistributed	5,938	—	—	
Total[2]	33,319,000	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]Data may not add to totals shown because of independent rounding.

TABLE 4

VALUE OF NONFUEL MINERAL PRODUCTION[2] PER CAPITA AND PER SQUARE MILE IN 1990, BY STATE

State	Area (square miles)	Population (thousands)	Total (thousands)	Per square mile		Per capita	
				Dollars	Rank	Dollars	Rank
Alabama	51,705	4,041	$560,639	10,843	24	139	16
Alaska	591,004	550	576,620	976	49	1,048	3
Arizona	114,000	3,665	3,065,448	26,890	3	836	4
Arkansas	53,187	2,351	302,640	5,690	32	129	19
California	158,706	29,760	2,779,799	17,515	11	93	26
Colorado	104,091	3,294	386,192	3,710	43	117	21
Connecticut	5,018	3,287	117,893	23,494	8	36	45
Delaware	2,044	666	[1]6,968	3,409	44	10	50
Florida	58,664	12,938	1,564,204	26,664	4	121	20
Georgia	58,910	6,478	1,495,124	25,380	5	231	11
Hawaii	6,471	1,108	[1]106,095	16,395	13	96	25
Idaho	83,564	1,007	399,761	4,784	36	397	9
Illinois	56,345	11,431	665,134	11,805	23	58	38
Indiana	36,185	5,544	431,766	11,932	22	78	34
Iowa	56,275	2,777	316,370	5,622	34	114	22
Kansas	82,277	2,478	346,119	4,207	37	140	15
Kentucky	40,409	3,685	358,864	8,881	28	97	23
Louisiana	47,751	4,220	367,918	7,705	30	87	27
Maine	33,265	1,228	62,544	1,880	47	51	40
Maryland	10,460	4,781	368,614	35,240	1	77	35
Massachusetts	8,284	6,016	127,498	15,391	18	21	48
Michigan	58,527	9,295	1,438,123	24,572	6	155	13
Minnesota	84,402	4,375	1,469,922	17,416	12	336	10
Mississippi	47,689	2,573	112,313	2,355	46	44	41
Missouri	69,697	5,117	1,093,618	15,691	17	214	12
Montana	147,046	779	567,684	3,861	39	729	6
Nebraska	77,355	1,578	90,329	1,168	48	57	39
Nevada	110,561	1,202	2,610,876	23,615	7	2,172	1
New Hampshire	9,279	1,109	[1]35,166	3,790	40	32	46
New Jersey	7,787	7,730	229,470	29,468	2	30	47
New Mexico	121,593	1,515	1,097,550	9,026	27	724	7
New York	49,107	17,990	772,839	15,738	14	43	43
North Carolina	52,669	6,629	564,591	10,720	25	85	30
North Dakota	70,703	639	26,568	376	50	42	44
Ohio	41,330	10,847	728,840	17,635	10	67	37
Oklahoma	69,956	3,146	260,177	3,719	42	83	32
Oregon	97,073	2,842	237,406	2,446	45	84	31
Pennsylvania	45,308	11,882	1,030,042	22,734	9	87	28
Rhode Island	1,212	1,003	[1]17,844	14,723	19	18	49
South Carolina	31,113	3,487	449,853	14,459	20	129	18
South Dakota	77,116	696	298,452	3,870	38	429	8
Tennessee	42,144	4,877	662,560	15,721	15	136	17
Texas	266,807	16,987	1,457,225	5,462	35	86	29
Utah	84,899	1,723	1,334,010	15,713	16	774	5
Vermont	9,614	563	81,954	8,524	29	146	14
Virginia	40,767	6,187	507,275	12,443	21	82	33
Washington	68,138	4,867	473,229	6,945	31	97	24
West Virginia	24,231	1,793	136,338	5,627	33	76	36
Wisconsin	56,153	4,892	212,047	3,776	41	43	42
Wyoming	97,809	454	910,848	9,313	26	2,006	2
Undistributed	XX	XX	5,938	XX	XX	XX	XX
Total[3] or average	3,618,700	248,082	33,319,000	9,207	XX	134	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 606,900.

[3]Data may not add to totals shown because of independent rounding.

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

TABLE 5

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

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
ALABAMA							
Cement:							
Masonry	thousand short tons	273	$16,457	252	$13,852	262	$15,462
Portland	do.	3,524	7,214	3,169	130,590	3,585	165,344
Clays[2]	metric tons	2,282,670	16,039	1,878,070	18,537	2,049,776	27,747
Gem stones		NA	5	NA	W	NA	W
Lime	thousand short tons	1,450	66,576	1,481	70,361	1,526	70,816
Sand and gravel:							
Construction	do.	11,742	41,417	e10,400	e36,500	14,103	50,243
Industrial	do.	871	8,507	805	8,092	878	9,075
Stone (crushed)	do.	e29,700	e140,100	3 31,737	3 167,332	e 3 36,100	e 3 202,400
Combined value of bauxite, clays (bentonite, kaolin 1990), salt, stone (crushed granite 1989-90, dimension), talc and pyrophyllite, zircon concentrates, (1988-89), and values indicated by symbol W		XX	13,180	XX	r15,489	XX	19,552
Total		XX	459,495	XX	460,753	XX	560,639
ALASKA							
Gem stones		NA	50	NA	W	NA	W
Gold[4]	kilograms	4,210	59,320	5,756	70,800	3,232	40,200
Sand and gravel (construction)	thousand short tons	17,200	48,749	e17,000	e48,500	15,100	41,800
Silver[4]	metric tons	1	135	W	W	W	W
Stone (crushed)	thousand short tons	e1,800	e8,400	2,900	20,300	e2,700	e19,800
Combined value of cement (portland), lead (1989-90), tin, zinc (1989-90), and values indicated by symbol W		XX	2,040	XX	73,752	XX	474,820
Total		XX	118,694	XX	213,352	XX	576,620
ARIZONA							
Clays	metric tons	168,392	1,590	188,211	2,506	140,162	2,318
Copper[4]	do.	842,728	2,238,875	r898,466	r2,593,734	978,767	2,657,649
Diatomite	do.	7,257	1,208	W	W	W	W
Gem stones		NA	3,300	NA	2,821	NA	2,098
Gold[4]	kilograms	4,549	64,106	r2,768	r34,047	5,000	62,191
Lime	thousand short tons	674	29,637	W	W	W	W
Pumice	metric tons	907	7	—	—	W	W
Sand and gravel:							
Construction	thousand short tons	32,399	123,854	e33,900	e133,900	27,915	92,166
Industrial	do.	119	3,045	W	W	W	W
Silver[4]	metric tons	152	31,974	171	30,186	173	26,836
Stone:							
Crushed	thousand short tons	e7,400	e33,000	6,649	28,552	e5,300	e13,500
Dimension	short tons	W	e1	W	W	W	W
Combined value of cement, gypsum (crude), iron oxide pigments (crude, 1989-90), lead (1988-89), molybdenum, perlite, pyrites, salt, tin (1988-89), and values indicated by symbol W		XX	235,596	XX	r220,594	XX	208,690
Total		XX	2,766,193	XX	3,046,340	XX	3,065,448

See footnotes at end of table.

TABLE 5—Continued

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

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
ARKANSAS							
Abrasives[5]	metric tons	1,120	$429	W	W	W	W
Bromine[e]	thousand kilograms	W	W	W	W	177,000	$97,350
Clays	metric tons	844,466	15,376	871,313	$17,391	989,383	21,578
Gem stones		NA	2,300	NA	4,041	NA	1,503
Sand and gravel:							
Construction	thousand short tons	7,722	26,201	e7,500	e25,500	9,663	35,475
Industrial	do.	669	6,784	545	5,507	742	7,209
Stone:							
Crushed	do.	e17,100	e70,100	3 18,791	3 76,419	e 3 17,800	e 3 76,900
Dimension	short tons	e10,541	e629	W	W	W	W
Combined value of bauxite, cement, gypsum (crude), lime, stone (crushed slate and dolomite, 1989-90), talc and pyrophyllite, tripoli, vanadium (1989-90), and values indicated by symbol W		XX	184,785	XX	253,051	XX	62,625
Total		XX	306,604	XX	381,909	XX	302,640
CALIFORNIA							
Boron minerals[6]	metric tons	577,877	429,667	562,311	429,806	1,093,919	436,176
Cement:							
Masonry	thousand short tons	8	730	W	W	W	W
Portland	do.	10,423	601,152	10,911	642,020	10,032	604,080
Clays	metric tons	2,015,488	31,620	2,195,830	39,243	3 2,163,515	3 40,217
Gem stones		NA	3,365	NA	2,982	NA	1,501
Gold[4]	kilograms	22,442	316,246	29,804	366,595	29,607	368,300
Gypsum (crude)	thousand short tons	1,490	11,222	1,734	13,066	W	W
Lime	do.	458	20,242	395	24,503	345	19,425
Mercury	metric tons	W	W	W	W	(7)	(7)
Peat	thousand short tons	2	119	—	—	—	—
Pumice	metric tons	31,752	1,245	79,000	4,612	71,739	5,088
Sand and gravel:							
Construction	thousand short tons	141,946	622,074	e138,300	e670,800	132,214	626,000
Industrial	do.	2,444	42,078	2,426	43,863	2,452	48,055
Silver[4]	metric tons	15	3,148	21	3,650	21	3,209
Stone:							
Crushed	thousand short tons	e49,100	e275,000	54,887	238,034	e42,500	e200,600
Dimension	short tons	e42,048	e5,991	28,829	5,564	e30,077	e5,213
Combined value of asbestos, barite (1988, 1990), calcium chloride (natural), clay (fuller's earth, 1990), copper, diatomite, feldspar, iron ore (by-product material [1988-89], usable), magnesium compounds, molybdenum, perlite, potash, rare-earth metal concentrates, salt, soda ash, sodium sulfate (natural), talc and pyrophyllite, titanium concentrates (ilmenite, 1989-90), tungsten ore concentrates, and values indicated by symbol W		XX	334,755	XX	r369,664	XX	421,935
Total		XX	2,698,654	XX	2,854,402	XX	2,779,799
COLORADO							
Clays	metric tons	247,471	1,890	265,435	2,064	262,292	$1,864
Copper[4]	do.	898	2,386	W	W	W	W
Gem stones		NA	100	NA	240	NA	66
Gold[4]	kilograms	5,126	72,237	3,448	42,411	2,338	29,084

See footnotes at end of table.

TABLE 5—Continued

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

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
COLORADO—Continued							
Peat	thousand short tons	W	W	W	$412	W	W
Sand and gravel (construction)	thousand short tons	21,566	$69,882	e25,300	e104,000	24,938	$86,541
Silver[4]	metric tons	27	5,588	W	W	23	3,557
Stone:							
Crushed	thousand short tons	e10,600	e42,400	3 7,261	3 32,435	e 3 7,600	e 3 36,100
Dimension	short tons	e3,450	e143	5,310	398	e8,490	e1,394
Combined value of cement, clay (bentonite, 1990), gypsum (crude), helium (Grade-A, 1990), lead, lime, molybdenum, perlite, sand and gravel (industrial), stone (crushed traprock, 1989-90), vanadium, zinc, and values indicated by symbol W		XX	169,379	XX	r275,765	XX	227,586
Total		XX	364,005	XX	457,725	XX	386,192
CONNECTICUT							
Gem stones		NA	2	NA	2	NA	2
Sand and gravel (construction)	thousand short tons	8,275	32,102	e5,800	e24,700	8,542	37,943
Stone :							
Crushed	do.	e11,400	e76,900	3 11,480	3 78,734	e 3 10,200	e 3 70,600
Dimension	short tons	e19,718	e1,914	W	W	W	W
Combined value of clays (common), feldspar, mica (scrap, 1988, 1990), sand and gravel (industrial), stone (crushed granite, 1989-90), and values indicated by symbol W		XX	7,198	XX	9,780	XX	9,348
Total		XX	118,116	XX	113,216	XX	117,893
DELAWARE							
Gem stones		NA	1	NA	1	NA	1
Marl (greensand)	short tons	750	10	—	—	—	—
Sand and gravel (construction)	thousand short tons	1,933	5,988	e1,900	e6,200	2,184	6,967
Total[8]		XX	5,999	XX	6,201	XX	6,968
FLORIDA							
Cement:							
Masonry	thousand short tons	411	25,892	477	31,231	442	27,777
Portland	do.	3,682	168,719	4,357	207,857	3,954	186,404
Clays	metric tons	536,922	44,423	2 563,687	2 46,941	2 391,334	2 39,625
Peat	thousand short tons	266	5,091	235	4,515	252	4,381
Sand and gravel:							
Construction	do.	18,654	53,083	e17,900	e55,500	18,472	59,123
Industrial	do.	636	6,928	681	7,768	520	7,024
Stone (crushed)	do.	e 3 83,200	e 3 374,400	83,995	341,397	e74,000	e317,400
Combined value of clays (common, 1989-90), gem stones, magnesium compounds, phosphate rock, rare-earth metal concentrates, staurolite, stone (crushed marl 1988), titanium concentrates (ilmenite and rutile), and zircon concentrates		XX	713,345	XX	913,054	XX	922,470
Total		XX	1,391,881	XX	1,608,263	XX	1,564,204
GEORGIA							
Clays	metric tons	10,274,358	908,771	9,768,312	1,004,954	9,855,248	1,060,539
Gem stones		NA	20	NA	21	NA	20

See footnotes at end of table.

TABLE 5—Continued

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

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
GEORGIA—Continued							
Sand and gravel:							
Construction	thousand short tons	9,526	$30,185	e6,100	e$18,900	5,158	$16,644
Industrial	do.	W	W	537	7,013	W	W
Stone:							
Crushed	do.	e57,400	e317,200	50,417	262,805	e53,000	e317,300
Dimension	short tons	e190,472	e27,768	3145,545	312,087	e 3147,068	e 312,483
Talc and pyrophyllite	do.	23,587	260	W	W	W	W
Combined value of barite, bauxite (1988-89), cement, feldspar, iron oxide pigments (crude), mica (scrap), peat, stone (dimension marble [1989-90]), and values indicated by symbol W		XX	89,621	XX	81,515	XX	88,138
Total		XX	1,373,825	XX	1,387,295	XX	1,495,124
HAWAII							
Cement:							
Masonry	thousand short tons	10	1,531	10	1,566	12	1,870
Portland	do.	354	28,880	493	40,495	532	46,311
Gem stones		NA	W	NA	44	NA	55
Sand and gravel (construction)	do.	652	3,173	e600	e3,200	438	2,459
Stone (crushed)	do.	e5,700	e41,000	6,205	46,746	e7,000	e55,400
Combined value of other industrial minerals and values indicated by symbol W		XX	348	XX	(9)	XX	(9)
Total		XX	74,932	XX	892,051	XX	8106,095
IDAHO							
Clays[2]	metric tons	8,519	W	W	W	W	W
Copper[4]	do.	2,269	6,028	2,950	8,516	W	W
Feldspar	do.	—	—	11,612	720	W	W
Gem stones		NA	500	NA	500	NA	320
Gold[4]	kilograms	3,218	45,349	3,057	37,602	W	W
Phosphate rock	thousand metric tons	4,706	81,011	W	W	4,380	101,610
Pumice	metric tons	W	W	W	W	31,333	220
Sand and gravel:							
Construction	thousand short tons	6,914	19,897	e5,800	e18,900	9,222	25,590
Industrial	do.	483	5,089	459	5,037	552	6,234
Silver[4]	metric tons	340	71,512	439	77,651	436	67,565
Stone (crushed)	thousand short tons	e3,400	e13,100	3,298	12,609	e4,300	e12,900
Combined value of antimony, cement, clays, (bentonite, 1989-90, common, kaolin), garnet (abrasive), lead, lime, molybdenum (1989-90), perlite, stone (dimension, 1988-89), vanadium, zinc, and values indicated by symbol W		XX	48,130	XX	r203,075	XX	185,322
Total		XX	290,616	XX	364,610	XX	399,761
ILLINOIS							
Cement (portland)	thousand short tons	2,307	101,760	2,776	117,224	2,842	116,781
Clays[2]	metric tons	163,571	704	142,207	641	598,479	2,516
Gem stones		NA	30	NA	W	NA	W
Sand and gravel:							
Construction	thousand short tons	30,098	93,504	e33,000	e108,900	32,380	104,728
Industrial	do.	4,328	56,142	4,582	52,935	4,486	62,531
Stone:							
Crushed	do.	e57,900	e251,200	360,829	3256,832	e 362,700	e 3283,100

See footnotes at end of table.

TABLE 5—Continued

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

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
ILLINOIS—Continued							
Stone—Continued							
Dimension	short tons	e1,175	e$129	W	W	W	W
Combined value of barite (1989-90), cement (masonry), clays (fuller's earth), copper, fluorspar, lead, lime, peat, silver, stone (crushed sandstone,1989-90), tripoli, zinc, and values indicated by symbol W		XX	84,157	XX	$96,829	XX	$95,478
Total		XX	587,626	XX	633,361	XX	665,134
INDIANA							
Cement:							
Masonry	thousand short tons	405	27,442	357	24,054	368	27,813
Portland	do.	2,315	107,179	2,364	108,297	2,417	114,414
Clays	metric tons	1,035,837	4,630	871,179	3,836	2,3[1,051,703]	2,3[3,273]
Gem stones		NA	10	NA	W	NA	W
Peat	thousand short tons	54	W	34	607	37	W
Sand and gravel:							
Construction	do.	25,923	79,985	e29,600	e99,200	23,879	76,886
Industrial	do.	362	1,829	W	W	W	W
Stone:							
Crushed	do.	e36,600	e130,000	3[36,188]	3[136,252]	e3[36,700]	e3[147,700]
Dimension	short tons	e195,444	e24,956	3[198,531]	3[27,212]	e3[194,728]	e3[29,504]
Combined value of abrasives (1988-89), clays (ball, 1990), gypsum (crude), lime, stone (crushed marl and miscellaneous stones [1989-90], dimension sandstone, 1989-90), and values indicated by symbol W		XX	30,358	XX	34,657	XX	32,176
Total		XX	406,389	XX	434,115	XX	431,766
IOWA							
Cement:							
Masonry	thousand short tons	W	W	47	4,450	53	5,054
Portland	do.	2,029	98,930	2,072	102,387	2,525	122,466
Clays	metric tons	403,923	1,588	439,323	1,773	423,227	1,376
Gem stones		NA	W	NA	10	NA	14
Gypsum (crude)	thousand short tons	2,047	13,710	2,273	16,884	2,192	14,243
Peat	do.	15	433	W	W	W	W
Sand and gravel (construction)	do.	11,880	36,087	e12,800	e37,800	14,953	46,432
Stone:							
Crushed	do.	e29,200	e128,500	28,049	111,182	e29,000	e118,600
Dimension	short tons	W	e588	15,151	613	W	W
Combined value of other industrial minerals and values indicated by symbol W		XX	10,420	XX	7,603	XX	8,185
Total		XX	290,256	XX	282,702	XX	316,370
KANSAS							
Cement:							
Masonry	thousand short tons	50	2,988	42	2,514	39	2,011
Portland	do.	1,569	72,805	1,505	69,390	1,707	76,564
Clays[2]	metric tons	555,739	2,632	533,099	2,700	625,969	4,056
Gem stones		NA	3	NA	W	NA	W
Salt[10]	thousand short tons	1,284	55,753	1,948	82,212	2,390	92,119
Sand and gravel:							
Construction	do.	10,760	25,329	e13,000	e33,200	10,863	24,170

See footnotes at end of table.

TABLE 5—Continued

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

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
KANSAS							
Cement:							
Masonry	thousand short tons	50	$2,988	42	$2,514	39	$2,011
Portland	do.	1,569	72,805	1,505	69,390	1,707	76,564
Clays[2]	metric tons	555,739	2,632	533,099	2,700	625,969	4,056
Gem stones		NA	3	NA	W	NA	W
Salt[10]	thousand short tons	1,284	55,753	1,948	82,212	2,390	92,119
Sand and gravel:							
Construction	do.	10,760	25,329	e13,000	e33,200	10,863	24,170
Industrial	do.	W	W	230	2,690	W	W
Stone:							
Crushed	do.	e17,300	e72,700	3 15,850	3 56,976	e 3 20,800	e 3 79,200
Dimension	short tons	e6,889	e219	W	W	W	W
Combined value of clay (bentonite, 1989-90), gypsum (crude), helium (crude and Grade-A), pumice, salt (brine), stone (crushed sandstone and quartzite, 1989-90), and values indicated by symbol W		XX	59,284	XX	68,449	XX	67,999
Total		XX	291,713	XX	318,131	XX	346,119
KENTUCKY							
Clays[2]	metric tons	762,324	3,217	716,990	3,357	826,205	8,282
Gem stones		NA	3	NA	W	NA	W
Sand and gravel (construction)	thousand short tons	6,325	15,243	e5,500	e15,100	8,802	29,581
Stone (crushed)	do.	e50,700	e207,900	3 48,178	3 187,849	e 3 50,100	e 3 182,900
Combined value of cement, clays (ball clay, fire clay, 1988-89), lead (1990), lime, sand and gravel (industrial, 1988-89), silver (1990), stone (crushed dolomite, 1989-90), zinc (1988, 1990), and values indicated by symbol W		XX	118,616	XX	124,353	XX	138,101
Total		XX	344,979	XX	330,659	XX	358,864
LOUISIANA							
Clays	metric tons	340,900	9,535	233,992	6,115	368,322	1,066
Gem stones		NA	3	NA	14	NA	7
Salt	thousand short tons	14,274	108,982	13,218	115,203	14,348	120,827
Sand and gravel:							
Construction	do.	14,233	52,820	e13,600	e54,400	14,589	55,902
Industrial	do.	318	4,786	572	9,664	559	10,003
Stone (crushed)	do.	e 2 3,700	e 2 29,200	3,206	24,414	e2,100	e16,800
Sulfur (Frasch)	thousand metric tons	1,719	W	1,334	W	1,337	W
Combined value of cement (masonry, [1988], portland, [1988]), gypsum (crude), lime, stone (crushed miscellaneous, 1988), and values indicated by symbol W		XX	229,210	XX	169,912	XX	163,313
Total		XX	434,536	XX	379,722	XX	367,918
MAINE							
Gem stones		NA	150	NA	W	NA	W
Sand and gravel (construction)	thousand short tons	10,183	33,007	e8,600	e30,100	7,865	29,349

See footnotes at end of table.

TABLE 5—Continued

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

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MARYLAND—Continued							
Lime	thousand short tons	6	329	—	—	—	—
Peat	do.	7	W	3	W	3	W
Sand and gravel (construction)	do.	19,266	$95,169	e16,900	$e84,500	18,271	$104,023
Stone:							
Crushed	do.	e32,700	e167,000	30,841	153,375	e30,500	e163,900
Dimension	short tons	e20,729	e1,515	27,529	2,072	e24,102	e1,751
Combined value of other industrial minerals and values indicated by symbol W		XX	7,804	XX	6,216	XX	6,053
Total		XX	362,921	XX	342,050	XX	368,614
MASSACHUSETTS							
Gem stones		NA	1	NA	3	NA	1
Sand and gravel:							
Construction	thousand short tons	22,168	79,364	e13,900	e57,000	12,774	51,466
Industrial	do.	W	W	34	601	30	401
Stone:							
Crushed	do.	e17,500	e91,900	11,880	67,768	e9,200	e54,500
Dimension	short tons	W	W	67,533	10,302	e56,254	e10,992
Combined value of clays (common), lime, peat, and values indicated by symbol W		XX	20,973	XX	8,452	XX	10,138
Total		XX	192,238	XX	144,126	XX	127,498
MICHIGAN							
Cement:							
Masonry	thousand short tons	265	22,915	255	22,286	272	23,880
Portland	do.	5,253	231,141	5,449	253,324	5,906	263,607
Clays	metric tons	1,248,121	4,432	1,249,198	4,599	1,201,542	4,094
Gem stones		NA	25	NA	10	NA	11
Gypsum (crude)	thousand short tons	1,958	11,630	2,089	15,589	2,000	11,511
Iron ore	thousand metric tons	14,623	W	15,045	W	10,034	W
Lime	thousand short tons	714	36,088	621	32,479	622	30,898
Peat	do.	322	6,256	286	6,082	280	6,264
Sand and gravel:							
Construction	do.	53,508	138,171	e48,000	e132,000	53,729	153,057
Industrial	do.	3,045	27,150	2,865	24,577	2,310	19,285
Stone (crushed)	do.	e38,800	e120,300	40,905	123,678	e43,100	e129,000
Combined value of bromine (1988), calcium chloride (natural), copper, gold (1988-89), iron oxide pigments (crude), magnesium compounds, potash (1989-90), salt, silver, stone (dimension), and values indicated by symbol W		XX	989,453	XX	984,347	XX	796,516
Total		XX	1,587,561	XX	1,598,971	XX	1,438,123
MINNESOTA							
Gem stones		NA	40	NA	42	NA	46
Iron ore	thousand metric tons	40,735	1,134,539	41,044	r1,223,909	45,139	1,308,920
Peat	thousand short tons	29	1,414	r33	1,415	48	2,972
Sand and gravel (construction)	do.	33,769	72,678	e33,700	e82,600	33,869	77,502
Stone:							
Crushed	do.	e8,300	e28,200	8,760	30,218	e9,100	e31,900
Dimension	short tons	e45,000	e13,000	44,605	16,031	e60,195	e20,836

See footnotes at end of table.

TABLE 5—Continued

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

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
MINNESOTA—Continued							
Combined value of clays (common, kaolin), lime, and sand and gravel (industrial)		XX	$18,015	XX	$22,022	XX	$27,746
Total		XX	1,267,886	XX	1,376,237	XX	1,469,922
MISSISSIPPI							
Clays[2]	short tons	1,093,316	24,564	899,373	23,573	817,828	16,196
Gem stones		NA	1	NA	5	NA	1
Sand and gravel (construction)	thousand short tons	13,314	38,806	e15,600	e51,500	13,032	45,817
Stone (crushed)	do.	e1,500	e9,000	1,069	3,994	e1,400	e5,500
Combined value of cement, clays (ball, fuller's earth, [1990]), sand and gravel (industrial)		XX	31,029	XX	28,539	XX	44,799
Total		XX	103,400	XX	107,611	XX	112,313
MISSOURI							
Barite	thousand metric tons	24	1,930	W	W	W	W
Cement:							
Masonry	thousand short tons	153	6,310	W	W	W	W
Portland	do.	4,679	184,755	4,922	182,005	4,481	180,090
Clays[2]	metric tons	1,435,045	12,171	1,479,898	14,665	1,347,558	12,864
Iron ore	thousand metric tons	816	W	1,060	W	1,002	W
Lead[4]	metric tons	353,194	289,194	366,931	318,320	372,383	377,824
Sand and gravel:							
Construction	thousand short tons	11,217	32,941	e10,000	e32,500	9,243	25,097
Industrial	do.	744	9,876	750	9,972	W	W
Silver[4]	metric tons	45	9,550	53	9,456	35	5,462
Stone:							
Crushed	thousand short tons	e52,100	e183,000	51,754	171,848	e53,100	e190,900
Dimension	short tons	e3,644	e547	W	W	W	W
Zinc[4]	metric tons	41,322	54,842	50,790	91,885	48,864	80,355
Combined value of clays (fuller's earth), copper, gem stones, iron oxide pigments (crude), lime, and values indicated by symbol W		XX	182,833	XX	r219,236	XX	221,026
Total		XX	967,949	XX	1,049,887	XX	1,093,618
MONTANA							
Clays[2]	metric tons	91,802	1,416	95,743	1,835	29,741	193
Gem stones		NA	1,602	NA	2,500	NA	3,692
Gold[4]	kilograms	9,175	129,291	r12,434	r152,941	13,012	161,861
Gypsum (crude)	thousand short tons	27	W	W	W	—	—
Lead[4]	metric tons	8,266	6,768	W	W	W	W
Palladium metal[11]	kilograms	r3,730	r14,750	r4,850	r22,454	5,930	21,735
Platinum metal[12]	do.	r1,240	r20,850	r1,430	r23,310	1,810	26,478
Sand and gravel (construction)	thousand short tons	7,984	20,225	e5,800	e13,900	5,114	14,319
Silver[4]	metric tons	192	40,457	194	34,367	220	34,114
Stone (crushed)	thousand short tons	e1,800	e4,500	2,846	9,718	e4,000	e15,300
Talc and pyrophyllite	metric tons	415,642	14,524	453,978	12,718	430,125	18,883
Zinc[4]	do.	18,935	25,130	W	W	W	W

See footnotes at end of table.

TABLE 5—Continued

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

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
MONTANA—Continued							
Combined value of barite (1989-90), cement, clay (bentonite, [1990], fire clay, [1988-89]), copper, graphite (natural, 1988-89), iron ore, lime, molybdenum, peat, phosphate rock, sand and gravel (industrial), stone (dimension), vermiculite, and values indicated by symbol W		XX	$265,008	XX	$r292,394	XX	$271,109
Total		XX	544,521	XX	566,137	XX	567,684
NEBRASKA							
Clays	metric tons	215,419	786	224,624	880	227,292	1,685
Gem stones		NA	10	NA	2	NA	7
Sand and gravel (construction)	thousand short tons	11,229	28,928	e15,200	e41,800	11,453	30,056
Stone (crushed)	do.	e4,900	e22,000	3,978	20,050	e4,000	e21,200
Combined value of cement, lime, and sand and gravel (industrial)		XX	39,468	XX	41,085	XX	37,381
Total		XX	91,192	XX	103,817	XX	90,329
NEVADA							
Barite	thousand metric tons	289	5,053	209	3,473	337	5,884
Clays[2]	metric tons	26,186	2,143	57,264	5,457	34,625	4,098
Gem stones		NA	280	NA	1,402	NA	407
Gold[4]	kilograms	114,322	1,611,020	r153,995	r1,894,172	176,551	2,196,191
Lead[4]	metric tons	W	W	—	—	830	842
Perlite	short tons	5,000	42	5,000	136	W	W
Sand and gravel:							
Construction	thousand short tons	15,729	50,928	e20,000	e70,000	18,377	59,008
Industrial	do.	602	W	718	W	07	W
Silver[4]	metric tons	608	127,760	625	110,442	708	109,653
Stone (crushed)	thousand short tons	e41,300	e45,700	1,560	4,638	e1,600	e5,000
Zinc[4]	do.	—	—	—	—	7,889	12,973
Combined value of brucite (1989-90), cement (portland), clays (fuller's earth [1990], kaolin), copper, diatomite, fluorspar, gypsum (crude), lime, lithium minerals, magnesite, mercury, molybdenum (1990), salt, stone (crushed dolomite, 1988), and values indicated by symbol W		XX	151,356	XX	r220,441	XX	216,820
Total		XX	1,954,382	XX	2,310,161	XX	2,610,876
NEW HAMPSHIRE							
Gem stones		NA	$100	NA	$51	NA	$8
Sand and gravel (construction)	thousand short tons	9,089	32,614	e6,000	e20,400	7,901	26,599
Stone:							
Crushed	do.	e2,400	e9,800	771	4,020	e600	e2,500
Dimension	short tons	e73,393	e10,546	55,305	8,769	e45,073	e6,029
Total[8]		XX	53,060	XX	33,240	XX	35,166
NEW JERSEY							
Clays[2]	metric tons	14,954	368	18,492	400	W	W
Gem stones		NA	3	NA	3	NA	3
Peat	thousand short tons	43	797	W	638	W	527
Sand and gravel:							
Construction	do.	18,318	74,183	e15,200	e68,400	13,862	64,245
Industrial	do.	1,860	25,437	1,797	26,138	1,762	26,190

See footnotes at end of table.

TABLE 5—Continued

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

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
NEW JERSEY—Continued							
Stone (crushed)	thousand short tons	[3]e19,300	[3]e$123,500	20,799	$140,998	e21,200	e$131,700
Zircon concentrates	metric tons	W	W	W	8,988	W	W
Combined value of clays (common and fire [1990]), marl (greensand), stone (crushed limestone 1988), and values indicated by symbol W		XX	10,044	XX	3,318	XX	6,805
Total		XX	234,332	XX	248,883	XX	229,470
NEW MEXICO							
Clays	metric tons	28,555	83	31,012	94	[2]27,994	[2]74
Copper[4]	do.	258,660	687,182	r259,640	r749,540	262,815	713,622
Gem stones		NA	200	NA	279	NA	225
Gold[4]	kilograms	W	W	1,076	13,231	888	11,041
Perlite	short tons	458,000	14,294	487,000	13,080	501,000	11,049
Potash	thousand metric tons	1,271	213,800	1,365	242,619	1,451	245,571
Pumice	metric tons	76,204	852	77,000	795	W	W
Sand and gravel (construction)	thousand short tons	8,787	31,367	e11,800	e45,400	10,362	39,708
Silver[4]	metric tons	W	W	W	W	48	7,431
Stone:							
Crushed	thousand short tons	e3,500	e13,900	2,784	11,672	e2,400	e12,800
Dimension	short tons	e21,893	e626	W	W	W	W
Combined value of cement, clays (fire, 1990), gypsum (crude), helium (Grade-A), iron ore (includes by-product material), lead, mica (scrap), molybdenum, salt, zinc (1989-90), and values indicated by symbol W		XX	60,368	XX	r45,593	XX	56,029
Total		XX	1,022,672	XX	1,122,303	XX	1,097,550
NEW YORK							
Clays	metric tons	551,375	3,654	531,559	3,429	490,552	2,906
Gem stones		NA	200	NA	350	NA	365
Peat	thousand short tons	W	W	W	10	W	W
Salt	do.	4,614	127,994	5,424	161,427	5,401	162,900
Sand and gravel:							
Construction	do.	33,884	124,341	e31,600	e118,500	29,750	121,525
Industrial	do.	53	625	53	633	W	W
Stone:							
Crushed	thousand short tons	e39,900	e193,500	39,851	201,749	e39,900	e207,600
Dimension	short tons	e30,751	e4,333	23,756	3,575	e23,437	e3,589
Combined value of cement, emery (1988), garnet, gypsum (crude), iron ore (includes byproduct material, 1988-89), lead, silver, talc and pyrophyllite, wollastonite, zinc, and values indicated by symbol W		XX	241,053	XX	255,495	XX	273,954
Total		XX	695,700	XX	745,168	XX	772,839
NORTH CAROLINA							
Clays	metric tons	2,880,103	16,349	2,270,384	15,529	[2]2,179,428	[2]9,356
Feldspar	do.	460,838	17,312	435,845	14,024	418,402	13,389
Gem stones		NA	688	NA	784	NA	1,057
Mica (scrap)	thousand metric tons	79	4,512	73	4,192	65	3,796
Peat	thousand short tons	21	W	W	W	13	W
Sand and gravel:							
Construction	do.	11,076	38,459	e11,200	e43,700	11,733	44,872

See footnotes at end of table.

TABLE 5—Continued

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

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
NORTH CAROLINA—Continued							
Sand and gravel—Continued							
Industrial	thousand short tons	1,246	$15,953	1,627	$19,902	1,177	$15,338
Stone:							
Crushed	do.	e50,500	e250,000	51,519	257,976	e52,900	e276,200
Dimension	short tons	e31,977	e5,0266	2,665	10,477	e66,531	e11,551
Combined value of clays (kaolin, 1990), lithium minerals, olivine, phosphate rock, talc and pyrophyllite, and values indicated by symbol W		XX	181,135	XX	214,984	XX	189,032
Total		XX	529,434	XX	581,568	XX	564,591
NORTH DAKOTA							
Clays	metric tons	76,918	147	47,903	W	50,485	W
Gem stones		NA	2	NA	10	NA	10
Lime	thousand short tons	108	7,094	107	5,439	82	4,623
Sand and gravel (construction)	do.	3,772	8,079	e3,600	e8,100	7,644	17,219
Stone (crushed)	short tons	W	W	—	—	e1,000	e4,600
Combined value of other industrial minerals and values indicated by symbol W		XX	3,485	XX	111	XX	116
Total		XX	18,807	XX	13,660	XX	26,568
OHIO							
Cement:							
Masonry	thousand short tons	129	11,140	128	11,233	124	10,880
Portland	do.	1,424	70,816	1,446	73,230	1,426	72,883
Clays	metric tons	3,365,164	14,423	3,519,668	14,983	2,546,151	13,334
Gem stones		NA	10	NA	18	NA	W
Lime	thousand short tons	2,065	87,431	1,888	94,157	1,884	92,817
Peat	do.	W	W	8	182	12	182
Salt	do.	3,795	115,860	W	W	W	W
Sand and gravel:							
Construction	do.	46,104	156,318	e44,400	e148,700	44,552	165,394
Industrial	do.	1,361	23,441	1,394	24,662	1,349	24,205
Stone:							
Crushed	thousand short tons	e48,000	e252,000	46,426	183,190	e48,400	e190,900
Dimension	short tons	e38,300	e3,137	59,923	3,455	e61,783	e3,468
Combined value of other industrial minerals and values indicated by symbol W		XX	2,676	XX	145,346	XX	154,777
Total		XX	737,252	XX	699,156	XX	728,840
OKLAHOMA							
Cement (portland)	thousand short tons	1,4324	2,131	1,236	39,360	1,544	60,457
Clays	metric tons	684,067	1,803	565,956	1,619	631,302	3,156
Gem stones		NA	18	NA	W	NA	W
Gypsum (crude)	thousand short tons	2,1731	3,393	2,523	14,369	2,184	11,154
Iodine (crude)	kilograms	1,015,210	W	1,505,714	23,947	1,972,849	30,486
Sand and gravel:							
Construction	thousand short tons	9,273	22,654	e8,500	e20,000	9,235	21,993
Industrial	do.	1,268	17,381	1,216	18,310	1,258	22,984
Stone:							
Crushed[3]	do.	e26,300	e92,000	23,598	81,969	e25,300	e89,500
Dimension	short tons	e7,746	e785	8,290	762	e8,138	e684

See footnotes at end of table.

TABLE 5—Continued

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

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
OKLAHOMA—Continued							
Tripoli	metric tons	W	W	W	W	18,801	$155
Combined value of cement (masonry), feldspar, lime, salt (1988, 1990), stone (crushed dolomite [1988], crushed granite [1989-90]), and values indicated by symbol W		XX	$29,972	XX	$18,695	XX	19,608
Total		XX	220,137	XX	219,031	XX	260,177
OREGON							
Clays	metric tons	225,001	1,049	210,893	875	223,452	1,390
Gem stones		NA	894	NA	1,304	NA	1,683
Nickel (content of ores and concentrates)	short tons	—	—	382	r4,662	4,080	W
Sand and gravel (construction)	thousand short tons	14,880	52,657	e14,400	e49,700	15,785	60,928
Stone (crushed)	do.	e22,200	e77,600	218,407	281,204	e 218,000	e 286,600
Talc and pyrophyllite	metric tons	W	W	204	18	105	10
Combined value of cement, diatomite, emery (1989-90), gold, lime, pumice, silver, stone (crushed dolomite and quartzite, 1989), value indicated by symbol W		XX	45,988	XX	r49,965	XX	86,795
Total		XX	178,188	XX	187,728	XX	237,406
PENNSYLVANIA							
Cement:							
Masonry	thousand short tons	391	28,713	349	26,473	303	22,594
Portland	do.	6,309	329,634	5,757	301,980	5,621	286,185
Clays[2]	metric tons	1,248,139	5,843	1,049,973	4,936	840,646	2,900
Gem stones		NA	5	NA	5	NA	5
Lime	thousand short tons	1,641	91,214	1,660	92,139	1,626	92,557
Peat	do.	21	736	20	746	18	730
Sand and gravel (construction)	do.	19,826	91,966	e19,500	e94,600	20,883	97,348
Stone:							
Crushed	thousand short tons	e104,600	e470,700	393,123	3455,004	e 395,800	e 3502,700
Dimension	short tons	e59,022	e9,584	44,267	10,032	e43,952	e9,898
Combined value of clays (fire, [1990], kaolin), mica (scrap), sand and gravel (industrial), stone (crushed granite, 1989-90), and tripoli		XX	14,098	XX	14,754	XX	15,125
Total		XX	1,042,493	XX	1,000,669	XX	1,030,042
RHODE ISLAND							
Gem stones		NA	1	NA	2	NA	2
Sand and gravel (construction)	thousand short tons	1,853	7,847	e1,100	e3,900	1,969	9,042
Stone (crushed)	do.	e1,500	e9,400	131,208	7,170	e 131,600	e8,800
Total[8]		XX	17,248	XX	11,072	XX	17,844
SOUTH CAROLINA							
Cement (portland)	thousand short tons	2,533	118,670	2,188	99,083	2,464	109,644
Clays	metric tons	1,867,829	40,541	1,596,153	39,075	2,062,824	44,486
Gem stones		NA	10	NA	10	NA	10
Sand and gravel:							
Construction	thousand short tons	7,529	20,751	e7,500	e23,300	8,627	24,941
Industrial	do.	859	15,271	842	16,635	844	15,972

See footnotes at end of table.

TABLE 5—Continued

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

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
SOUTH CAROLINA—Continued							
Stone:							
Crushed[3]	thousand short tons	e23,500	e$105,800	24,429	$111,656	e26,200	e$135,400
Dimension	short tons	e353	e31	W	W	W	W
Combined value of cement (masonry), gold, manganiferous ore, mica (scrap), peat, silver, stone (crushed shell), vermiculite, and values indicated by symbol W		XX	56,728	XX	135,538	XX	119,400
Total		XX	357,802	XX	425,297	XX	449,853
SOUTH DAKOTA							
Cement:							
Masonry	thousand short tons	4	W	W	W	W	W
Portland	do.	490	W	W	W	W	W
Gem stones		NA	100	NA	150	NA	110
Gold[4]	kilograms	13,981	197,026	16,123	198,318	16,860	209,732
Lead[4]	metric tons	—	—	4	3	—	—
Sand and gravel (construction)	thousand short tons	7,929	18,681	e6,400	e20,800	9,689	23,689
Silver[4]	metric tons	3	552	4	705	6	940
Stone:							
Crushed	thousand short tons	e5,500	e20,600	3,833	14,303	e4,800	e16,800
Dimension	short tons	e43,297	e16,472	54,623	17,738	e50,688	e12,871
Combined value of clays (common), feldspar, gypsum (crude), iron ore, lime, mica (scrap) and values indicated by symbol W		XX	32,288	XX	32,341	XX	34,310
Total		XX	285,719	XX	284,358	XX	298,452
TENNESSEE							
Clays[2]	metric tons	1,165,736	27,696	1,137,152	26,292	1,060,66	225,776
Sand and gravel (construction)	thousand short tons	6,836	23,343	e6,100	e21,900	7,619	23,474
Stone:							
Crushed	do.	e52,200	e235,000	52,917	252,785	e54,600	e268,600
Dimension	short tons	e3,942	e567	4,888	437	e10,108	e2,051
Zinc[4]	metric tons	119,954	159,201	W	W	W	W
Combined value of barite (1988-89), cement, clays (bentonite [1988], common [1989], fuller's earth), copper, gem stones, lead, lime, phosphate rock, sand and gravel (industrial), silver, and values indicated by symbol W		XX	139,842	XX	336,993	XX	342,659
Total		XX	585,649	XX	638,407	XX	662,560
TEXAS							
Cement:							
Masonry	thousand short tons	136	10,800	133	10,735	142	10,106
Portland	do.	7,000	292,256	7,200	286,236	7,678	296,680
Clays[2]	metric tons	2,714,451	17,468	2,276,629	15,962	2,162,095	14,652
Gem stones		NA	340	NA	W	NA	W
Gypsum (crude)	thousand short tons	1,943	15,790	1,993	17,044	1,868	10,166
Lime	do.	1,192	55,935	1,304	60,829	1,337	76,181
Salt	do.	7,802	62,925	7,856	69,934	8,212	75,149
Sand and gravel:							
Construction	do.	50,370	171,167	e43,900	e155,800	46,083	158,080

See footnotes at end of table.

TABLE 5—Continued

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

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
TEXAS—Continued							
Sand and gravel—Continued							
Industrial	thousand short tons	1,631	$26,645	1,661	$29,107	1,849	$40,880
Stone:							
Crushed	do.	e82,000	e271,300	76,823	252,982	e81,800	e285,700
Dimension	short tons	e66,354	e8,310	81,268	12,449	e84,500	e12,600
Sulfur (Frasch)	thousand metric tons	2,622	W	2,446	W	2,340	W
Talc and pyrophyllite	metric tons	236,729	4,466	241,777	4,564	227,138	4,844
Combined value of clays (ball clay, [1988-89], bentonite [1990], fuller's earth [1990], kaolin), helium (crude and Grade-A), iron ore, magnesium compounds, magnesium metal, sodium sulfate (natural), and values indicated by symbol W		XX	531,416	XX	546,812	XX	472,187
Total		XX	1,468,818	XX	1,462,454	XX	1,457,225
UTAH							
Beryllium concentrates	metric tons	5,308	6	4,592	5	4,548	5
Cement (portland)	thousand short tons	772	39,664	W	W	W	W
Clays	metric tons	308,585	2,469	321,949	2,633	[2]277,795	[2]1,774
Gem stones		NA	370	NA	659	NA	713
Lime	thousand short tons	365	17,252	373	17,974	354	18,878
Salt	do.	1,006	35,294	1,183	40,421	1,171	50,436
Sand and gravel:							
Construction	do.	17,843	49,796	e14,300	e41,500	13,601	44,881
Industrial	do.	3	60	3	60	2	42
Silver[3]	metric tons	W	W	W	W	147	22,750
Stone:							
Crushed	thousand short tons	e7,300	e20,600	4,683	19,176	e4,600	e20,200
Dimension	short tons	e2,004	e93	—	—	—	—
Combined value of cement (masonry), clays (bentonite, 1990), copper, fluorspar, gold, gypsum (crude), iron ore, magnesium copmpounds, magnesium metal, mercury, molybdenum, phosphate rock, potash, silver, sodium sulfate (natural), vanadium, and values indicated by symbol W		XX	849,243	XX	r1,168,065	XX	1,174,331
Total		XX	1,014,847	XX	1,290,493	XX	1,334,010
VERMONT							
Gem stones		NA	10	NA	10	NA	10
Sand and gravel (construction)	thousand short tons	6,047	17,478	e6,900	e20,400	3,675	11,948
Stone:							
Crushed	do.	e [2]2,000	e [2]18,000	3,119	28,110	e3,700	e35,000
Dimension	short tons	e105,000	e30,500	100,698	31,413	e99,243	e28,950
Combined value of other industrial minerals		XX	9,667	XX	8,969	XX	6,046
Total		XX	75,655	XX	88,902	XX	81,954
VIRGINIA							
Clays[2]	metric tons	1,010,114	6,614	1,001,394	6,302	882,383	3,741
Gem stones		NA	20	NA	27	NA	34
Lime	thousand short tons	741	33,875	821	38,353	846	39,784
Sand and gravel (construction)	do.	12,551	42,573	e12,900	e49,700	13,096	48,950
Stone:							
Crushed	do.	e66,000	e326,700	64,061	328,050	e59,400	e320,000
Dimension	short tons	e10,000	e2,900	W	W	W	W

See footnotes at end of table.

TABLE 5—Continued

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

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
VIRGINIA—Continued							
Combined value of aplite, cement, clays (fuller's earth), gypsum (crude), iron oxide pigments (crude), kyanite, sand and gravel (industrial), talc and pyrophyllite, vermiculite, and values indicated by symbol W		XX	$81,830	XX	r$86,669	XX	$94,766
Total		XX	494,512	XX	509,101	XX	507,275
WASHINGTON							
Cement (portland)	thousand short tons	979	48,233	W	W	W	W
Clays	metric tons	376,924	2,235	233,267	1,591	158,257	1,357
Gem stones		NA	200	NA	208	NA	281
Gold[3]	kilograms	W	W	W	W	9,620	119,671
Peat	thousand short tons	5	142	W	W	W	W
Sand and gravel (construction)	do.	31,170	94,402	e37,800	e124,700	40,251	133,067
Stone:							
Crushed	do.	e13,900	e48,700	13,259	55,624	e12,700	e41,900
Dimension	short tons	e697	e60	W	W	W	W
Combined value of calcium chloride (natural, 1988), cement (masonry), diatomite, gypsum (crude), lime, magnesium metal, olivine, sand and gravel (industrial), silver, and values indicated by symbol W		XX	265,362	XX	298,756	XX	176,953
Total		XX	459,334	XX	480,879	XX	473,229
WEST VIRGINIA							
Clays	metric tons	239,473	586	251,385	553	164,257	384
Gem stones		NA	1	NA	1	NA	1
Sand and gravel (construction)	thousand short tons	1,653	6,099	e2,300	e6,700	e3,208	e14,950
Stone (crushed)	do.	e11,600	e47,600	310,904	342,538	e[3]12,000	e[3]45,200
Combined value of cement, lime, peat (1988, 1990), salt, sand and gravel (industrial), and stone (crushed granite, 1989-90)		XX	73,169	XX	75,706	XX	75,803
Total		XX	127,455	XX	125,498	XX	136,338
WISCONSIN							
Gem stones		NA	15	NA	W	NA	W
Lime	thousand short tons	452	23,986	437	18,129	461	24,608
Peat	do.	11	270	13	309	12	256
Sand and gravel:							
Construction	do.	25,048	60,080	e21,700	e56,400	29,572	73,750
Industrial	do.	1,351	15,458	1,514	22,399	W	W
Stone:							
Crushed	do.	e[2]28,500	e[2]98,300	26,520	83,664	e26,600	e91,000
Dimension	short tons	e49,900	e6,200	35,587	4,376	e31,316	e3,811
Combined value of other industrial minerals and value indicated by symbol W		XX	564	XX	(9)	XX	18,622
Total		XX	204,873	XX	[8]185,277	XX	212,047
WYOMING							
Clays[2]	metric tons	2,138,796	72,174	2,166,497	74,697	2,523,573	76,082
Gem stones		NA	150	NA	157	NA	151
Lime	thousand short tons	26	1,640	W	W	W	W
Sand and gravel (construction)	do.	3,413	11,351	e4,500	e15,400	4,329	14,446
Stone (crushed)	do.	e2,500	e11,400	2,990	12,120	e2,200	e14,000

See footnotes at end of table.

TABLE 5—Continued

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

Mineral	1988		1989		1990	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
WYOMING—Continued						
Combined value of cement, clays (common), gypsum (crude), helium (Grade-A), soda ash, and values indicated by symbol W	XX	$613,097	XX	$724,987	XX	$806,169
Total	XX	709,812	XX	827,361	XX	910,848
UNDISTRIBUTED						
Delaware, Hawaii, Hew Hampshire, Rhode Island, Wisconsin (1989), and undistributed (1989)	XX	7,812	XX	9,043	XX	5,938

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]Beginning with 1989 data reported in B_2O_3, 1988 data converted.
[7]Less than 1/2 unit.
[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]Value excluded to avoid disclosing company proprietary data.
[10]Excludes salt in brines; value included with "Combined value" figure.
[11]Palladium metal separated from platinum-group metals in 1990. 1988-89 data revised.
[12]Platinum metal separated from platinum-group metals in 1990. 1988-89 data revised.
[13]Excludes traprock.

TABLE 6

NONFUEL MINERAL PRODUCTION[1] IN THE ISLANDS ADMINISTERED BY THE UNITED STATES

Mineral	1988		1989		1990	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
American Samoa: Stone (crushed) thousand short tons	—	—	48	$476	—	—
Guam: Stone (crushed) do.	—	—	1,063	11,133	—	—
Virgin Islands: Stone (crushed) do.	—	—	312	3,159	—	—
Total	XX	—	XX	14,768	XX	—

XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

TABLE 7

NONFUEL MINERAL[1] PRODUCTION IN THE COMMONWEALTH OF PUERTO RICO

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland)	thousand short tons	1,397	$113,966	1,374	$112,318	1,486	$122,027
Clays	metric tons	148,218	365	136,873	311	W	W
Lime	thousand short tons	25	3,802	26	3,800	29	3,483
Salt	do.	40	900	—	—	—	—
Sand and gravel (industrial)	do.	31	624	30	600	55	825
Stone (crushed)	do.	e9,350	e47,400	8,389	46,648	NA	NA
Total[2]		XX	167,057	XX	163,677	XX	126,335

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.

TABLE 8

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

Mineral		1989[r]		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS					
Aluminum:					
Aluminum sulfate	metric tons	941	$1,208	6,807	$1,299
Castings and forgings	do.	20,482	128,974	7,003	67,981
Metals and alloys, crude	do.	593,103	1,260,475	679,803	1,160,509
Plates, sheets, bars, etc.	do.	446,233	1,379,982	437,662	1,406,498
Scrap	do.	575,419	769,380	537,298	719,017
Other aluminum compounds (fluorides and chlorides)	do.	34,315	23,993	13,915	18,129
Antimony:					
Metal, alloys, crude, waste and scrap	do.	293	694	588	1,143
Oxide	do.	2,229	6,106	8,605	13,962
Bauxite (dried and calcined)	thousand metric tons	44	9,830	74	12,644
Beryllium, alloys, waste and scrap	kilograms	34,261	3,847	45,227	4,831
Bismuth metal, alloys, waste, and scrap	do.	122,171	540	121,677	878
Cadmium metal, alloys, dross, flue dust, etc.	metric tons	369	857	385	1,174
Chromium (gross weight):					
Chemicals	metric tons	23,303	23,626	22,500	26,449
Chromite ore and concentrate	do.	40,445	5,014	6,321	1,488
Metal and alloys:					
Chromium metal	do.	196	4,097	338	3,447
Chromium ferroalloys	do.	9,464	11,037	9,118	10,537
Pigments	do.	2,264	7,654	2,643	9,252
Cobalt:					
Cobalt ores and concentrates (gross weight)	do.	28	253	49	416
Metal (unwrought cobalt, powders, matte, waste and scrap (estimated cobalt content)	do.	355	9,452	543	8,880
Oxides and hydroxides (estimated cobalt content)	do.	603	6,073	922	6,776
Salts and compounds (estimated cobalt content)	do.	101	1,724	542	2,477
Wrought cobalt and cobalt articles (gross weight)	do.	171	7,033	481	12,300
Columbium metal, compounds, and alloys (gross weight)	thousand pounds	NA	NA	NA	NA
Copper:					
Blister and anodes	metric tons	5,475	14,664	6,422	14,701
Matte, ash, and precipitates (copper content)	do.	14,945	35,363	31,709	40,977
Ore and concentrate (copper content)	do.	266,831	539,325	258,235	401,785
Refined copper	do.	130,189	303,013	211,164	554,833
Scrap:					
Alloy	do.	212,522	314,521	184,766	292,723
Unalloyed scrap only	do.	154,935	244,195	139,624	227,418
Semimanufactures, copper and copper alloy	do.	70,984	270,587	68,519	278,528
Ferroalloys not elsewhere listed:					
Ferrophosphorous	do.	22,587	3,511	5,981	2,344
Ferroalloys, n.e.c.	do.	6,026	9,068	3,893	5,229
Gold:					
Bullion, refined	kilograms	123,599	1,490,151	140,923	1,719,470
Dore and precipitates	do.	42,935	242,690	88,203	413,980
Ores and concentrates	do.	16	165	328	3,721
Wastes and scrap	do.	44,541	542,150	66,943	729,150

See footnotes at end of table.

TABLE 8—Continued

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

Mineral		1989[r]		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued					
Iron ore (gross weight):					
Coarse ores	thousand metric tons	—	—	6	$213
Concentrates	do.	353	$13,887	11	333
Fine ores	do.	[1]145	[1]559	10	346
Pellets	do.	4,852	177,980	3,018	116,845
Roasted pyrites	do.	1	117	19	840
Other	do.	14	252	136	5,498
Iron chemicals (gross weight):					
Chlorides	metric tons	172	202	1,781	1,218
Sulfates	do.	—	—	—	—
Iron and steel:					
Iron and steel products (major):					
Fabricated steel products	thousand short tons	520	400,588	698	[e]420,000
Steel mill products	do.	4,578	2,063,103	4,303	[e]2,800,000
Other steel products	do.	120	117,995	131	[e]55,000
Iron and steel scrap: Ferrous scrap used rails for rerolling and other uses, and ships, boats, and other vessels for scrapping	thousand short tons	12,477	1,785,403	12,842	1,653,445
Pig iron	short tons	11,747	1,334	15,933	1,618
Lead:					
Ash and residues (lead content)	metric tons	9,960	5,612	12,765	8,096
Blocks, pigs, anodes, etc. (lead content)	do.	28,512	30,091	57,226	59,080
Ore and concentrate (lead content)	do.	57,038	23,516	56,600	33,369
Scrap (gross weight)	do.	59,909	26,165	75,507	33,934
Wrought and alloy	do.	5,365	14,113	6,759	19,923
Magnesium, metal and alloys, scrap, semimanufactured forms, n.e.c. (gross weight)	do.	56,631	170,374	51,834	164,413
Manganese:					
Ferromanganese (all grades)	short tons	9,014	7,310	8,302	6,565
Metal (includes alloys, waste, and scrap)	do.	5,667	10,632	6,773	14,043
Ore and concentrates	do.	57,191	5,014	77,101	9,297
Silicomanganese	do.	5,858	4,068	1,974	1,666
Mercury metal	metric tons	221	1,874	NA	NA
Molybdenum:					
Ferromolybdenum (gross weight)	do.	75	615	300	2,372
Molybdates, all (gross weight)	do.	295	2,338	680	3,963
Ore and concentrates (molybdenum content)	do.	51,231	272,336	41,380	169,888
Powder (gross weight)	do.	634	3,846	292	4,565
Unwrought (gross weight)	do.	253	3,215	180	2,453
Wire (gross weight)	do.	340	10,867	338	12,863
Wrought (gross weight)	do.	336	8,219	190	7,595
Nickel:					
Compound catalysts and waste and scrap	short tons	14,205	80,614	17,828	89,476
Primary (cathodes, pellets, briquets [unwrought], electroplating, ferronickel, powder, and flakes)	do.	2,302	XX	3,642	XX
Stainless steel scrap (nickel content)	do.	21,871	320,683	19,260	212,368
Wrought (bars, rods, profiles, wire, sheets, strips, foil, tubes, and pipes)	do.	592	11,951	457	5,047

See footnotes at end of table.

TABLE 8—Continued

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

Mineral		1989[r]		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued					
Platinum-group metals:					
Iridium, ruthenium, and osmium	kilograms	507	$4,232	782	$4,409
Platinum	do.	8,414	135,469	7,510	113,329
Palladium	do.	13,005	72,849	10,887	49,576
Rhodium	do.	1,156	28,519	969	45,050
Waste and scrap	do.	15,046	157,040	34,487	201,538
Rare-earth metals:					
Cerium compounds	do.	1,432,672	7,026	1,729,771	9,983
Rare-earth metals, including scandium and yttrium	do.	424,837	4,801	201,122	1,250
Thorium ore and concentrates	metric tons	2,000	30	—	—
Selenium	do.	372,126	3,429	194,608	1,458
Silicon:					
Ferrosilicon	do.	49,054	40,883	50,079	43,993
Silicon metal	do.	5,045	84,074	8,980	92,229
Silver:					
Bullion, refined	kilograms	430,110	77,812	735,993	119,892
Doré and precipitates	do.	78,664	15,478	13,184	2,353
Ores and concentrates	do.	607	166	21,861	3,994
Waste and scrap	do.	770,788	145,340	1,077,421	159,194
Tantalum:					
Unwrought (waste and scrap, powders, alloys, and metal)	do.	389	25,962	406	29,200
Wrought	do.	180	21,715	132	20,068
Tin:					
Ingots, pigs, and bars	metric tons	904	8,915	658	3,344
Tinplate and terneplate	do.	178,884	101,279	145,396	78,687
Tin scrap and other tin bearing material, except tinplate scrap, (includes bars, rods, profiles, wire, powders, flakes, tubes, and pipes	thousand pounds	100,703	54,135	106,288	55,913
Titanium:					
Ore and concentrates	do.	19,832	5,900	18,765	7,398
Other unwrought (billet, blooms and sheet bars, ingots, etc.)	do.	3,875	63,772	5,472	69,235
Pigments and oxides	do.	212,197	437,645	202,288	434,560
Scrap	do.	5,474	22,909	5,487	22,443
Sponge	do.	136	910	331	2,073
Wrought (bars, rods, etc.)	do.	3,857	110,511	4,526	148,290
Tungsten (tungsten content):					
Ammonium paratungstate	do.	178	1,503	356	2,456
Carbide powder	do.	1,360	27,209	1,074	21,946
Metal and alloy	do.	762	15,554	988	18,587
Miscellaneous tungsten-bearing materials (wire, crude form, waste and scrap, ferrotungsten, ferrosilicon tungsten, and compounds	do.	896	36,367	795	36,683
Ore and concentrate	do.	203	1,539	139	765
Vanadium:					
Ferrovanadium	kilograms	493,055	5,299	334,272	5,480
Other compounds	do.	1,550,381	4,262	976,481	6,024
Pentoxide, anhydride	do.	3,741,234	35,204	1,461,453	10,142

See footnotes at end of table.

TABLE 8—Continued

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

Mineral		1989[r]		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued					
Zinc:					
Blocks, pigs, anodes, etc.	metric tons	7,955	$14,433	5,804	$11,304
Dust and flakes	do.	8,137	13,861	8,701	17,039
Ore and concentrate	do.	78,877	64,224	220,446	188,686
Waste and scrap (zinc content)	do.	108,086	75,947	109,316	85,749
Wrought zinc and zinc alloys	do.	19,168	18,488	15,612	18,541
Zinc oxide	do.	12,286	17,872	7,141	10,032
Zirconium:					
Ore and concentrates	do.	48,071	31,134	30,195	21,101
Unwrought waste and scrap	do.	232	5,974	188	3,057
INDUSTRIAL MINERALS					
Abrasives (includes reexports):					
Diamond grinding wheels	thousand wheels	770	10,195	777	14,069
Abrasives (includes reexports)—Continued					
Industrial diamond, natural or synthetic:					
Powder or dust	thousand carats	78,235	124,180	71,041	109,500
Other	do.	2,755	33,248	1,698	20,120
Other natural and artificial metallic abrasives and products		XX	126,810	XX	151,784
Asbestos:					
Exports (includes reexports):					
Products		NA	153,081	NA	120,328
Unmanufactured	metric tons	27,004	7,690	27,965	7,964
Barite: Natural barium sulfate	do.	9,709	1,622	9,227	1,675
Boron:					
Boric acid	thousand metric tons	42	32,613	39	31,679
Sodium borates	do.	646	361,000	585	208,433
Bromine:					
Compounds (contained bromine)	thousand kilograms	28,998	24,093	14,443	18,166
Elemental	do.	3,557	3,165	2,932	4,008
Calcium chloride	metric tons	20,316	5,695	23,300	6,615
Cement: Hydraulic and clinker	thousand short tons	512	25,561	554	38,306
Clays:					
Bentonite	thousand metric tons	671	52,946	699	57,112
Kaolin and china clay	do.	2,337	370,919	2,826	427,890
Other	do.	748	126,478	566	98,237
Diatomite	metric tons	137	41,290	144	42,327
Feldspar, leucite, nepheline syenite	do.	9,329	829	24,795	2,167
Fluorspar	do.	5,134	694	14,921	1,891
Gem stones (including reexports):					
Diamonds	thousand carats	1,050	1,243,700	1,004	1,899
Pearls		NA	7,300	NA	900
Other		NA	222,200	NA	41,106
Graphite, natural and artificial[2]	metric tons	48,729	33,387	44,622	41,106
Gypsum:					
Boards	thousand short tons	97	25,140	69	30,959
Crude	do.	108	2,286	129	5,056
Plasters	do.	106	15,914	94	18,381
Other	do.	NA	16,972	30,056	84,452

See footnotes at end of table.

TABLE 8—Continued

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

Mineral		1989[r]		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)
INDUSTRIAL MINERALS—Continued					
Helium (Grade-A)	million cubic feet	796	$33,830	892	$33,450
Iron oxide pigments:					
Pigment grade	metric tons	9,966	15,700	9,510	18,533
Other grade	do.	34,631	54,567	198,631	110,732
Lime	short tons	32,241	3,893	44,287	4,755
Lithium compounds:					
Lithium carbonate	kilograms	9,045,732	28,214	9,312,903	30,160
Lithium hydroxide	do.	4,691,991	17,914	3,147,248	12,953
Lithium metal	do.	141,225	NA	111,737	NA
Magnesium compounds:					
Calcined dolomite	metric tons	39,639	10,683	10,379	2,213
Caustic-calcined magnesia	do.	4,375	2,263	2,313	1,406
Compounds, includes magnesium hydroxide, magnesium peroxide, magnesium chloride, and magnesium sulfate	metric tons	14,851	6,100	14,162	14,165
Dead-burned and fused magnesia	do.	22,525	10,685	58,610	19,709
Magnesite, natural	do.	10,380	8,299	8,009	8,060
Other magnesia	do.	15,843	9,213	37,747	16,108
Mica:					
Crude and rifted	do.	1,082	476	572	427
Powder	do.	1,230	1,634	4,319	2,050
Waste	do.	202	235	156	491
Worked	do.	415	7,227	612	7,567
Nitrogen compounds (major):					
Fertilizer materials	thousand short tons	13,569	NA	13,032	NA
Industrial chemicals	do.	192	150,813	89	126,658
Phosphate rock (ground and unground)	thousand metric tons	8,323	288,990	6,959	254,104
Phosphatic fertilizers:					
Diammonium and monoammonium phosphates	thousand metric tons	9,102	1,608,264	8,493	1,414,219
Elemental phosphorus	metric tons	19,934	28,294	17,916	29,620
Phosphoric acid	thousand metric tons	703	124,074	555	95,881
Superphosphates	do.	534	151,861	747	100,630
Potash:					
Potassium chloride	metric tons	496,575	NA	445,810	NA
Potassium sulfate, all grades	do.	448,880	NA	561,914	NA
Quartz crystal:					
Cultured	thousand kilograms	57	2,600	39	1,745
Natural	do.	NA	NA	NA	NA
Salt, crude and refined	thousand short tons	1,567	20,211	2,498	32,944
Sand and gravel:					
Construction:					
Gravel	do.	852	7,703	NA	NA
Sand	do.	273	5,888	468	11,880
Industrial sand and gravel	do.	2,060	78,308	1,155	83,826
Sodium compounds:					
Soda ash	thousand metric tons	2,648	365,469	2,392	346,693

See footnotes at end of table.

TABLE 8—Continued

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

Mineral		1989[r] Quantity	1989[r] Value (thousands)	1990 Quantity	1990 Value (thousands)
INDUSTRIAL MINERALS—Continued					
Sodium compounds—Continued					
Sodium sulfate	thousand metric tons	62	$6,241	62	$6,704
Stone:					
Crushed	thousand short tons	3,900	23,345	5,100	41,400
Dimension		NA	34,610	NA	42,668
Strontium compounds	metric tons	3,200	NA	1,300	NA
Sulfur, elemental	thousand metric tons	1,024	107,126	972	109,327
Talc, crude and ground	do.	319	28,949	238	32,909
Total[3]		XX	21,558,000	XX	20,868,000

[r]Revised. NA Not available. XX Not applicable.
[1]Either quantity or value data are incorrect. The U.S. Bureau of Mines and Bureau of the Census were unable to verify the correct data at time of publication.
[2]Artificial graphite includes a large amounts of materials made from petroleum coke.
[3]Data may not add to totals shown because of independent rounding.

TABLE 9

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

Mineral		1989[r] Quantity	1989[r] Value (thousands)	1990 Quantity	1990 Value (thousands)
METALS					
Aluminum:					
Aluminum oxide (alumina)	thousand metric tons	4,311	$1,228,123	4,070	$1,268,973
Metals and alloys, crude	metric tons	923,030	1,898,132	959,615	1,596,886
Plates, sheets, bars, etc.	do.	340,382	950,902	340,334	340,334
Scrap	do.	206,610	309,122	214,196	259,674
Antimony:					
Antimony metal	do.	10,621	21,143	13,940	23,380
Antimony oxides	do.	12,041	19,770	14,472	19,574
Ore and concentrate (antimony content)	do.	4,550	8,462	3,454	4,835
Arsenic:					
Acid	do.	48	67	21	31
Arsenic trioxide	do.	28,348	13,526	26,256	12,570
Metallic	do.	928	2,150	796	4,091
Sulfides	do.	2	19	—	—
Bauxite:					
Calcined	thousand metric tons	531	34,677	558	35,564
Crude and dried	do.	10,893	NA	12,142	NA
Beryllium ore	metric tons	601	655	342	418
Bismuth, metals and alloys (gross weight)	kilograms	1,880,321	21,586	1,611,862	11,747
Cadmium metal	metric tons	2,787	30,161	1,741	11,904
Chromium (gross weight):					
Chemicals	do.	12,895	23,677	10,130	24,136
Chromite ore and concentrate	do.	525,044	43,949	305,507	22,150
Metals and alloys:					
Chromium ferroalloys	do.	343,732	330,427	415,893	246,439
Chromium metal	do.	4,202	27,590	6,664	43,161
Pigments and preparation based chromiuum	do.	5,963	13,355	5,652	13,708

See footnotes at end of table.

TABLE 9—Continued

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

Mineral		1989[r]		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued					
Cobalt:					
Metal (estimated cobalt content)	metric tons	5,444	$91,960	6,027	$106,902
Other forms (estimated cobalt)	do.	75	1,426	547	3,227
Oxide and hydroxides (estimated cobalt content)	do.	273	6,598	351	8,539
Unwrought cobalt alloys (gross weight)	do.	90	3,301	65	2,398
Wrought cobalt and cobalt articles (gross weight)	do.	84	3,627	48	3,729
Other cobalt: matte, waste, and scrap (gross weight)	do.	364	5,054	250	1,806
Columbium:					
Ferrocolumbium	thousand pounds	8,178	28,657	6,435	24,685
Mineral concentrates	do.	4,910	8,060	4,964	7,898
Oxide	do.	1,454	9,470	2,145	15,348
Wrought and unwrought	do.	26	514	5	150
Copper (copper content):					
Blister and anode	do.	77,218	242,106	44,278	125,238
Matte, ash, and precipitates	do.	2,721	6,571	7,961	19,802
Ore and concentrate	metric tons	46,516	51,311	91,493	131,038
Refined copper	do.	303,803	865,684	261,672	674,774
Semimanufactures, copper and copper alloy	do.	100,254	398,605	NA	NA
Scrap:					
Alloy	do.	79,320	151,265	98,710	192,777
Scrap—Continued					
Unalloyed scrap only	metric tons	31,577	87,919	25,904	80,976
Ferroalloys not elsewhere listed, including spiegeleisen	do.	2,339	7,737	2,404	8,351
Gallium	kilograms	15,284	5,665	9,894	3,250
Germanium	do.	40,105	23,789	49,769	27,968
Gold:					
Bullion, refined	do.	96,967	1,198,734	64,755	795,007
Dore and precipitates	do.	13,159	157,952	4,245	50,635
Ore and concentrates	do.	2,426	7,103	5,346	8,355
Wastes and scrap	do.	39,952	115,685	23,173	206,975
Hafnium: Waste and scrap	metric tons	4	976	9	1,662
Indium	kilograms	26,813	8,944	30,158	6,555
Iron ore (gross weight):					
Coarse ores	thousand metric tons	662	15,566	545	14,445
Concentrates	do.	371	7,760	294	7,733
Fine ores	do.	11,629	297,913	7,338	181,696
Other	do.	1,186	23,251	2	179
Pellets	do.	5,628	175,728	9,875	355,470
Roasted iron pyrites	do.	121	2,045	([1])	2
Iron chemicals (gross weight):					
Chlorides	metric tons	1,116	494	2,447	731
Sulfates	do.	7,554	1,429	19,427	2,888
Iron and steel:					
Direct-reduced iron	short tons	188,038	22,621	367,782	40,974
Iron and steel products (major):					
Steel mill products	thousand short tons	17,321	7,590,841	17,162	[e]8,300,000
Fabricated steel products	do.	2,378	2,884,328	2,232	[e]1,450,000

See footnotes at end of table.

TABLE 9—Continued

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

Mineral		1989[r]		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued					
Iron and steel—Continued					
Iron and steel products (major)—Continued					
Iron products	thousand short tons	264	$173,910	229	e$92,000
Pig iron	short tons	488,175	73,184	382,737	60,069
Scrap, including tinplate and terneplate	thousand short tons	1,120	149,109	1,443	171,510
Lead:					
Ash and residue (lead content)	metric tons	677	286	281	102
Blocks, pigs, anodes, etc. (lead content)	do.	121,463	84,401	93,351	76,031
Miscellaneous products (lead content)	do.	852	11,908	515	6,782
Ore and concentrates (lead content)	do.	2,939	1,123	7,790	3,456
Pigments and compounds	do.	20,770	27,030	22,165	30,530
Scrap	do.	—	—	—	—
Wrought and alloys	do.	6,068	9,076	6,722	9,945
Magnesium metal and alloys, scrap, semimanufactured forms, n.e.c. (magnesium content)	do.	12,289	37,859	26,755	80,308
Manganese:					
Chemicals (manganese dioxide, potassium permanganate)	short tons	8,899	10,448	9,806	12,453
Ferromanganese (all grades)	do.	370,483	246,540	328,352	234,329
Ferrosilicon-manganese	do.	166,484	151,241	162,612	117,847
Metal	do.	16,147	22,283	14,279	19,741
Ore and concentrates (contained manganese)	do.	298,485	43,794	164,180	40,054
Mercury: Metal, waste and scrap	metric tons	131	1,247	15	231
Molybdenum:					
Ferromolybdenum	do.	772	9,062	871	6,990
Molybdates, all	do.	27	375	2	13
Ore and concentrates (molybdenum content)	do.	238	1,791	733	2,874
Powder	do.	198	2,077	71	1,771
Unwrought	do.	46	2,391	39	2,147
Wire	do.	8	553	3	249
Wrought	do.	50	3,311	61	4,217
Other	do.	3	637	2	720
Nickel:					
Primary; (cathodes, pellets, briquets and shot [unwrought], ferronickel, powder, flakes, oxide and oxide sinter, salts, and other [including slurry], nickel content)	short tons	130,725	378,936	144,530	1,177,611
Waste and scrap	do.	5,666	78,089	4,379	46,764
Wrought; (bars, rods, profiles, wire, sheets, strips, foil, tubes and pipes, [nickel content])	do.	911	16,511	1,140	15,495
Platinum-group metals:					
Iridium	kilograms	688	6,565	603	6,063
Palladium	do.	51,135	263,790	51,992	210,438
Platinum	do.	49,238	801,728	52,277	779,507
Ores	do.	12	83	109	671
Osmium	do.	58	605	75	678
Rhodium	do.	7,105	270,466	13,098	869,869
Ruthenium	do.	2,883	7,512	2,586	6,133
Waste and scrap	do.	2,159	30,944	4,614	32,471

See footnotes at end of table.

TABLE 9—Continued

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

Mineral		1989[r]		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued					
Rare-earth metals:					
Monazite	metric tons	774	$530	850	$686
Rare-earth metals, (including scandium and yttrium)	kilograms	294,236	4,181	198,840	3,050
Cerium compounds	do.	250,806	1,940	359,230	2,041
Rare-earth oxides, (excluding cerium oxide)	do.	501,898	6,986	150,728	8,018
Other rare-earth metals	do.	1,402,448	8,086	1,362,951	12,813
Other mixtures of rare-earth oxides or other rare-earth chlorides	do.	7,390,689	30,709	498,964	37,325
Ferrocerium and other pyrophoric alloys	do.	244,271	1,690	NA	NA
Rhenium:					
Metal including scrap	do.	3,785	4,197	6,068	6,864
Ammonium perrhenate (rhenium content)	do.	948	949	15,353	4,531
Selenium and selenium dioxide (selenium content)	do.	417,095	8,934	382,860	8,353
Silicon:					
Ferrosilicon	metric tons	177,895	131,631	238,983	134,993
Silicon metal	do.	43,196	80,388	66,383	114,385
Silver:					
Bullion, refined	kilograms	3,061,548	578,781	2,697,926	437,380
Dore and precipitates	do.	142,739	27,943	48,449	8,741
Ore and concentrates	do.	7,013	2,301	90,202	23,203
Waste and scrap	do.	90,753	96,254	507,649	86,421
Tantalum:					
Mineral concentrates	thousand pounds	3,850	52,762	2,240	25,589
Unwrought	do.	239	11,595	209	9,761
Wrought	do.	2	431	7	1,028
Tellurium	kilograms	42,871	3,249	34,012	3,928
Thallium	do.	1,173	123	450	61
Tin:					
Concentrates (tin content)	metric tons	216	1,938	—	—
Dross, skimmings, residues, scrap, tin alloys, n.s.p.f.	do.	10,270	34,695	6,788	35,291
Metal (unwrought)	do.	33,988	288,118	33,810	215,863
Tin compounds	do.	314	2,720	426	2,493
Tinfoil, powder, flitters, metallics and manufactures, n.s.p.f.	do.	XX	4,570	XX	2,086
Titanium:					
Ilmenite[2]	do.	797,897	110,611	719,530	112,412
Other unwrought (ingots, billets, powder, etc.)	do.	309	8,336	375	2,932
Pigments	do.	166,346	277,140	147,592	279,602
Rutile, natural and synthetic	do.	264,895	119,928	274,605	127,664
Sponge	do.	903	8,181	1,093	10,398
Titaniferous iron ore	do.	37,922	1,876	28,818	2,169
Waste and scrap	do.	5,308	41,898	3,037	17,550
Wrought	do.	1,250	34,085	1,266	35,746
Tungsten (tungsten content):					
Ammonium tungstate	do.	431	4,560	462	3,463
Ferrotungsten	do.	360	1,986	493	2,739
Ore and concentrates	do.	7,896	45,077	6,420	31,301

See footnotes at end of table.

TABLE 9—Continued

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

Mineral		1989[r]		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued					
Miscellaneous tungsten-bearing materials (waste and scrap, unwrought, wrought, tungstic acid, potassium tungstate, sodium tungstate, carbide, and other compounds)	metric tons	3,014	$48,751	2,537	$36,594
Vanadium:					
Ferrovanadium (vanadium content)	kilograms	486,705	13,493	244,250	3,720
Pentoxide, anhydride (vanadium content)	do.	92,079	1,911	82,627	719
Vanadium-bearing materials (slags and dross) (pentoxide content)	do.	4,072,778	18,762	3,321,890	6,702
Vanadium-bearing ash and residues (pentoxide content)	do.	1,432,094	5,035	1,801,071	4,786
Zinc:					
Blocks, pigs, slabs	metric tons	711,554	1,183,523	631,742	991,562
Dross, ashes, and fume (zinc content)	do.	9,031	7,856	6,411	5,942
Dust, powder, flakes	do.	7,253	15,123	8,834	17,724
Ore and concentrates (zinc content)	do.	40,974	23,047	46,684	17,970
Pigments and compounds	do.	71,825	105,089	61,107	83,449
Sheets, plates, strips, and other forms	do.	3,066	5,436	929	1,641
Waste and scrap	do.	9,367	6,674	31,720	15,101
Zirconium:					
Ore and concentrates	do.	73,129	33,917	26,783	12,407
Unwrought waste and scrap	do.	259	2,209	128	880
INDUSTRIAL MINERALS					
Abrasives:					
Diamond, natural and synthetic	thousand carats	70,342	105,295	96,483	137,607
Other		XX	313,789	XX	332,174
Asbestos	metric tons	55,306	14,031	41,348	10,773
Barite:					
Crude and ground	thousand metric tons	1,034	44,679	1,044	46,300
Witherite	metric tons	76	30	34	23
Chemicals	do.	32,637	24,041	28,429	22,165
Boron (contained boric oxide):					
Boric acid	thousand metric tons	3	2,197	22	8,120
Colemanite	do.	15	4,202	12	3,310
Ulexite	do.	27	1,552	29	7,360
Bromine:					
Compounds	thousand kilograms	30,524	55,599	20,359	84,871
Elemental	do.	460	293	756	508
Calcium metal	kilograms	679,603	3,210	651,000	3,779
Calcium chloride:					
Crude	metric tons	119,296	20,856	145,534	21,541
Other	do.	8,048	3,817	16,837	6,102
Cement: Hydraulic and clinker	thousand short tons	15,741	605,325	13,273	533,047
Clays	metric tons	27,794	10,928	29,550	11,988
Cryolite, natural and synthetic	do.	8,429	7,647	7,306	6,775
Diatomite	thousand short tons	838	e294	689	268
Feldspar, crude, ground and crushed or pulverized	metric tons	12,003	873	11,318	723
Fluorspar	do.	655,590	79,875	513,921	65,938

See footnotes at end of table.

TABLE 9—Continued

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

Mineral		1989[r] Quantity	1989[r] Value (thousands)	1990 Quantity	1990 Value (thousands)
INDUSTRIAL MINERALS—Continued					
Gem stones:					
Diamond	thousand carats	10,059	$4,358,147	7,528	$3,955,222
Emeralds	do.	3,402	207,546	3,720	162,375
Pearls (natural, cultured, and imitation)	do.	NA	154,173	NA	26,645
Rubies and sapphires	do.	6,666	183,344	5,817	180,375
Other precious or semiprecious stones		NA	211,339	NA	284,688
Graphite,natural and synthetic	metric tons	62,319	33,707	50,213	35,222
Gypsum:					
Boards	thousand short tons	355	29,355	272	22,786
Crude	do.	9,304	59,107	8,726	61,009
Plasters	do.	3	2	701	236
Other	do.	NA	22,280	26,174	110,205
Hydrofluoric acid	metric tons	118,902	117,919	101,792	409,384
Iodine (includes crude, potassium iodide, and resublimed iodine)	thousand kilograms	3,326	58,980	3,168	43,553
Iron oxide pigments:					
Natural	metric tons	4,961	1,354	1,859	991
Synthetic	do.	31,708	29,186	32,141	35,918
Lime:					
Hydrated	short tons	36,952	2,219	29,920	2,147
Other lime	do.	180,704	9,749	8,245	173,197
Lithium:					
Carbonate	metric tons	3,326	6,629	4,197	8,381
Compounds	do.	7,191	7,108	—	—
Lithium—Continued					
Hydroxide	metric tons	23	164	1	20
Metal	do.	15	31	—	—
Ores	do.	31,660	3,049	—	—
Salt	do.	14	14	—	—
Magnesium compounds:					
Calcined dolomite	do.	21,788	2,871	38,441	3,639
Caustic-calcined magnesia	do.	75,584	13,657	83,885	13,957
Compounds, includes magnesium hydroxide, magnesium peroxide, magnesium chloride, and magnesium sulfate	do.	29,002	6,942	33,046	9,238
Dead-burned and fused magnesia	do.	202,790	38,555	155,010	32,858
Natural magnesite	do.	8,372	1,354	1,957	722
Other magnesia	do.	5,874	9,194	5,037	8,573
Mica:					
Crude and rifted	do.	4,612	2,740	5,444	2,915
Powder	do.	8,902	4,971	9,142	5,133
Waste	do.	1,189	542	205	123
Worked	do.	1,129	6,711	1,085	7,431
Nepheline syenite, crude, ground, crushed, etc.	short tons	303,000	12,273	276,000	12,200
Nitrogen compounds (major):					
Fertilizer materials	thousand short tons	8,325	920,785	7,719	847,304
Industrial chemicals	do.	138	108,392	71	65,852
Peat moss (poultry and fertilizer grade)	short tons	529,706	69,931	598,802	87,533
Phosphate rock and phosphate materials	thousand metric tons	814	80,284	477	46,365

See footnotes at end of table.

TABLE 9—Continued

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

Mineral		1989[r]		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)
INDUSTRIAL MINERALS—Continued					
Potash (includes potassium chloride, postassium sulfate, potassium nitrate, and potassium sodium nitrate)	metric tons	5,618,300	$501,300	6,951,700	$545,700
Pumice:					
Crude or unmanufactured	do.	273,464	12,483	266,604	7,858
Wholly or partially manufactured	do.	23,691	3,649	13,704	2,021
Salt crude and refined	thousand short tons	6,084	74,474	6,580	88,419
Sand and gravel:					
Industrial sand and gravel	do.	35	2,057	73	3,148
Other sand and gravel	do.	427	6,618	1,742	22,912
Sodium compounds:					
Soda ash	do.	128,790	17,396	145,534	20,495
Sodium sulfate	do.	173	13,900	162	13,155
Stone:					
Calcium carbonate fines	do.	4	1,234	3	864
Crushed and chips	do.	4,352	35,631	4,969	34,442
Dimension		NA	525,052	NA	523,891
Strontium:					
Celestite (strontium sulfate)	metric tons	25,640	1,956	48,724	4,189
Compounds and metal	do.	19,112	11,068	20,162	12,982
Sulfur, elemental	thousand metric tons	2,260	209,465	2,571	206,450
Talc, unmanufactured	thousand short tons	77,716	12,128	65,099	11,056
Total[3]		XX	35,537,000	XX	33,389,000

[r]Revised. NA Not available. XX Not applicable.
[1]Less than 1/2 unit.
[2]Includes titanium slag averaging about 70% TiO_2. For details, see "Titanium" chapter.
[3]Data may not add to totals shown because of independent rounding.

TABLE 10

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

Mineral		1989			1990[p]		
		World production[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]	metric tons	66,283	W	NA	62,004	W	NA
Arsenic trioxide[3]	do.	48,562	—	—	47,632	—	—
Bauxite[4]	thousand metric tons	105,695	W	NA	112,180	W	NA
Beryllium concentrates (gross weight)	metric tons	7,532	[5]4,592	61	7,138	[5]4,548	64
Bismuth	do.	3,556	W	NA	3,200	W	NA
Chromite (gross weight)	thousand metric tons	13,542	—	—	12,846	—	—
Cobalt[2]	metric tons	43,030	—	—	37,136	—	—
Columbium-tantalum concentrate (gross weight)	thousand pounds	73,435	—	—	65,448	—	—
Copper[2]	thousand metric tons	8,730	1,498	17	8,815	1,587	18
Gold[2]	kilograms	1,999,458	265,541	13	2,049,946	290,202	14
Iron ore (gross weight)	thousand metric tons	924,869	59,032	6	920,778	56,408	6
Lead[2]	do.	3,368	420	12	3,367	495	15

See footnotes at end of table.

TABLE 10—Continued

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

Mineral		1989			1990[p]		
		World production[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—Continued							
Manganese ore (gross weight)	thousand short tons	27,626	—	—	27,192	—	—
Mercury	metric tons	6,263	W	NA	5,785	W	NA
Molybdenum[2]	do.	116,799	63,105	54	111,652	61,611	55
Nickel[2]	thousand short tons	1,067	—	—	1,029	(6)	(6)
Platinum-group metals[3]	kilograms	283,158	6,280	2	286,704	7,740	3
Silver[2]	metric tons	14,760	2,007	14	15,108	2,170	14
Tin[2]	do.	233,773	W	NA	219,333	W	NA
Titanium concentrates (gross weight):							
Ilmenite	thousand metric tons	4,236	W	NA	4,051	W	NA
Rutile	do.	454	W	NA	452	W	NA
Tungsten[2]	metric tons	42,099	W	NA	40,350	W	NA
Vanadium[2]	short tons	33,549	W	NA	33,868	W	NA
Zinc[2]	thousand metric tons	7,191	288	4	7,325	543	7
METALS, SMELTER BASIS							
Aluminum (primary)	do.	18,020	4,030	22	17,817	4,048	23
Cadmium	metric tons	21,075	1,550	7	20,207	1,678	8
Cobalt	do.	25,516	—	—	25,775	—	—
Copper (primary and secondary)[7]	thousand metric tons	9,510	1,480	16	9,378	1,463	16
Iron, pig	thousand short tons	602,790	55,873	9	593,699	54,750	9
Lead, refined (primary and secondary)[8]	thousand metric tons	5,987	1,288	22	5,942	1,327	22
Magnesium (primary)	metric tons	344,043	152,066	44	351,198	139,333	40
Nickel[9]	short tons	958,323	382	(6)	928,465	4,080	(6)
Selenium[10]	kilograms	1,614,716	253,427	16	1,817,747	286,755	16
Steel, raw	thousand short tons	862,268	97,943	11	850,982	98,906	12
Tellurium[10]	kilograms	64,031	W	NA	67,001	W	NA
Tin (primary and secondary)	metric tons	249,757	[11]1,569	1	249,804	W	NA
Zinc (primary and secondary)	thousand metric tons	7,203	358	5	7,041	358	5
INDUSTRIAL MINERALS							
Asbestos	do.	4,243	17	(9)	3,980	W	NA
Barite	do.	5,577	[12]290	5	5,577	[12]439	8
Boron minerals	do.	2,926	[12]1,114	38	2,906	[12]1,094	38
Bromine	metric tons	442,479	[12]174,600	39	438,000	[12]177,000	40
Cement, hydraulic	thousand short tons	1,248,916	[13]78,559	6	1,251,112	[13]78,606	6
Clays:							
Bentonite[3]	thousand metric tons	8,987	[12]3,112	35	9,472	[12]3,474	37
Fuller's earth[10]	do.	3,060	[12]1,882	62	3,471	[12]2,307	66
Kaolin[3]	do.	24,522	[12]8,974	37	25,024	[12]9,762	39
Diamond, natural	thousand carats	97,743	—	—	99,096	—	—
Diatomite	thousand metric tons	1,852	617	33	1,821	613	34
Feldspar	do.	5,176	655	13	5,023	630	13
Fluorspar	do.	5,586	661	5,107	64	1	
Graphite, natural	metric tons	648,827	W	NA	660,600	—	—
Gypsum	thousand short tons	109,023	17,624	16	107,671	16,406	15
Iodine, crude	metric tons	15,459	1,508	10	17,017	1,973	12
Lime	thousand short tons	152,846	[12 13]17,178	11	150,151	[12 13]17,481	12
Magnesite, crude	thousand metric tons	11,343	W	NA	10,713	W	NA

See footnotes at end of table.

TABLE 10—Continued

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

Mineral		1989			1990[p]		
		World production[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							
Mica (including scrap and ground)	metric tons	229,523	119,142	52	214,560	108,845	51
Nitrogen: N content of ammonia	thousand short tons	109,142	13,449	12	108,056	13,940	13
Peat	do.	217,531	761	(6)	198,489	763	(6)
Perlite	do.	1,973	[12]601	30	1,959	[12]639	33
Phosphate rock (gross weight)	thousand metric tons	158,966	48,866	31	154,106	46,343	30
Potash (K_2O equivalent)	do.	29,210	1,595	5	28,310	1,713	6
Pumice[10]	do.	10,913	424	4	10,964	443	4
Salt	thousand short tons	209,949	[12 13]38,902	19	202,339	[12 13]40,738	20
Sand, industrial (silica)	do.	133,973	[12]29,205	22	133,198	[12]28,406	21
Sodium compounds, n.e.s. (natural and manufactured):							
Soda ash	thousand metric tons	31,939	8,995	28	32,429	9,156	28
Sulfate	do.	5,009	685	14	4,998	665	13
Strontium[10]	metric tons	234,189	—	—	234,600	—	—
Sulfur, all forms	thousand metric tons	58,717	11,592	20	57,668	11,560	20
Talc and pyrophyllite	do.	8,271	1,253	15	8,251	1,267	15
Vermiculite[10]	short tons	694,700	[12]275,000	40	645,933	[12]230,000	36

[e]Estimated. [p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; not included in world total.

[1]For those commodities for which U.S. data are withheld to avoid disclosing company proprietary data, the world total excludes U.S. output and the U.S. percent of world production cannot be reported.

[2]Content of ore and concentrate.

[3]World total does not include an estimate for China.

[4]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 eqiuivalent basis, but for some countries available data are insufficient to permit this adjustment.

[5]Shipments.

[6]Less than 1/2 unit.

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

[8]Includes bullion

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

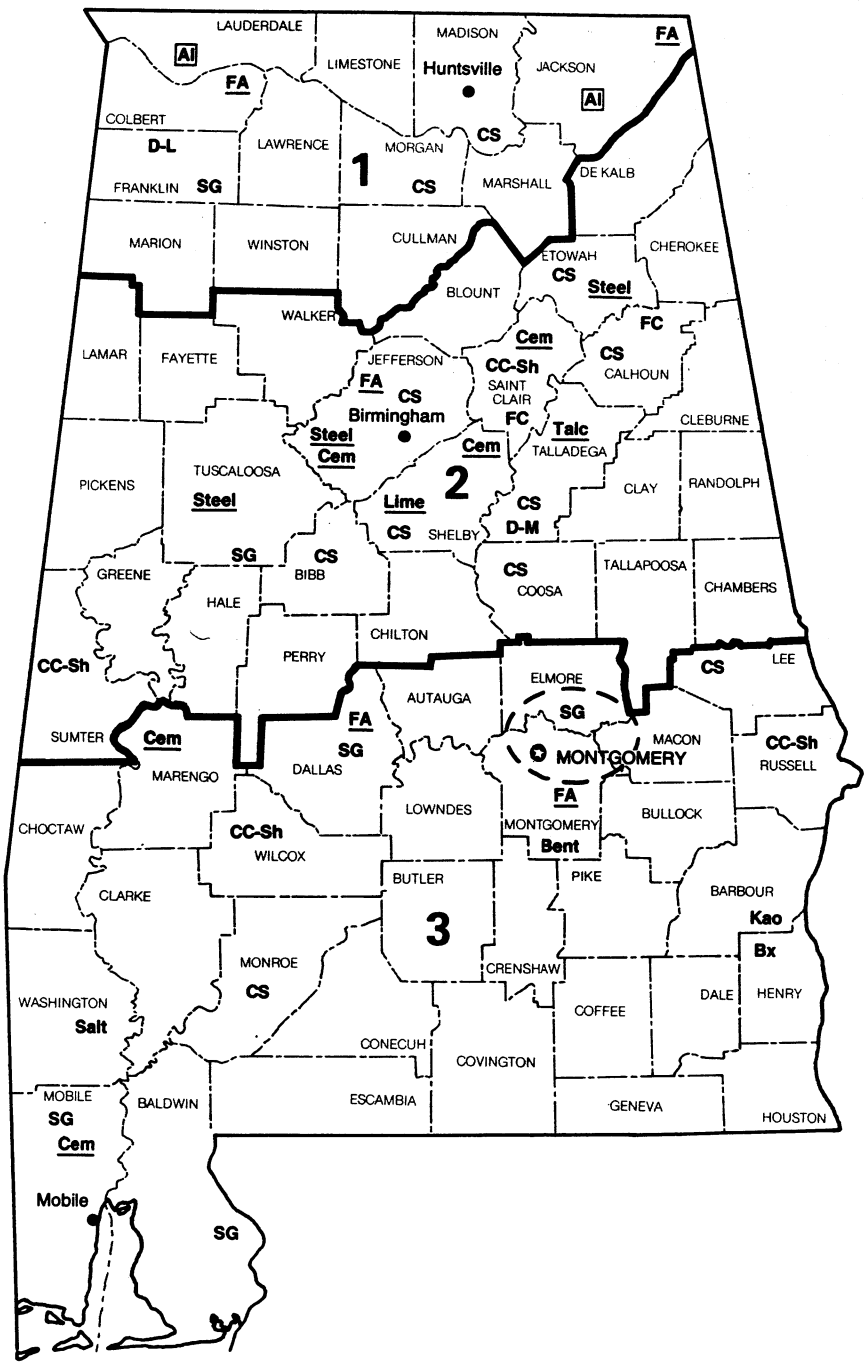
[10]World total does not include estimates for output in the U.S.S.R. or China.

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

[12]Quantity sold or used by producers.

[13]Includes Puerto Rico.

ALABAMA



LEGEND

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

MINERAL SYMBOLS

AI	Aluminum plant
Bent	Bentonite
Bx	Bauxite
CC-Sh	Common Clay & Shale
Cem	Cement plant
CS	Crushed Stone
D-L	Dimension Limestone
D-M	Dimension Marble
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

Concentration of mineral operations

Principal Mineral-Producing Localities

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 nonfuel mineral industry produced $560.6 million of mineral commodities in 1990. This was an increase of $99 million over the 1989 value and a new State record, a record achieved despite the slowdown in the national economy. This was the first year that Alabama's mineral value exceeded one-half of 1 billion dollars. The value of stone and cement, the two leading mineral commodities in terms of sales, increased $71 million over that reported for 1989 and was the primary reason for the new mineral value record. The State ranked 21st among the 50 States in total mineral value and contributed 1.68% of the total U.S. mineral value of $33.3 billion.

TRENDS AND DEVELOPMENTS

The year marked the fifth consecutive that the value of Alabama's mineral production increased. During the past 10 years, value has risen $246 million, from $314 in 1981 to $560 million in 1990, and the value of nonfuel mineral production totaled $4.1 billion.

In 1990, capital investments in new and/or expanding mineral-related industries totaled $266.6 million. Industrial minerals had 3 new and 11 expanding facilities, while cement and concrete had 6 expanding operations. Fuel minerals had 7 expansions, and primary metals had 4 new and 33 expansions.

The industrial mineral sector included new or expanding facilities for the mining or manufacturing of calcium carbonate, clays, ferroalloys (silicon), limestone, marble, salt brines, sand and gravel, and talc.

The Alabama State Docks at Mobile established a fourth consecutive tonnage record, and a significant amount of the materials handled were minerals. The Bulk Materials Handling Plant transshipped 1.9 million short tons of mineral commodities. Iron ore imports, 1.2 million short tons, increased 21% due to increased demand for raw material by Gulf States Steel in Gadsden. Other mineral commodities passing through the port included copper slag, furnace coke, gypsum, magnetite, manganese, petroleum, potash, rutile, and talc.

TABLE 1
NONFUEL MINERAL PRODUCTION IN ALABAMA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	273	$16,457	252	$13,852	262	$15,462
Portland	do.	3,524	157,214	3,169	130,590	3,585	165,344
Clays[2]	metric tons	2,282,670	16,039	1,878,070	18,537	2,049,776	27,747
Gemstones		NA	5	NA	W	NA	W
Lime	thousand short tons	1,450	66,576	1,481	70,361	1,526	70,816
Sand and gravel:							
Construction	do.	11,742	41,417	e10,400	e36,500	14,103	50,243
Industrial	do.	871	8,507	805	8,092	878	9,075
Stone (crushed)	do.	e29,700	e140,100	[3]31,737	[3]167,332	e [3]36,100	e [3]202,400
Combined value of bauxite, clays (bentonite, kaolin 1990), salt, stone (crushed granite 1989-90, dimension), talc and pyrophyllite, zircon concentrates, (1988-89), and value indicated by symbol W		XX	13,180	XX	r15,489	XX	19,552
Total		XX	459,495	XX	460,753	XX	560,639

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

The Bulk Materials plant was equipped with two ship unloaders with a combined capacity of 3,000 short tons per hour. Two parallel conveyor lines were used to move cargo from ship to storage, barge, or railcar. Open and covered storage for 1.2 million short tons of bulk commodities was available.

The McDuffie Coal Terminal, the largest coal handling facility on the U.S. Gulf Coast and the second largest in the Nation, handled 8.3 million short tons of coal. The terminal was equipped with two, 45-foot deep shiploading berths; three stacker-reclaimers; three barge unloaders; and two railcar dumps served by separate loop track systems. Ground storage was available for two million short tons of coal.[5]

The Alabama State Docks maintained 10 inland ports on the State's river system. Coal, logs, and gravel were the three leading cargos shipped through the inland ports.[6]

Mineral commodities imported or exported by private industry at State docks leased property included cement-clinker, fly ash, gravel, gypsum, iron ore, petroleum, sand, and shell.[7]

The trend in the world's paper industry to convert from the acid to the alkaline-train process was a boon to those firms holding reserves of high-purity calcium carbonate. The alkaline-train process uses less wood pulp and more filler, calcium carbonate, and produces a paper with longer lasting qualities. The Sylacauga marble belt in east-central Alabama contains high-grade calcium carbonate of sufficient purity and whiteness for paper applications.

Developments in Alabama's mineral industry included the announcement of Georgia Marble Co. and the Swiss-based Pluess-Staufer forming a joint-venture company, Alabama Carbonates L. P., to produce calcium carbonate pigment at Sylacauga. Occidental Chemical Corp. announced a $15 million expansion at its chlorine and caustic soda plant in Mobile, and Occidental Chemical Corp. increased caustic potash output by 25,000 short tons per year at its Muscle Shoals facility.

On the metals scene, Fairfield Works, Birmingham, began casting double-stand slabs from a single mold, the first such casting of its kind in the United States. Birmingham Steel Co. reported a loss for fiscal year 1990 because of declining steel prices, expenses associated with out-of-State projects, and the aborted merger transactions with the Harbert Co. Reynolds Aluminum Co., Listerhill, broke ground for a $175 million casting facility at its aluminum complex near Sheffield. The company also announced plans to invest $15 million for new environmental control equipment for its Listerhill and Sheffield plants.

EMPLOYMENT

Alabama's total employment declined from 1.77 million in 1989 to 1.76 million in 1990. Nonfuel mining employment, however, increased from 11,600 in 1989 to 12,900 in 1990, and construction employment increased 4,200 between 1989 and 1990. Construction employment is a measure of the demand for the State's construction mineral commodities, cement, clays, sand and gravel, and stone.[8]

REGULATORY ISSUES

Some of Alabama's mineral producers faced the specter of higher electricity rates and possible decreased process water supply as Alabama and Florida filed suit against Georgia to stop plans for impounding water in Georgia that currently drained into Alabama waterways. Alabama and Florida officials feared that the impoundments in the Atlanta-area would decrease the amount of water flowing along Alabama's eastern border and through the Florida panhandle.

The Federal Environmental Protection Agency reported that two Birmingham-area coke manufacturing facilities ranked among the State's top air polluters. Interstate Lead Co., Birmingham, was fined $10,700 for violating State wastewater standards by discharging untreated storm waters. A company spokesperson noted that the firm had spent several million dollars installing a state-of-the-art water treatment system and the fine was a misunderstanding between company and State officials.

EXPLORATION ACTIVITIES

Announced exploration activity in the State during 1990 was limited to gold. Included were the evaluation of potential drill sites in the Devils Backbone District of Tallapoosa County and a limited amount of reconnaissance exploration and trenching in the Arbacoochee District of Cleburne County.[9]

LEGISLATION AND GOVERNMENT PROGRAMS

A bill creating the Spill Response Task Force was signed into law following the 1990 legislative session (Act 90-741). The duties of the task force were to evaluate the State's readiness to respond to oil and hazardous materials spills in the State's coastal waters.

Among the studies completed by the Geological Survey of Alabama, Tuscaloosa, were several relating to the State's mineral resources. These included published reports on (1) high-calcium limestone deposits; (2) industrial extender and filler resources; (3) mineral reports for Montgomery, Macon, Cherokee, and Elmore Counties; (4) geology and mineral resources of the Inner Piedmont; (5) clay resources of the Upper Cretaceous Tuscaloosa Group; and (6) assessment of nonhydrocarbon mineral resources in the exclusive economic zone of offshore Alabama.

One of the nine research centers maintained by the U.S. Bureau of Mines was on the University of Alabama campus at Tuscaloosa. The Tuscaloosa Research Center, established in 1936, was involved in five major areas of mineral research: (1) powder processing, (2) composite structure and properties, (3) separation science and process control, (4) process kinetics, and (5) environmental technology.

Several of the projects under investigation by the U.S. Bureau of Mines scientists and engineers were in Alabama. Included were (1) the

establishment of a well-point dewatering system to mitigate the effects of a wastewater plume that inadvertently contaminated the ambient ground water table at a wastewater impoundment site, (2) the removal of toxic metals from the wastewater stream at a major brass foundry, and (3) the flocculation response of coal waste and coal-clay waste fines generated from ultrafine grinding techniques.

The U.S. Geological Survey continued monitoring the quantity and quality of streamflow in Alabama, and the U.S. Mine Safety and Health Administration continued the program of inspecting the State's nonfuel mining operations to ensure worker safety.

FUELS

Alabama's fuel mineral output in 1990 was estimated at $1.8 billion. The estimated oil and condensate value, based on the average price per barrel, was $166 million and $202 million, respectively. The estimated gas value, based on the average price per thousand cubic feet, was $204.8 million, and coal value, based on the average price per ton, was $ 1.19 billion.[3]

Coal production totaled a record 28.1 million short tons, a 1.5 million ton increase over the 1989 production level. Natural gas output, 187.6 billion cubic feet, increased 6.3 billion cubic feet over the 1989 level, while oil and gas condensate production declined to 18.5 million barrels from the 19.6 million barrels reported in 1989.[4]

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

The State's industrial mineral sector mined or manufactured 14 industrial minerals. Stone, cement, and lime were the three leading commodities. With one exception, a dimension stone operation near Russellville, all production was from surface mines.

Cement.—Portland cement was again the State's second leading mineral commodity in terms of value, accounting for almost 30% of Alabama's 1990 mineral value. The State retained its seventh place ranking among the 39 States with portland cement production and continued to rank fifth among the 36 States with masonry cement output.

Portland cement production, 3.6 million tons valued at $165 million, was 410,000 tons and almost $3.5 million above that reported in 1989. The increase in output and sales reflected an upswing in construction activity in the State.

Alabama's portland cement industry consisted of five plants in the Birmingham, Demopolis, Mobile, and Montevallo areas. The five plants were equipped with seven kilns. All five plants used the dry process to manufacture clinker. Three plants in Greystone, Roberta, and Theodore produced masonry cement.

Clays.—Alabama's clay industry, 22 companies, ranked sixth among the 44 clay-producing States. Clay sales accounted for approximately 5% of the State's mineral value. The clay industry produced bentonite, common clay, fire clay, and kaolin. Output of common clay and fire clay was 2 million metric tons, an increase of approximately 171,000 tons. Value, $27.7 million, increased about $9.2 million above that reported in 1989.

Bentonite.—One firm, American Colloid Co., mined bentonite, a clay with superior absorbent properties, from its Sandy Ridge Mine in Lowndes County. After mining, the clay was dried, shredded, and sized and sold to the foundry and agricultural industries. Output and value decreased below that reported in 1989.

Common Clay and/or Shale.—Approximately 86% of Alabama's clay production was common clay and/or shale. Fifteen companies produced clay and/or shale from 20 mines. Jefferson, Russell, and Sumter Counties continued as the leading common clay-shale-producing areas in the State. Most of the clay (48%) was used in brick manufacture; other uses included concrete block manufacture (29%), cement manufacture (21%), and in abrasives, structural concrete, and grogs. Production and value (276,000 metric tons, $13.3 million) were higher than those reported in 1989.

Two companies produced lightweight aggregate by calcining shale and clay. Vulcan Materials operated two shale mines and a calciner unit in Jefferson County, and Livlite Corp. mined and calcined a Tertiary clay at Livingston.

Fire Clay.—Four companies operated four mines in Calhoun, St.Clair, Shelby, and Walker Counties to produce 96,000 metric tons of fire clay valued at $3.98 million. This was a decrease of 12,000 metric tons and $71,000 below that reported by the four in 1989. Fire clay, a material with properties to withstand elevated temperatures in excess of 1,500° C, was marketed to the refractory industry for fire and insulation brick manufacture.

Kaolin.—Two companies with mines in Barbour and Henry Counties produced kaolin, a light-colored clay containing the mineral kaolinite. The refractory, heavy-clay products, and chemical materials industries were the principal markets. Output and value increased slightly over the 1989 level.

Lime.—The sales of lime ranked third in Alabama's total mineral value, accounting for 13% of the State's total. Production was by four companies operating quarries and calcining facilities in Shelby County. Both quicklime and hydrated lime were produced. Production and value increased approximately 45,000 short tons and $457,000 million over those reported by the four in 1989.

Salt.—The State continued to rank 10th among the 13 salt-producing States. One firm, the Olin Corp., operated a solution

mine and chemical complex in Washington County. The solution mine was in the McIntosh salt dome; recovered brine was used to produce chlorine, caustic soda, compressed hydrogen, and salt at the chemical complex. Sales were to the pulp and paper, water purification, and sewage treatment industries. Salt shipments continued to a company plant in Georgia. Work continued on the development of a cavity in the salt dome for the Alabama Electric Cooperative. The cavity will be used for a compressed-air energy storage plant.

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 1988 and 1990 and estimates for 1989.

The value of construction sand and gravel ranked fourth among the mineral commodities produced during 1990 and accounted for 9% of the State's total mineral value. Alabama ranked 22d among the 50 construction-sand-and-gravel-producing States; production was 14.1 million short tons valued at $50.2 million. This was an increase of almost 4 million short tons and $14 million over the estimate for 1989. Fifty-seven firms operated 79 mines; sand and gravel were processed at 42 stationary and 15 portable plants. Six counties had production in excess of 1 million tons. The five leading counties were Elmore, Macon, Mobile, Montgomery, and Escambia, which accounted for approximately 50% of the State's total production. Principal sand and gravel sales were for concrete aggregate (76%), road base and cover (11%), and asphaltic concrete (8%); uses for about 43% of the sand and gravel were unspecified. Most of the sand and gravel produced was used in-State, but a small tonnage was shipped to Florida and Georgia.

Alabama construction sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 4 presents end-use data for the State's three districts.

Industrial.—The production of industrial sand and gravel was reported by 8 companies operating 12 mines in an 8-county area. The leading counties, in order of production, were Tuscaloosa, Bullock, and Chilton, accounting for 59% of the tonnage. Sand output accounted for approximately 54% of the total; the remainder was gravel. Sand sales were to the foundry industry for molds and cores, for sandblasting media, filtration uses, and for traction applications. Gravel sales were for silicon, ferrosilicon production, and nonmetallurgical flux.

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 1988 and 1990 and actual data for 1989.

Crushed.—The estimated value of crushed stone production, $202 million, ranked stone as the leading mineral commodity, in terms of sales, in Alabama. Value increased $35.1 million, and output was up 4.4 million short tons above the level reported by the stone industry in 1989.

Work continued on ECC America's $8 million expansion at Sylacauga. The work began in May 1989 and will increase the company's capacity to produce fine-ground calcium carbonate for the paint, plastics, and paper industries.

In October 1986, ECC negotiated the purchase of Moretti-Harrah Marble Co.'s Sylacauga Calcium Products Div.; in May 1988, ECC purchased Cyprus Industrial Mineral's plant that produced ground calcium carbonate. The two purchases were merged to form ECC America Calcium Products Inc.

In midyear, the Atlanta-based Georgia Marble Co. and Pluess-Staufer A. G. of Switzerland announced joint-venture plans to construct a calcium carbonate slurry plant in Sylacauga. Georgia Marble is to supply the stone (marble) reserves, and Pluess-Staufer is to supply the technology. The multimillion-dollar plant, a major source of filler and coating pigments for the paper industry, will operate under the name of Alabama Carbonates L. P.

Georgia Marble was the Nation's leading supplier of calcium carbonate fillers to the plastics, paint caulking, carpet, cultured marble, and building products industries. Pluess-Staufer was the world's largest producer of finely ground calcium carbonate for the paper industry and the acknowledged industry leader in advanced calcium carbonate production technology.[10]

Dimension.—Three companies reported dimension stone production from quarries in Franklin, Blount, and Talladega Counties. Output consisted of various stone products cut from limestone, marble, and sandstone; production and value increased over those reported in 1989.

Alabama Limestone Co. produced rough blocks and cut and veneer stone from an underground quarry developed in the Rockwood Oolite member of the Bangor Limestone. The rough blocks were trucked to a surface mill nearby. The Alabama operation was one of two underground dimension limestone quarries in the United States. Marble of Alabama Inc., Sylacauga, fabricated a variety of stone products from surplus dimension marble blocks from the old Moretti-Harrah operation. Lamb Stone Co., Blount County, produced sandstone shapes—primarily sawed, dressed, and flagstone—from a surface operation.

Sulfur (Recovered).—Alabama continued to rank sixth among the 26 sulfur-producing States. Five companies recovered sulfur at seven natural gas processing facilities and/or petroleum refineries. Output and value, 375,000 metric tons valued at $33 million, fell below the 410,000 metric tons valued at $40 million reported in 1989.

Mobil Exploration & Producing U.S. Inc. began construction of a natural gas treatment plant at the Mary Ann Field. The plant will remove impurities from natural gas piped from the Outer Continental Shelf (OCS) fields about 4 miles offshore from Dauphin Island. The

new plant will process almost 250 million cubic feet of gas per day compared to the existing Mary Ann Field facility. A pipeline will be constructed from a production platform to be placed in the Mobile OCS Block 823 Field to a central gathering platform in the Mary Ann Field 1 1/2 miles east of Dauphin Island. The gas will then be transported to shore in a previously installed pipeline. The $26 million gas processing facility is expected to be completed in the third quarter of 1991.[11]

Talc.—Cyprus Minerals Co.'s Alabama operation was the only active talc mine and mill in the Southern United States. The company mined and ground talc at its Winterboro facility near Alpine. The company also received shipments of talc from Montana and Australia for grinding. Principal markets were the cosmetic and pharmaceutical industries.

Other Industrial Minerals.—In addition to the commodities listed in table 1, a number of minerals were shipped into Alabama and processed into higher value products. Fused aluminum oxide and aluminum-zirconium oxide for abrasive use were produced by the Norton Co. at a plant in Huntsville, Madison County. Magnesium minerals from Mexico, Turkey, and Greece were imported by Muscle Shoals Minerals, Barton, in Colbert County, for the production of fused magnesium oxide for heating elements. Zirconium ore and concentrates were obtained from the Republic of South Africa and Florida for the production of fused zirconium oxide. Fluorspar was shipped into the State by International Minerals and Chemicals Co., Florence, in Lauderdale County, for the manufacture of fluorosilicic acid.

Hydrous ammonia plants were operated by the Tennessee Valley Authority, Muscle Shoals, and USS Agri-Chemicals Inc., Cherokee, both in Colbert County. Iodine was imported by a Mobile firm. Mica was produced as a byproduct of tantalum ore beneficiation by O'Dell Construction Co. at its beneficiation facility in Coosa County and sold to a North Carolina firm. Expanded perlite facilities in Irondale, Jefferson County, and Mobile, Mobile County, were operated by W. R. Grace & Co. and Armstrong World Industries. Crude perlite was obtained from mines in the Western United States. Vermiculite obtained from South Carolina was exfoliated by W. R. Grace at its Irondale facility. Synthetic iron oxide pigments and regenerator oxides were produced by Gulf States Steel Inc., Gadsden, in Etowah County, as a byproduct of steelmaking. Synthetic mullite was produced by Harbison-Walker at its operation in Eufaula. Tungsten was used by Martin Technologies, Huntsville, in the manufacture of M-74 grenade bodies for the military. Zeolite catalysts were produced by Union Carbide Corp. at a plant in Chickasaw near Mobile. Diabase from North Carolina was utilized by Partek Insulations Inc. in the manufacture of mineral filler at a Phenix City plant.

Metals

The metal industry in Alabama consisted of one extractive operation (tantalum) and several operations that used scrap metal as feedstock. Two extractive bauxite operations produced clay for a nonmetal end use.

Aluminum.—Reynolds Metals Co. operated the company's largest aluminum fabricating facility at Listerhill in Colbert County. The plant, with revenue of more than $1 billion, employed 2,100 workers. The facility produced aluminum sheet for cans, siding, and appliances. Scrap aluminum was converted into 15-ton, 26-inch-thick bars of aluminum ingot and then rolled into coils of sheet, some less than 1/100-inch-thick.

During the past 3 years, Reynolds has invested $430 million in the Colbert County complex, $125 million of it for a new casthouse. The casthouse raised capacity 30% while cutting costs 39%. The increase in efficiency was achieved with fewer furnaces and employees; in 1990, 105 jobs were eliminated by the new equipment.[12] During the year, the company broke ground for a $525,000 facility that will house the Process Control and Development Department of the company's Manufacturing Technology Laboratory. The laboratory will work on improving the technologies involved in the extraction, fabrication, and reclamation of aluminum and its alloys.[13]

Bauxite.—Alabama and Georgia were the only States with bauxite production. Two companies, Harbison-Walker Refractories Div. of Dresser Industries Inc. and Mullite Co. of America, mined bauxite, a high-alumina clay, in Barbour and Henry Counties in the southeastern part of the State. Most of the clay was calcined and sold to the refractory industry. Production and value decreased significantly below that reported in 1989.

A third company, Carbo Ceramics in Eufaula, purchased bauxite for the manufacture of proppants for the petroleum industry.

Ferroalloys.—The State continued to rank third among the 15 States with ferroalloy production. In 1990, Alabama's ferroalloy industry produced 97,000 metric tons valued at $93 million, a decrease of 10,000 metric tons and $5 million below those reported in 1989.

Iron and Steel.—The State's steel industry was composed of six firms with plants in Birmingham, Gadsden, and Tuscaloosa. Gulf States Steel Co., Gadsden, and USX Corp., Birmingham, operated integrated steel mills; Birmingham Steel Corp., Commercial Metals Co. (CMC), and SMI Steel Inc., all in the Birmingham area, operated minimills; and Tuscaloosa Steel Corp. operated a plate mill.

Fairfield Works, the steelmaking division of USX Corp., completed its 10-year, $1 billion renovation with the dedication of its cold reduction mill. The $1 billion renovation included a $750 million seamless pipe mill and bloom caster completed in the early 1980's and a $200 million continuous slab caster and a renovation of the plant's hot strip mill completed in 1988.

The Fairfield Works was the largest steelmaking plant in the Southeast. Plant

capacity was in excess of 1 million short tons of sheet steel and 540,000 tons of finished seamless pipe per year.[14]

Work was underway at CMC's Birmingham mill to install a new four-stand continuous caster. CMC's steel businesses operated under the name Structural Metals Inc. (SMI). Once the continuous caster project is completed, CMC plans to install a new meltshop at SMI Alabama. The Alabama facility has a capacity of 325,000 short tons per year, but when the new meltshop comes on-stream in 1993, capacity will be raised to approximately 500,000 short tons per year of medium-size angles, flats and channels, and 8-inch wide flange beams.[15]

Lead.—Interstate Lead Co. operated a secondary lead smelter at Leeds, near Birmingham. The firm processed scrap batteries to recover the lead content. In July, the company began work on removing contaminated soil from a "ditch-like tributary" to meet terms of a 1988 agreement between the company, the Alabama Department of Environmental Management, and the U.S. Environmental Protection Agency.[16] In August, the company was fined for discharging untreated storm water into a tributary of Dry Creek, which flows into Lake Purdy, a major source of Birmingham's drinking water. The "tributary" was the ditch from which the company was removing the contaminated soil.[17]

Tantalum.—Alabama's only extractive metal producer, Coosa Mining Ltd., owned by O'Dell Construction Co., mined and processed a tantalum concentrate from property in Coosa County near Rockford. This was the only tantalum operation in the United States. The company mined a pegmatite and used wet gravity methods to recover a tantalum concentrate that was sold to the U.S. Government. Scrap mica and beryl were recovered as a byproduct.

Other Metals.—Ilmenite was imported from Australia by Kerr McGee Chemical Corp. for feedstock for its synthetic rutile plant near Mobile. The synthetic material was shipped to a Kerr McGee plant in Hamilton, MS, for use in the manufacture of titanium dioxide pigments. Manganese and chromite were imported by Prince Manufacturing Co., Phenix City, for a coloring agent in the manufacture of brick. Iron ore fines were recovered from the tailings from former iron mining operations in Franklin County. The fines were sold to cement manufacturers.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 30 years of mineral-related industry and government experience and has covered 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.

[3]Dean, L. S. (ed.). Minerals in Alabama, 1990. Alabama Geological Survey, Information Series 64I, 1991, p. 2.

[4]Alabama Business and Economic Indicators, Center for Business and Economic Research. V. 60, No. 5, May 1991.

[5]Port of Mobile. Annual Report Highlights. V. 64, No. 3, Mar. 1991, pp. 4-9.

[6]Port of Mobile. State Docks Establishes Fourth Consecutive Tonnage Record. V. 64, No. 4, Apr. 1991, p. 6.

[7]Port of Mobile Tonnage Report. Waterborne. Jan.-Dec. 1990.

[8]Alabama Business and Economic Indicators, Center for Business and Economic Research. V. 60, No. 5, May 1991.

[9]Mining Engineering. V. 43, No. 5, May 1991, p. 493.

[10]Industrial Minerals. US Carbonate Joint Venture. No. 274, July 1990, p. 86.

[11]Alabama Development News. V. XX, No. 6, May 1990, p.5.

[12]The Wall Street Journal. Dying Breed. June 3, 1991.

[13]Alabama Development News. V. XX, No. 10, Sept. 9, 1990, p.4.

[14]Page 7 of work cited in footnote 3.

[15]Metals Bulletin Monthly. Steelmaking Proves Attractive to Commercial Metals. May 1991.

[16]The Birmingham News. State May Fine ILCO Over Discharges. July 28, 1990.

[17]Birmingham Post-Herald. Interstate Lead Gets Water Pollution Fine. Aug. 10, 1990.

TABLE 2

ALABAMA: LIME SOLD OR USED BY PRODUCERS, BY USE

Use	1989		1990	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Paper and pulp	448,825	$20,384	413,085	$19,857
Water purification	247,250	11,889	237,517	7,395
Other[1]	785,168	38,088	875,412	43,564
Total	1,481,243	70,361	1,526,014	70,816

[1]Includes acid water neutralization, alkalies, aluminum and bauxite, basic oxygen steel, citric acid, electric steel, ladle desulfurization, incinerator gas scrubber, magnesia, mason's lime, open hearth steel, ore concentraton, other chemical and industrial, other construction, other metallurgy, petroleum refining, road stabilization, sewage treatment, sugar refining, and tanning.

TABLE 3

ALABAMA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	5,999	$16,379	$2.73
Plaster and gunite sands	W	W	3.76
Concrete products (blocks, bricks, pipe, decorative, etc.)	W	W	3.67
Asphaltic concrete aggregates and other bituminous mixtures	589	4,400	7.47
Road base and coverings[1]	920	2,190	2.38
Fill	146	246	1.68
Railroad ballast	7	20	2.86
Other[2]	398	1,318	3.31
Unspecified:[3]			
Actual	4,797	22,129	4.61
Estimated	1,248	3,561	2.85
Total or average	[4]14,103	50,243	3.56

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules.
[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.

TABLE 4

ALABAMA SAND & GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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]	806	1,816	909	2,596	4,408	12,433
Asphaltic concrete aggregates, and road base and coverings[2]	128	530	445	1,240	1,082	5,067
Railroad ballast	—	—	—	—	7	20
Other miscellaneous[3]	—	—	—	—	274	853
Unspecified:[4]						
Actual	423	3,100	664	2,599	3,709	16,430
Estimated	132	351	432	1,094	683	2,115
Total	1,489	5,797	[5]2,451	7,529	10,163	36,918

[1]Includes plaster and gunite sands.
[2]Includes fill, road, and other stabilization (cement and lime).
[3]Includes roofing granules.
[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.

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 & Chemical 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.

See footnotes at the end of table.

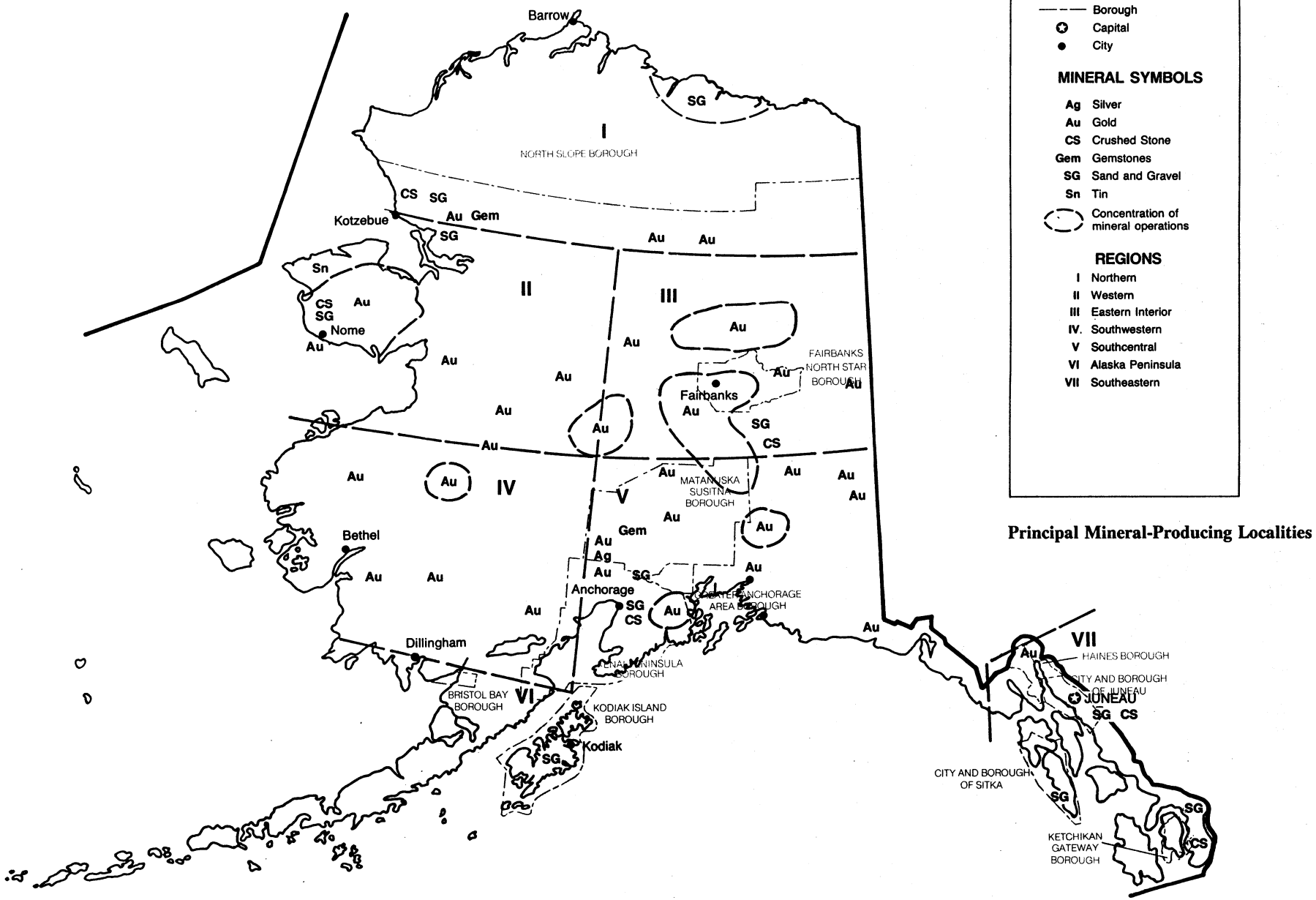
TABLE 5-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Salt:			
Olin Corp.	Box 28 McIntosh, AL 36553	Brine wells and chemical plant	Washington.
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.

ALASKA



Principal Mineral-Producing Localities

THE MINERAL INDUSTRY OF ALASKA

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

By Tom L. Pittman[1]

Alaska's nonfuel mineral production reported to the Bureau of Mines in 1990 was $576.6 million; in 1989, the value was $213.4 million. Alaska ranked 18th among the States in 1990, up from 36th in 1989. The State ranked first in production of zinc, second in lead and third in silver. The production of gold, lead, silver, and zinc by the Greens Creek Mine and of lead, silver, and zinc by the Red Dog Mine accounted for most of the increase in value. Greens Creek was in its second year of operation and Red Dog completed its first year. Gold production in 1990 was more than 18% below that reported in 1989, according to published State reports. The gold and silver was recovered by about 218 placer mines and 2 lode mines. A few tons of tin was recovered as a coproduct at several gold placer operations. Alaska also produced jade, portland cement, and soapstone. Construction sand and gravel production was about 11% below 1989 output. The production of crushed and broken stone was estimated at 7% lower than the amount reported in 1989.

Nonfuel mineral exploration expenditures were estimated by the State to be about $62.9 million, up from about $46.8 million in 1989. Almost $57.2 million of this amount was spent on exploration of precious metal lode and placer deposits. Expenditures on exploration of four lode gold mines were $35.7 million: the Alaska Juneau, Kensington, and Treadwell Mines near Juneau and the Fort Knox Mine near Fairbanks. Development expenditures were reported to be about $11.3 million in 1990, down from $132.1 million in 1989. The rapid and drastic drops were due to the virtual completion of the development programs at the Greens Creek Mine and at the Red Dog Mine and the transition of those properties to producing mines.

Three bills passed by the Alaska legislature were favored by the minerals industry. They established the Stan Price State Wildlife Sanctuary on Douglas Island, the Caribou Creek Recreational Mining Area, and an act relating to the reclamation of land and water subject to mining operations. The new regulations required by the reclamation act were not published in 1990. The effective date of the act was set for October 15,1991. A reclamation permit will be required for each mining operation in Alaska after this act becomes effective.

The Mental Health Lands Trust is now the subject of a proposed agreement crafted by the Governor and members of the legislature. The agreement could clear title to the Trust land, provide revenue for mental health costs and possibly resolve the constitutional conflicts apparent in the law passed early in 1990. A ruling on this agreement is expected in 1991 by the court that issued the

TABLE 1
NONFUEL MINERAL PRODUCTION IN ALASKA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$50	NA	W	NA	W
Gold[2]	kilograms	4,210	59,320	5,756	$70,800	3,232	$40,200
Sand and gravel (construction)	thousand short tons	17,200	48,749	e17,000	e48,500	15,100	41,800
Silver[2]	metric tons	1	135	W	W	W	W
Stone (crushed)	thousand short tons	e1,800	e8,400	2,900	20,300	e2,700	e19,800
Combined value of cement (portland), lead (1989-90), tin, zinc (1989-90), and values indicated by symbol W		XX	2,040	XX	73,752	XX	474,820
Total		XX	118,694	XX	213,352	XX	576,620

eEstimated. 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]Recoverable content of ores, etc.

injunction that stopped actions provided for by the 1990 law.

TRENDS AND DEVELOPMENTS

The rate of production of lead, silver and zinc continued to increase in 1990 because the Greens Creek and the Red Dog Mines each operated for the entire year. Published State surveys listed the total production of zinc at 164,300 metric tons, up from 18,007 metric tons in 1989; lead at 40,106 metric tons, up from 8,698 metric tons in 1989; and silver at 315.199 metric tons, up from 162.102 metric tons in 1989. Greens Creek Mine was the top silver producer in the United States for the second consecutive year. The production of zinc, lead, and silver reported to the U.S. Bureau of Mines was withheld to avoid disclosing company proprietary data. Gold production reported by the State decreased to 7206 kilograms in 1990 from 8852 kilograms in 1989. The decrease was due chiefly to low production by the offshore bucketline dredge BIMA, near Nome, and loss of most of the mining season at the Valdez Creek placer mine. It was necessary to reroute Valdez Creek above where the main pay channel lies beneath the present creek bed. A few tons of tin was recovered from some gold placer mines as cassiterite concentrates. No mercury, platinum, or tungsten production was reported in 1990. Construction sand and gravel production dropped from an estimated 17 million short tons to 15.1 million short tons and crushed and broken stone declined from 2.9 million short tons to 2.7 million short tons from 1989 to 1990. Few road, construction, or oil exploration projects were active. Placer mines continued to improve effluent water quality and reduce the amount of process water used to wash a cubic yard of gravel. Improvements in design and construction of machinery and of processing by companies and government agencies has lowered operating costs and benefited the mining environment. Blasting and the mechanical removal of frozen overburden is supplanting cold water thawing. The increasing effort to make regulations more specific and eliminate many of dubious value is helping to save time, money, and confusion in the mineral industry. There was continued interest in finding and exploring low grade bulk minable precious metal deposits and base metal deposits with enough gold and silver values to carry a significant part of the production costs. The organization of small, militant, antimining groups in southeast Alaska has slowed permitting and increased costs of current mining projects. Several mining companies formerly very active in Alaska have reduced or terminated projects here and are increasing exploration, development, and acquisition activities in various foreign countries. Another interesting trend is the appearance of foreign specialty service companies in Alaska. A Russian geophysical exploration company has been engaged to apply its specialized aerial and ground methods to the large gold prospect property of Tri-Valley Corp. north of Richardson. Environmental Protection Agency (EPA) guidelines requiring 100% recycling of placer wash water became effective in 1990 and will have had a depressing effect on the output of gold because many of the small-scale placer operators are still making the necessary alterations in their washing plants to save water and enhance effluent discharge quality.

The detailed results of State surveys of the mining industry were published in Alaska's Mineral Industry 1990--Special Report 45. 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 3,470 by the State, a decrease of about 16% from the 4,157 estimated in 1989. Mechanized placer mining employed 1151 persons; lode gold and silver, 265; base metals, 425; recreational mining, 315; construction sand and gravel, 645; stone, 160; tin, jade and soapstone, 40; exploration, 374; and development, 95. 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 employment has dropped from 4274 to 3476 persons since 1988, mostly because of virtual completion of the development and construction programs at the Greens Creek and the Red Dog Mines.

REGULATORY ISSUES

The legislature passed Senate Bill 544 (Ch. 92, SLA 90) early in 1990. This statute replaced the reclamation section of Senate Bill 129 (Ch. 101, SLA 89), enacted in May 1989. This law was to become effective October 15, 1991. The act requires reclamation for most mining operations on Federal, State and private lands in Alaska, including sand and gravel and other materials. There is an exemption for small operations disturbing less than 5 acres or gravel operations removing less than 50,000 cubic yards at one location. An operator must have an approved reclamation plan before mining starts except on small projects mentioned above. The Department of Natural Resources is given the authority to establish and manage a statewide bonding pool. Bonding is mandatory and a ceiling of $750 per acre is the maximum required. The regulations for the annual rental section of Senate Bill 129 became effective May 18, 1990. They dealt with mining, leasing, annual labor, and claim abandonment. The holder of any mining claim, leasehold location, or mining lease on State land must pay annual rental in advance to retain equity in the property. The rental for the year that began at noon on September 1, 1989, must have been paid on or before June 29, 1990, or not

later than 90 days after posting of the location notice, whichever was later. The rental for each year shall be credited against the production royalty for that year. Annual rental rates per acre were set at $0.50 from 0 to 5 years since located, $1.00 for 6 to 10 years, and $2.50 for 11 years or more. The holder may pay $100 per claim before the end of the labor year instead of performing the labor requirement. Failure to pay rent or royalty is considered abandonment of the claim.

Payment of a Production Royalty of 3% on minerals recovered from State lands is required under Senate Bill 129, Section 38.05.212. A published description states "--- the owner, operator and any middle interests monetarily benefiting from a producing property need to pay production royalty." The annual rental due and paid on a mining property shall be credited against the production royalty for that year. Royalties for the calendar year 1990 were due May 1, 1991, but have been changed to November 30, 1991. Production royalty returns are due May 1 following each year in which production occurs. Royalty payments are considered delinquent on December 1 of the year the returns were due. Failure to file a royalty return when due, or pay any portion of the royalty when due, constitutes abandonment of the mining claim, leasehold, or mining lease. The holder of any equity in a State mineral property should obtain and study a copy of Senate Bill 129 (Ch. 101,SLA 89) and Senate Bill 544 (Ch. 92, SLA 90) and the regulations resulting from them. These laws and regulations are difficult to describe adequately in a brief condensation.

The Mental Health Land Trust problems have not been resolved. In 1990 legislation provided guaranteed income to the trust to fund mental health costs and added land to reconstitute the 1 million acres in the original trust. A Superior Court injunction stopped the conveyance or permitting on any of the trust land. A proposed agreement that could clear title to the trust land and provide mental health income was crafted by the Governor and incumbent members of the 1991 legislature. This proposed agreement has not been ruled on to date by the judge of the court that issued the injunction.

Handling and dissolution of the Mental Health Trust Lands in past years by the Alaska legislature resulted in many diverse problems. In 1956, the U.S. Congress instructed the Territory of Alaska to designate and set aside 1 million acres of land potentially valuable for natural resources in a trust to fund costs of Alaska's mental health program. The lands were selected for their known or assumed value to produce income from mineral, coal, and timber development. About one-half of the lands, containing the most obvious natural resource values, were disposed of and the State acquired the balance of the lands by dissolving the trust. Part of this land was disposed of by sale and lease to various private owners and municipalities. In 1985, a suit against the State of Alaska was won by concerned advocates of the mental health program. The suit demanded reconstitution of the land trust. Results of the suit and other actions stopped development of the new Wishbone Hill coal property, curtailed activities on part of the Usibelli coal mine and prohibited issuance of title to other private owners who had bought or leased land from the trust. Many of these private owners had completed building dwellings and other structures, and others were unable to arrange financing for planned projects and improvements.

EXPLORATION ACTIVITIES

Exploration expenditures reported by the State surveys were estimated at $62.9 million, an increase of almost 17% over expenditure of $46.8 million in 1989. Expenditures by commodity groupings in 1990 were precious metals, $57.2 million (90.9%); base metals, $5.3 million (8.4%); industrial and other nonfuel minerals, $0.4 million (0.7%). About one-half of the exploration expenditures were in southeastern Alaska, one-quarter in the eastern interior, and lesser and decreasing amounts in western, southcentral, southwestern, Alaska peninsula, and northern regions. Most of the exploration effort was on old mines and prospects. Exploration provided employment for 97,421 workdays, the equivalent of 374 workyears of 260 days each. This was an increase of almost 7% above the employment in 1989. State surveys in 1990 showed that there were 2,573 new State claims and 1,888 new Federal claims located, compared to 3,786 State claims and 1664 Federal claims in 1989. There were 62,578 active State and Federal claims in 1990, about 8% lower than in 1989. There were 843 active prospecting sites on State lands, consisting of 325 extensions and 518 new sites.

Over one-half of the exploration expenditures were spent on four advanced precious metal projects: the Alaska Juneau and Treadwell Mines, the Kensington Mine, and the Jualin Mine, all near Juneau, and the Fort Knox prospect property near Fairbanks. The Alaska Juneau Mine is being planned as a metric 22,500 short tons (st) per day operation, the Kensington is scheduled for 4000 st per day and the Jualin at about 400 st per day. Current plans for the Fort Knox project call for a daily capacity of from 15,000 st per day to 30,000 st per day. Each of these gold and silver projects would require its own cyanide mill. Exploration continued at the old Jualin mine with promising results. American Copper Nickel Co. explored a gold-copper-bismuth deposit and Lac Minerals (USA) Inc. held its Lookout copper-zinc-gold and Ruby Tuesday lead-zinc prospects on Prince of Wales Island. The Greens Creek Mine was engaged in an underground exploration drilling program to enlarge its gold-silver-lead-zinc reserves on Douglas Island. Several other companies and individuals also did exploration work in the Juneau, Ketchikan, and Hyder districts.

Central Alaska Gold Co. continued exploration of the Nixon Fork gold-copper deposits northeast of McGrath. It has brought the Mystery sulfide deposits and the Crystal-Garnet oxidized deposits to the feasibility stage and started a fast-track permitting effort. The company reported it is planning on producing from

150 st per day to 300 st per day by mid-1992. Fairbanks Gold Ltd. continued trenching, drilling, and bulk sampling at its large low-grade open pit gold prospect northeast of Fairbanks. The property was offered for sale to a company capable of bringing the deposit to production. Fairbanks Gold continued exploration of a large low-grade gold deposit near Flat. Citigold Alaska Inc.,operator of the Ryan Lode gold mine on Ester Dome, diamond drilled the main lode system and started exploration on another lode system west of the Ryan Lode. American Copper Nickel Co. continued exploring the Grant Mine on Ester Dome, west of Fairbanks. After 3 years' work, the company determined the Ptarmigan Hill prospect in the Seventy Mile River area was uneconomic. Tenneco Minerals Co. replaced Placer Dome as operator at the Dry Creek gold lode prospect just north of Nome. There was also active exploration at the Mount Distin gold lode prospect about 20 miles north of Nome. Cominco Alaska Inc. is drilling an original discovery, the Pebble Beach low-grade copper-gold deposit, north of Illiamna. There were many other companies involved in lode and placer exploration projects in Alaska. Information is incomplete on exploration on Native lands. Claim or lease registrations on Native lands is not required at State or Federal government agencies.

LEGISLATION AND GOVERNMENT PROGRAMS

Land was withdrawn from mineral entry by the provision for 296,000 acres of Wilderness and by some other sections of the Tongass Timber Reform Act. The scheduled revision of the Tongass Land Management Plan by the U.S. Forest Service recognized the importance of minerals as a natural resource. It provided minerals prescriptions covering several of the 52 areas suggested by the U.S.Bureau of Mines. The Alaska Science and Technology Foundation was formed to assist the economy of the State by providing matching funds for viable projects. Goldstream Exploration Inc. of Fairbanks applied for and received a grant to construct and run a trial operation on a placer mining system that would process about 40 cubic yards per hour of feed. The system operated in 1990 and met State and Federal reclamation and water quality requirements, as specified in the design submittal. A larger plant is planned for operation in 1991. There is a shortage of experienced people with mining and milling experience in Alaska and the resurgence of underground and open pit hard rock mining has required bringing in help from outside of the State. Two programs associated with the university system have been organized to furnish basic vocational training for entry-level mineral industry jobs. The Institute of Mining Technology (MIT) of the University of Alaska, Southeast, is based in Juneau and operates as a partnership between the University and the mining industry. MIT has had good cooperation from a local underground mine that treats a complex base-precious metals ore in a 1,000 tons per day selective flotation mill. It also works closely with two other companies exploring local underground gold-silver mines and planning on flotation/cyanide mills with capacities of 4,000 st per day and 22,500 st per day. The Mining and Petroleum Training Service (MAPTS) is situated in Soldotna. MAPTS training serves southcentral Alaska and is organized to furnish basic vocational training for oilfield, refinery, and mining jobs. There is more emphasis on placer mining than at MIT. The State reports job placements for over 80% of the graduates from these training programs. The graduates have had the necessary training from certified instructors to meet the Mine Safety and Health Administration standards for minerals industry employment.

FUELS

Usibelli Coal Mine Inc. operated the only really commercial scale coal mine in Alaska. Usibelli sold about 1,576,000 tons of subbituminous-C coal worth about $45 million. The coal supplied Alaskan markets and about one-half of it was exported to the Korean Electric Power Co. in Honam, South Korea. The company sold coal to Alaskan powerplants and other users for about 40 years before it began exporting coal in 1984. The coal has a very low sulfur content but is high in ash and moisture. It will require cleaning and reduction of the moisture content to become generally competitive outside of Alaska. The Healy Clean Coal Project has proposed building an upgrading unit and a modern mine-mouth powerplant at Healy to lower the ash and moisture in the coal as export considerations and to demonstrate the advantages of firing a clean low-sulfur fuel. Usibelli drilled 6,300 feet of auger and reverse-circulation holes for exploratory and hydrologic studies, according to the State survey.

The Alaska Industrial Development and Export Authority applied to the Department of Energy for a grant of $93 million 2 years ago to provide part of the funding to build a 50-megawatt powerplant near Healy in the late 1990's. Fuel will be supplied by Usibelli. Golden Valley Electric Association, of Fairbanks, is scheduled to operate and maintain the plant and purchase power. The permit application was submitted to the Alaska Power Authority too late for consideration in 1990. Various utility board and other hearings and further negotiations on financing are scheduled for 1991.

Idemitsu Alaska Inc. carried on exploration and other work at its Wishbone Hill Mine near Palmer. The State reported Idemitsu drilled about 11,500 feet of churn drill and core drill holes for development, geophysical logging, and environmental baseline studies. The announced reserve of high heat, low-sulfur coal is about 15 million st with a scheduled mine life of 15 years. The Diamond Chuitna Mine in the Beluga coalfields conducted engineering, environmental, and permitting activities. The published reserve for this deposit is about 300 million st of lower grade coal. It is jointly owned by the BHW Group and the Diamond Shamrock Chuitna Coal Joint Venture and is managed by D & R

Ventures Inc., according to State survey information. This project had a development program active in 1990. Hobbs Industries Inc. said it has an estimated 22.4 million st of better grade reserves at its Castle Mountain Mine near Sutton. Hobbs prepared an adit portal, built access roads, and did other basic surface facility preparation work. Only about 2 million st of Hobbs' 22.4 million st of reserves is not involved in the Mental Health Land Trust dispute.

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Gold.—Gold production reported to the Bureau of Mines in 1990 was 3,232 kilograms (103,900 troy ounces) valued at $40.2 million, reported by 3 lode and 14 placer operators. This reported production was probably about 56% of the amount reported to the Bureau in 1989 and 57% of the value. The average price of gold in 1990 was $386.91 per troy ounce. Gold production reported to the Bureau was about 45% of the State's estimated production.

The State estimated 1990 gold production at 7,206 kilograms (231,700 troy ounces) valued at $89.2 million. State production estimates for 1990 "are based on data compiled from 204 DGGS questionnaires returned by companies and individuals; responses by another 15 sand, gravel, and stone quarry operators; summaries supplied by the Department of Public Facilities (DOTPF) and the U.S. Forest Service (USFS); and bullion sale volume from precious metal refiners." About 83% of the gold was produced by placer mines and the balance of 17% was recovered by two lode mines. In 1990, the 10 largest producers in Alaska recovered 49% of the State's production, 114,083 troy ounces of gold. These producers were Kennecott Greens Creek Mining Co., Alaska Gold Co., Westgold Ltd., Cambior Mines Inc., Polar Mining, Inc., Anvil Mining, Sphinx Mining, Alaska Placer Development, Nyac Mining, and Citigold Alaska Inc. The Greens Creek Mine was the largest gold producer in 1990. In 5 of the last 6 years the Valdez Creek Mine was the largest gold producer in the State. In 1990, it only mined for about 6 weeks and spent the rest of the season rerouting Valdez Creek, building a new washing plant and preparing for a full season of mining in 1991. The large offshore bucketline dredge BIMA had a serious mechanical failure in September, and the operation was terminated after a season of poor gold recovery and mechanical problems. The dredge was moved to Tacoma, WA, for sale or salvage.

The northern region produced 4,750 troy ounces of gold from 11 placer operations that employed 35 people. Production in 1989 was 6,800 troy ounces of gold from 13 operations that employed 38 people. The miners had problems complying with the new water recycling and reclamation laws and regulations. Activities were reported in the Chandalar, Wild Lake, and Wiseman districts in the central part of the Brooks Range. The biggest producer was Chandalar Mines Inc. that mined ground on Tobin Creek leased from Chandalar Development Corp. The operator, D.M. Ackels, moved his modern washing plant and equipment to Tobin Creek from Gold Dust Creek, near Fairbanks, the previous winter. The State Survey reported the following operators working in the Wiseman district: Dave Ketscher on the South Fork of the Koyukuk River; Paul Dionne working underground near the Hammond River; Outland Resources Group on Chapman Creek and Koyukuk River; Paradise Valley Mining on Birch Creek near Wild Lake, also operating a recreational mining venture for tourists; Dan Even on Jim Pup and California Creek; Wild River Ventures on Lake Creek; Robert Aumiller on Prospect Creek; Northern Lights Mining on Jay Creek; and Steve Green and Jon Brewis on Rocker and Davis Creeks.

The western region produced an estimated 79,100 troy ounces of gold from 42 placer mines, about 10% less gold than in 1989. Alaska Gold Co. operated two bucketline stacker dredges near Nome. Dredge No. 5 worked on the Third Beach (Monroeville) deposit at its intersection with Dry Creek, about 3 miles northeast of town. Dredge No. 6 continued digging westerly along the Submarine Beach, about 3 miles west of the Nome airport. Each dredge has a digging capacity of about 9,000 cubic yards per day. These dredges operated 160 days, from May to early November and employed about 135 seasonal people. The State reported production of 24,000 troy ounces of gold from all Alaska Gold Co. land in the western region.

Westgold Ltd., owner of the BIMA, announced in October it would sell its offshore dredge and 22,000 acres of offshore State leases near Nome. The economics of the operation did not work out. In the 5 years of operation, gold recovery did not come up to the forecast 50,000 troy ounces per year, the price of gold decreased, there were serious mechanical breakdowns, and gold recovery did not meet expectations. During the 1990 mining season, Westgold recovered about 15,200 troy ounces of gold, about one-half of the average in previous seasons, employing 125 workers. The total recovery from 1986-90 was 121,861 troy ounces of refined gold. The company developed an apparently successful track-mounted, remote controlled, sea-bottom suction mining unit that recovered about 700 troy ounces of gold during test runs, but that project was apparently dropped when the BIMA operation was terminated. Other large operations on the Seward Peninsula include: Anvil Mining Co., on Anvil Creek in the Nome District; GHD Resources at Kiwalik Flats, Candle district; and Bud Meyers and Associates, Mud Creek, Candle district.

Many small mining firms were active on the Seward Peninsula. The State survey list includes: N.B. Tweet and Sons with a small dredge on Henry Creek, Kougarok district; the Edwin Hatch and Tom Johnson operations on Sweepstakes Creek, Koyuk district; Howard Smith on Little Rocker Creek, Nome district; Bert Pedigrew on Speciman Gulch, Nome district; Paul Steinhacher, Iron Creek, Casedepaga district; Darrel Walker, Clara Creek, Nome district; Alan Vesey,

Hastings Creek, Nome district; Mark Gumaer on Macklin and Duck Creeks, Serpentine district; Alaska Placer Development, Solomon Creek, Solomon district; Jerry Pushcar, Nelson Creek, Council district; Mathisen and Christoferson on Eagle and Iron Creeks, Council district; Hugo Lindfors and C.M. Reader on Dome and Telegraph Creeks, Council district; Roger Nordlum, Candle Creek; Inmachuk Gold Corp., Inmachuk River; and Global Resources Inc., Penny River, west of Nome. Global continued a combination tourist-recreational operation using the old American Creek flume dredge and hand methods.

Alaska Gold Company's Hogatza River placer unit in the Hughes district was leased to Taiga Mining Co. Taiga operated the 6 cubic-foot dredge on the left limit of the ground previously mined. Sphinx Mining Co. worked on Midnight Creek in the Ruby-Poorman district, about 30 miles south of the Yukon River. Sphinx recovered about $1.6 million in gold-silver bullion and tin concentrates, employing 10 workers, according to the State survey. Other active mining companies in the Ruby-Poorman district were: Flat Creek Mining Co. on Flat Creek; Mike Hartman on Poorman Creek; Yukon Mining Co. (Joel Ramsted), Illinois and Golden Creeks; Ross Novak, Boothby Creek; Conrad House, Swift Creek; Green Mining and Exploration, Swift Creek; Mike Sweetser, Trail Creek; Howard Miscovich, Poorman Creek; and Keith Tryck on Ophir Creek. In the Tolstoi area, Rosander Mining Co. operated on Colorado Creek. The newly designed washing plant used water recycling and effluent containment. Castle Mining Co. worked on Alamin Mining Co.'s Bear Creek ground; gold recovered was below Castle's expectations.

The eastern interior region produced an estimated 78,480 troy ounces of gold from 115 mines in 1990 and employed 495 people. In 1989 the region produced 79,300 troy ounces of gold from about the same number of mines, using about the same number of employees. The Fairbanks district was again the largest producer of gold in the region. Estimated production from the district's 27 placer mines and 2 lode mines was 27,800 troy ounces of gold and 5,500 troy ounces of silver worth $10.7 million. Total employment was 190 people, with 158 jobs at placer mines and 32 jobs at lode mines. The State estimates production and employment were about 20% lower than in 1989 due mainly to reduced lode mine activity. On Ester Dome, west of Fairbanks, Citigold Alaska Inc. did no mining but recovered about 2,500 troy ounces of gold and 2,200 troy ounces of silver from continued leaching of existing heaps. The company carried on a diamond drilling and exploratory project on the Ryan Lode deposit and started work on its new discovery, the Curlew/Iving Lode, another similar gold deposit northwest of the Ryan Lode. Several holes drilled to depths of more than 1,000 feet on the Ryan Lode indicate the deposit maintains its width and grade to at least that depth. Citigold continued monitoring ground water wells and other water sources because of reports and allegations to the Department of Environmental Conservation (DEC) that cyanide solutions were escaping from the leaching operation and causing contamination threatening adjacent properties. The Grant Mine, controlled by Silverado Mines U.S. Inc., was leased by American Copper and Nickel Co. (ACNC). The company diamond drilled 17,434 feet of holes on the O'Day vein structure and in the Ethel Pit area east of the Ryan Lode property and planned to do more work in 1991.

Polar Mining Co. operated a large placer pit on Goldstream Creek, north of Ester Dome between Sheep and Nugget Creeks, and a smaller placer pit on Fairbanks Creek. Both of these properties were leased from Alaska Gold Co. The Goldstream operation used heavy equipment for stripping after drilling and blasting permafrost overburden. The pay gravel was then mined with a loader and hauled to the washing plant. Polar was the largest gold producer in the eastern interior district and one of the five largest in Alaska. The company usually works about 350 days per year on exploration, development, and mining, using 28 regular and as many as 15 seasonal employees. The Christina Vein workings near Cleary Summit were leased from Fairbanks Exploration Inc. Polar stripped some of the vein, installed a small crushing, screening, and gravity concentration mill, and ran some bulk sampling and milling tests on the ore.

Roberts Mining continued its underground placer operation on Dome Creek downstream from the former United States Smelting, Refining and Mining Co. dredging ground. The State survey said Roberts Mining produced about 15,000 cubic yards of pay gravel during the winter for summer sluicing; it averaged more than 0.04 troy ounce of gold per cubic yard. The father and son crew drills the frozen ground with a jackleg, loads the round with ANFO, and blasts using gelatin primers. A standard round usually releases about 25 cubic yards of overburden and pay gravel. Don Read continued reprocessing old tailings and working a small drift mine on Treasure Creek on the north side of the Fairbanks district. Alaska Gold Co. leased placer ground to Alf Hopen on Dome Creek; SVZL for drift mining on Eldorado Creek; Ron Roman on Fish Creek; and Walter Roman on Fish and Pearl Creeks. Fairbanks district operators included: Cooks Mining on Fairbanks Creek; Jack Neubauer, Fox Creek; Don Stein, Pedro Creek; Andy Miscovich, Chatham Creek; Dwayne Savage, Last Chance Creek; Alex Twogood, Goldstream Creek; Jim Childs, new mine on Nugget Creek; Howard Lambert, Ester Creek; Carson Holt, Willow Creek; and the operations of Jerry Hansel and of Roger Moore on Ready Bullion Creek.

The Circle mining district activity was about the same as in 1989, according to the State survey. About 37 companies produced, out of 52 that applied for mining permits. This district had the largest number of placer mines in Alaska but most of them were relatively small. Goldstream Mining Inc., on Mastodon Creek, received a grant from the Alaska Science and Technology Foundation to design and build a testing plant that operated successfully in 1989. Goldstream then built a similar plant with a capacity

of about 50 cubic yards per hour that mined through the 1990 season. The new plant mined, washed with less water than usual, and reclaimed the ground during the mining operation. Some of the larger mines in the district were: Paul and Company on Porcupine Creek; Greenhorn Mining Co. (Stan Gelvin), Crooked Creek; and Alaska Ventures (Vince Halverson) on Mammoth Creek. The State listed these other placer mines active in 1990: Gold Post Mining Co. on Deadwood Creek; Ron Wrede, Deadwood Creek; Superstock Mining, Crooked Creek; Points North (Bob Cacey), Portage Creek; Jim Belfield, Switch Creek; Steve Olson, Eagle Creek; Dugger Mining Co., Mastodon Creek; Lyle Colledge and Vern Stepp, Bottom Dollar Creek;Magic Circle Mining, Deadwood Creek; Aurora Mining, Pup Creek; John Sipes, Deadwood Creek; Dick Blevins, Portage Creek; John Hendrickson, Sourdough Creek; George Seuffert, Cripple Creek; Last Hope Mining, Harrison Creek; and Clyde Henry, on 43 Creek.

There were three placer mines active in the Livengood district in 1990. Alaska Placer Development Inc. was the largest operator again, as it has been for at least the last 6 years. The company hydraulically stripped muck overburden and mined and sluiced a gravel paystreak overlying a rough limestone bedrock. Mine effluents are contained in a pond of about 160 acres that was constructed by a previous operator. Process water is reclaimed and recycled. Scott Rendich mined on Willow Creek and Dick Geraghty mined on Olive Creek. The Eureka-Tofty and Rampart districts supported 15 placer mines in 1990 compared to 9 in 1989. The State survey reported Shoreham Resources recovered 1,074 troy ounces of gold, 208 troy ounces of silver and 2,600 pounds of tin from Cache Creek, in the Tofty district. The company washed 26,000 cubic yards of pay gravel. Mechanical problems, deep overburden and low metal prices adversely effected the operation. Alaska Placer Development Inc. started a new placer mine on American Creek east of Manly Hot Springs.

Smaller placer operators in the district included: Robert Roberts on Skookum Creek; Ric Swenson, Doric Creek; Orval McCormach, on American Creek and on Eureka Creek; Mike Krenzke, Eureka Creek; Jim Wood, Little Boulder Creek; Salter and Associates, Joe Bush Creek; Delima Placers Inc., on Colorado and on American Creeks; Harold Bergman, on Cache and on Sullivan Creeks;Vern Petefish, Little Boulder Creek; Anna Russell on Trail Creek; John Shilling on Slate Creek in the Rampart district; and Frank Wilford on Hoover Creek bench gravels, also in the Rampart district.

The Fortymile district had 28 placer mines in 1990, an increase from 16 in 1989. The State survey characterized the operations as "small mechanized sluicing plants or scaled-up suction dredges normally associated with recreational mining or ground testing." Listed operators were: Mike Buzby mined on Chicken Creek, on claims leased from Alaska Gold Co.; Velvet Mining Co., South Fork of Fortymile River; Dome Creek Mining and Development, Dome Creek; Leo Regner, Lillywig Creek; and Charles Hammond, 45 Creek. Smaller operations were: Mike Chambliss and Clyde Baldwin on the South Fork of the Fortymile River; Hank and Sons, Lost Chicken Creek; Maxwell Mine and Exploration and Al Ruddick on Canyon Creek; Ken Wise, Mosquito Fork of the Fortymile River; Dave Moss, Liberty Creek; Freedom Mining and Exploration, Robinson Creek; Richard Goodson, Fortymile River; Hayden Exploration and Mining and Maxwell Exploration, each on Baby Creek; Lone Spruce Mining, Squaw Creek; Frank Lockner, 60 Mile River; Joe Trudeau; Jefferson Creek; Franklin O'Donnell, Moose Creek; Mike Williams, Kenyon Creek; Steve Bills, O'Brien Creek; and Judd Edgerton on Robinson Creek. Suction dredge miners in the district included: Ostler Mining, Tom Erickson, John Roop and Wesley Devore. The most controversial operation was probably David Likins' "New Zealand Dredge" on the Fortymile River. It was described in news stories as a smaller plant using a recovery system similar to that used on bucketline stacker dredges. The publicity was picked up by environmental organizations, misinterpreted and the fight was on, partly because the Fortymile River had been designated a Wild and Scenic River in 1980.

In the Bonnifield district, the number of active mines increased to 12 in 1990 from 9 in 1989. This district is east of Healy and north of the Alaska Range. Alaska Unlimited Inc., on Gold King Creek, was again the largest operator in the district. The gold is believed to have been eroded from Nenana Gravel of Tertiary age or from the Nenana coal-bearing formation. Gypsy Luck Mining Co. mined on Walker Creek, near Gold King Creek. Other medium to small capacity operators were: P & P Mining on Newman Creek; Barney Harrod, Bonnifield Creek; Old Yeller Mining and Kerry Knapp, each on Totatlanika River; Tom Faa, Moose Creek; The Four Stewards, Iron Creek; Glenn Parr, Walker Creek; the Annabelle Mine (Jim Rowland), Moose Creek; Tommy Van Inc., Flat Creek; Fred Cook, Portage Creek; and Jackson Mining Co. on the Totatlanika River.

Several old camps in the Alaska Range had new activities: Tok Gold and Exploration mined on the Tok River near Stibnite Creek; Law Iosua and MVM Associates mined on Rainy Creek and Richard Knutson mined at Broxson Gulch, west of Rainy Creek. Rainy Creek and Broxson Gulch contain both gold and platinum. David Jensen mined gold from July and McCumber Creeks, near the Granite Mountains.

The south-central region produced an estimated 16,670 troy ounces of gold in 1990, down from 73,100 troy ounces estimated production in 1989, according to the State survey. Employment dropped from 280 to 160 employees. Cambior Alaska Inc., the operator of the Valdez Creek placer mine, rerouted Valdez Creek to allow upstream work under the upper channel of the creek. It mined for 5 weeks in the fall and produced an estimated 8,031 troy ounces of refined gold from about 138,000 cubic yards of pay gravel. The Alaska Department of Fish and Game required the creek diversion to protect the fishery and as a

requirement to issuing new operating permits. The mine should have a full season of operation in 1991 with a new washing plant much closer to the current mining site. Smaller placer mines working in the Valdez Creek district were Crooked Dog Mining on Grogg Creek, Howard McWilliams on Johns Creek and Broad Pass Mining Co. on Squaw Creek. In the Chistochina district Hoffman Mining produced gold, silver, and platinum from the Middle Fork Mine on the Chistochina River. William Beerman and George Livermore mined on Slate Creek and Ruby Gulch. The Mrak placer mine and the placer of Magnum Resources International each operated on Willow Creek. Lonesome Mining Co. mined on the Little Susitna River.

The Kahiltna district was moderately active. Fine sizes of gold particles usually required specialized mechanical plants for satisfactory recoveries. Ed Ellis recovered gold and platinum by hand methods from the Golden Bar Group of claims situated on a bar in Cache Creek. Jim Watkins mined on Falls Creek. Arne Murto mined gold and platinum on Martin Creek in the upper Kahiltna drainage. Martin Herzog continued placer mining on Cache Creek. The State survey reported low activity on the Kenai Peninsula, confined mostly to recreational suction dredges or small mechanized plants run as combination placer mines and tourist attractions. Cynthia Toohey mined by hand and with a small suction dredge in the Hope district. Wallace Saline used a suction dredge on Canyon Creek. In the Girdwood district, Outsider Mining Co. worked on the Wagner Group claims. He used a suction dredge and hand methods. There were apparently no regular mining operations in the Nelchina district but a considerable amount of assessment work and claim maintenance was accomplished.

Southwestern region's estimated production was about 14,400 troy ounces of gold with some silver, mercury and platinum from 26 placer mines, employing about 100 people. The largest placer mine in the Nyac district was operated by Nyac Mining Co. at the head of Bear Creek, about 35 miles south of Aniak. The State survey reported about 20 people mined several hundred thousand cubic yards of pay gravel from a shallow bedrock placer. About 30% of the mechanics and support staff were Alaska natives who lived at Crooked Creek. They started mining careers working at a hard rock joint venture gold prospect on Donlin Creek that was explored by Westgold and the Calista Native Corp. Flat Creek Placers continued mining on upper Flat Creek, in the Iditarod district. Richard Fullerton died; he and his brother John Fullerton had mined together for more than 50 years. Lyman Resources of Alaska built a new washing plant and did exploration work on Donlin Creek but did not mine in the 1990 season. Magnuson Mining Co. mined in the Ganes Creek drainage and did some exploration work at the old Independence Mine near the head of Carter Creek. The Golden Horn Mining Co. (owned by the John Miscovich family) leased claims to R.R. Hensler Inc. of California. This operation on Otter Creek, near Discovery Camp, reworked dredge tailings but did not pay out. On Chicken Creek, Richard Wilmarth mined a small cut and dug a bedrock drain. Washing the waste rock paid off, also.

Julian Creek Mining Co. continued placer mining on Julian Creek, a tributary to the George River. L.E. Wyrick recovered coarse gold from shallow pay gravel on upper Granite Creek in the George River area. John O'Carroll worked on Spruce Creek Bench. Allan (Eep) Anderson worked some new ground and old dragline tailings on Yankee Creek, west of Takotna. Paul Sayer mined and explored on Ester and Little Creeks near Ophir. R&W Mining mined on Ophir Creek, an area that had been idle for several years. Alvin Agoff mined on Prince Creek at the base of Chicken Mountain.

Among the scattered and isolated operators the State reported Dave Penz mined good ground on Buster Creek near Russian Mission. Fred Noden had a fairly new small operation on Chanuk Creek, tributary to the Mulchatna River, north of Lake Clark. Also north of Lake Clark, Richard Busk mined ground on Scynneva Creek in the Bonanza Hills. This ground was formerly worked by Terry and Victoria Gill. LBMB Mining Co. worked a small cut on Murray Gulch and New York Creek along the Kuskokwim River and south of the Horn Mountains. The Taylor Creek Mine in the Taylor Mountains, south of Sleetmute, was reactivated by Scott Greger. Holitna Basin Mining and Exploration completed some test work on placer ground on 47-Creek, south of Sleetmute.

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. The underground Greens Creek Mine of the Kennecott Greens Creek Mining Co. produced 38,103 troy ounces of gold from 382,574 short tons of ore, according to the State Survey. The mine is situated about 18 miles southwest of Juneau in a nonwilderness area on Admiralty Island. The gold was recovered by smelting the lead, zinc and mixed lead-zinc concentrates from the flotation concentrator. Greens Creek produced more gold in 1990 than any other mine in Alaska. An intensive exploration diamond drilling program is being conducted with indications there will be substantial additions to the reserve tonnage in the mine. During this second year of operation significant improvements were made in metal recoveries by finer grinding and improved flotation practices. Small amounts of placer gold were recovered by several placer miners. Jerry Fabrizio, operating as Snow Lion Mining Co., worked claims on Porcupine Creek near Haines. About 30 cubic yards per day of beach strandline deposit material was mined and sluiced by Carl Glanville near Yakutat. Andrew Moritz, Jr., tested strandline deposits near Mount Fairweather but did not develop commercial deposits of placer gold, according to State survey reports.

Exploration at the Alaska Juneau (A-J) Mine east of Juneau was continued by the joint venture Echo Bay Alaska Inc. (85%) and Watts, Griffis and McOuat Ltd.

(WGM) (15%), of Toronto, Canada. Echo Bay is the project operator. The property is leased from Alaska Electric Light and Power Co. and the City and Borough of Juneau (CBJ), the owners. The 1990 program increased the proven and probable reserves to over 100 million short tons containing about 3.3 million troy ounces of gold, according to Echo Bay's 1990 Annual Report. The forecast milling grade will be 0.052 troy ounces gold per st over a mine life of 12 years. Present plans call for a flotation and gravity mill with a capacity of 22,500 tons of ore per day with regrind and cyanidation capacity to recover gold and silver from the concentrates. Gold from the flotation and gravity concentrates will be smelted to dore' bullion and shipped outside for refining. The new mill, surface facilities, and haulage adit portal will be at Thane, about 4 miles south of Juneau. The 1990 exploration program completed about 83,000 feet of diamond drilling and a considerable footage of underground drifting, crosscutting, and raising. This work increased the reserves about 50% above the 1989 figures. Other mineralization was listed by Echo Bay at about 2.1 million troy ounces of gold in lower grade rock, a 300% increase above the 1989 estimate.

The Environmental Impact Statement (EIS) is being prepared by the Bureau of Land Management (BLM). The scoping meetings began in April 1989 to obtain public input and identify environmental and socioeconomic issues. A Preliminary Draft EIS was released to government agencies in December 1989. After the agency comments and public concerns were compiled, Echo Bay published a revised project description in May 1990. The revised description proposed a site for the surface facilities and mine access adit portal near Thane and proposed using LPG fuel instead of diesel fuel for electrical power generation. Thane is about 4 miles south of Juneau, practically free of snow avalanche danger, has more favorable terrain, and is much closer to the preferred tailings disposal site. The Final EIS should be released early in 1991. The deposit is about 3 miles long and varies from about 50 feet to 600 feet wide. Most of the gold and silver values are contained in swarms of quartz stringers and veins that are from less than 1 inch wide to 15 feet wide and contain some pyrrhotite, lesser sphalerite, small amounts of galena, and very small amounts of free gold. The veins average about 6 inches in width and about 0.5 troy ounce in gold. The vein swarms are localized along the Coast Range Megalineament and emplaced near the contact between metadiorite and slate or phyllite hanging wall rocks and a green schist footwall. The east-west Silverbow fault cuts the deposit near the northerly end, dividing it into the north and south ore bodies. The fault has about 1,800 feet of oblique left-lateral displacement. The north ore body was developed by an internal shaft from the mill haulage level at an elevation of about 460 feet above mean sea level (msl) to about 1,000 feet below msl and partially mined to the surface. A long crosscut was started from the 10th level of the shaft at about 530 feet below msl and through the fault toward the south ore body; it was only advanced about 750 feet beyond the fault when the mine closed. The south section of the deposit was partially mined above the old mill haulage level only and includes the ground at the south end purchased by the Alaska Juneau Mining Co. from the Alaska Gastineau Gold Mining Co. about 1934.

The Echo Bay-WGM joint venture also leases the Treadwell group of mines on the east shore of Douglas Island, about 1 mile westerly across Gastineau Channel. The Treadwell operations produced about 3 million troy ounces of gold from 1881 to 1917 when a hanging wall cave-in flooded the mine with sea water. Mining had progressed from the surface to 2,300 feet below msl and exploration and development was progressing to the 2,800 foot level. Echo Bay contracted with Tonto Drilling Services to diamond drill a directionally controlled hole from the east side of Gastineau Channel to intersect the Treadwell deposit and then to drill three offset holes through the structure. Echo Bay's 1990 annual report stated: "The first three holes encountered the diorite formation that hosts the Treadwell zone, but showed scant gold. The fourth hole encountered 600 feet of diorite, of which 186 feet graded 0.10 ounce/ton gold, including 49 feet of 0.22 ounce/ton." About 10,000 feet of hole was drilled. It may be possible to access the Treadwell ore zone by a decline from a shaft in the A-J workings.

The Kensington Mine is about 50 miles north of Juneau and about a mile east of Lynn Canal. It is owned by a joint venture of Echo Bay (50%) and Coeur d'Alene Mines Corp. (50%). Echo Bay is the operator. There was a small production of gold and silver in the early 1900's from stopes near the outcrop and from a short level at an elevation of about 2,400 feet. The 1990 annual report by Echo Bay lists reserves at the end of 1990 at about 1.9 million troy ounces of gold averaging 0.148 troy ounce gold per st, an increase of about 40% above the 1989 reserves. The State survey lists this reserve as contained in 12.8 million tons of ore. Drilling and other work from the new 5,200-foot crosscut adit driven easterly from the foot of the mountain at the 800-foot level has identified the Kensington stockwork of quartz veins in diorite over a vertical range of 2,800 feet and along strike for about 1,600 feet. The structure strikes about north and south and dips steeply to the east. The average width is about 50 feet. Gold occurs mainly as calaverite (a gold telluride) and native gold. There are small amounts of pyrite and minor chalcopyrite present. A raise connects the 800 level to the 2,000 level. Ramps provide access from the 800 level to levels at elevations of 900 feet and 1,175 feet. The 800 level was driven as a production sized opening although it would intersect the Kensington structure about 600 feet below the lowest old drill holes. The 800 level crosscut the Horrible and three other gold-bearing zones before reaching the Kensington. The 2,000 level cut the Eureka zone just west of the Kensington and one small zone to the east before intersecting and drifting north and south on the Johnson zone.

Planning in 1990 indicates rock and ore is competent enough to allow use of modified longhole stoping techniques. Bulk sampling and milling tests yielded

gold recoveries of at least 92%. The proposed mine, mill, and infrastructure will have a scheduled capacity of 4,000 st per 24-hour day, produce 200,000 troy ounces of gold per year, and employ about 350 people. Flotation concentrates will be cyanided and all gold recovered will be smelted to dore' bullion and shipped out for refining. The company estimates the gold production cost will be about $225 per troy ounce. Capital costs should be about $170 to $180 million including a contingency fund of $15 to $20 million.

The Jualin Mine and some nearby property is being explored on a buy-in basis by Placer Dome (U.S.) Inc. In 1987 Curator American Inc., and later International Curator (60%) and Granges Inc. (40%), optioned the property from Hyak Mining Co., of Juneau. Hyak retained a 5% royalty. The Jualin Mine is on Johnson Creek and is just south and east of the Kensington Mine. A reserve figure published in November 1990 listed 1.07 million st averaging 0.349 troy ounces, uncut, and not considering mining dilution or mill recoveries. About 26,000 feet of diamond drilling was completed in 1990. The main zone consists of a quartz and carbonate vein stockwork about 50 feet wide in sheared diorite, similar to the Kensington host rock to the north. These stockwork zones with quartz, carbonates, pyrite, galena, sphalerite, chalcopyrite, and native gold contain most of the estimated reserve tonnage. More compact high-quartz veins from about 1 to 5 feet thick contain more abundant sulfides and gold; they commonly crosscut the carbonate-carrying veins and usually enrich them. Some gold-bearing felsic dikes crosscut the diorite and were exposed in earlier trenching. There has been renewed interest in prospecting and exploring dikes that show significant quartz-sericite-pyrite-sphalerite-gold mineralization. These dikes tend to crosscut the general trend of the diorite and the main mineralized zone.

The Jualin Mine produced an estimated 48,375 troy ounces of gold in the period from 1896 to 1920, when the small stamp mill burned. The ore came from four or five quartz veins that ranged in width from 2 to 10 feet. One vein averaged about 1 1/2 troy ounces of gold per st; the other veins each averaged less than 1/2 troy ounce of gold per st. A Belgian company controlled the property when World War I interrupted its financing and drain tunnel project, and loss of the mill shut off the last source of revenue. The patented mining claims were foreclosed by the State for nonpayment of taxes. Hyak Mining Co. relocated the property as State mining claims in 1978. Bear Creek Mining Co. leased the property in 1983 and did some diamond drilling. Curator American Inc. leased the property in 1987 and core drilled about 14,000 feet in 28 holes. In 1988 Curator diamond drilled an additional 14,000 feet and built a
5-mile access road from a cove near the entrance to Berners Bay to the mine. Curator leased the Dream deposit in the Chilkat Mountains across Lynn Canal, to the west, and started to explore them. A field crew from the Bureau of Mines had discovered the Dream precious metal and base metal deposit and it had been located by local prospectors and leased to Hyak. Placer Dome (U.S.) Ltd. leased the Jualin and Dream properties in 1989 and continued exploring them as possible low-grade but large-tonnage gold producers.

The State survey lists other exploration projects in the southeast region. Hecla Mining Co. diamond drilled on the Red Diamond, Yakima, and Lawson Creek deposits on Douglas Island. Lac Minerals (U.S.) Inc. and Noranda Exploration Inc. jointly explored at the old Niblack Mine-Lookout Mountain area and the Ruby Tuesday deposit on Prince of Wales Island and the Kaigani prospect on Dall Island.These are precious metal and/or base metal deposits. Sealaska Corp. did some exploration work at several localities: a buried porphyry with gold mineralization north of Klawok; skarn copper with gold at Coco Harbor; volcanogenic massive sulfide copper deposits with gold values in the Hetta Inlet and Trocadero Bay areas, Dora Bay and Sukwan Island; and the Dolomi area copper-gold deposit leased to American Copper and Nickel Inc. The Lucky Nell Mine adit on Prince of Wales Island was reopened and the underground workings and mine dumps were sampled by Guy Comer of Ketchikan. Hyak Mining Co. used mapping, geophysical surveys, and geochemical sampling on Chichagof Island. BHP-UTAH funded a month-long sampling and mapping project on Prince of Wales Island. Delta Minerals explored in the Porcupine townsite using reverse circulation drilling, mapping, sampling, and geophysical surveys in the old gold placer district near Haines. Pulsar Resources (U.S.) Inc. contracted for 5,500 feet of core drilling and did regional geological and geochemical work in the Hyder area in 1990. Pulsar is a subsidiary of Hyder Gold Inc.

Exploration in the classic epithermal gold setting of the Alaska Peninsula region was valued at about $1.77 million in 1990, down from about $2.01 million in 1989. Battle Mountain Exploration Co. vigorously explored land leased from the Aleut Corp. on Unga, Popof, and Nagai Islands in the Shumagin group of islands. The State survey described the program as including mapping, rock sampling, and drilling following a large airborne magnetic-electromagnetic geophysical survey. Work on Umnak and Unalaska Islands included a smaller geophysical survey followed by intensive geologic mapping, geochemical sampling, and drilling. Alaska Apollo Mines Ltd. reported reserves at the Apollo and Shumagin Mines on Unga Island average 0.765 troy ounces gold and 2.47 troy ounces silver contained in 208,260 st of ore.

Silver.—Silver production reported to the State in 1990 was 10,135,000 troy ounces, valued at an estimated $50,675,000. The State reported silver production in 1988 and 1989 at 49,790 and 5,211,591 troy ounces, respectively, valued at $281,950 and $27,360,852. Alaska ranked third among the States in production of silver, up from sixth in 1989. The Greens Creek Mine, in its second year, produced 7,636,501 troy ounces of silver from 382,574 st of ore. This was Greens Creek's second year as the top-ranked silver mine in the United

States. The milling rate averaged 1,050 st 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 1990. An average of about 4,000 tons of open pit ore 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 1990 was reported to have averaged about 25.7% zinc and 10.5% lead, from a published reserve of 85 million tons averaging 17.1% zinc, 5.0% lead and 2.4 troy ounces silver per st. Some of the ore exposed at the surface of the deposit contained badly oxidized mineralization and was stockpiled for later research and treatment. The moderately oxidized ore yielded rather poor recoveries of lead and silver and required considerable work on the grinding and flotation circuits to attain the expected metallurgical results. Silver recovery was about proportional to the lead content of the mill products. Elemental sulfur is present in the ore and requires preliminary flotation to keep it from diluting the shipping concentrates. Anticipated annual silver production is about 3.9 million troy ounces when milling 6,000 tons of ore per day. The silver would be recovered from smelting 560,000 st of zinc concentrates averaging 3.0 troy ounces of silver per st, 120,000 st of lead concentrates at 16.5 troy ounces silver per st, and 50,000 st of bulk concentrates at 4.5 troy ounces silver per st. Placer gold recovered in 1990 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 25.855 metric tons of tin, valued at about $200,000, was produced in Alaska in 1992. The reported tin output in 1989 was 87.99 metric tons valued at $672,000. Sphinx Mining Inc. recovered a byproduct placer tin concentrate at its placer gold mine on Midnight Creek, in the Ruby-Poorman district, about 30 miles south of the Yukon River, in the western region. Shoreham Resources Ltd. also produced a placer tin concentrate from its gold placer on Cache Creek in the Tofty district, in the eastern interior region. Kennecott Exploration Inc. mapped 8 square miles, took soil and rock geochemical samples and drilled two holes in a tin exploration program at Potato Mountain, on the Seward Peninsula. There was little exploration effort and expenditure on tin in 1990 other than that necessary to hold several promising prospects justified by previous work.

Zinc and Lead.—The State survey reported 1990 zinc production at 164,350 metric tons valued at $253,680,000 and lead production at 40,106 metric tons valued at $30,954,000. This was an increase from 18,007 metric tons of zinc and 8,698 metric tons of lead valued at $29,383,400 and $7,692,009 in 1989. The amounts and value of 1990 zinc,silver and lead production reported to the Bureau of Mines has been withheld to avoid disclosing company proprietary data. Alaska ranked first among the States in zinc production, second in lead production and third in silver production. Nevada and Idaho silver output topped Alaska in 1990.

The Greens Creek Mine operated full time during its second year. The mine is in a nonwilderness area east of Hawk Inlet, on Admiralty Island, about 18 miles southwest of Juneau. The underground mine supplied an average of 1,050 st per day of ore to the selective flotation mill, for a total of 382,574 tons. The State survey lists 1990 production at 7,636,501 troy ounces of silver, 38,103 troy ounces of gold, 33,457,804 pounds of lead and 74,006,086 pounds of zinc in concentrates. Copper and barium minerals in the ore were not recovered. Startup problems in the mill were brought under control by finer grinding and by modifications of the flotation circuits and reagents. Lead, zinc, and a bulk lead-zinc concentrate were shipped to foreign smelters from the company's Hawk Inlet storage and loading dock. The bulk concentrate goes to Imperial Smelting Furnace (IFS) smelters for the recovery of the complex mixture of contained metals. The known ore bodies have been described as volcanogenic massive sulfide deposits in folded metasedimentary rocks of late Triassic age. The explored ore deposits are the north, central, and south zones. The zones range from 6 to 80 feet thick, from 200 to 700 feet down dip and 1,200 to 2,000 feet long. Mining was by drift and fill methods in the narrower parts of the deposits and by modified cut and fill methods in the wider stopes. Much of the stope fill is deslimed and pressure-filtered mill tailings backhauled into the mine. Jumbo drilling, loading, and hauling is accomplished by diesel-powered equipment. There was an ambitious program of 61,500 feet of development and exploration drilling in addition to 47,500 feet of production drilling. The operating work force is about 265 people. The State believes this operation adds about $30 million annually to the economy of Juneau in salaries, goods, and services. Except for a few people, the operating crew lives in the Juneau area and is transported by the Alaska Dream, a catamaran crew boat, from Auke Bay to Youngs Bay on Admiralty Island and thence by buses to the mine and mill sites on Greens Creek and the storage and shipping site on Hawk Inlet. The company has a smaller standby catamaran based at its Auke Bay dock.

The Red Dog Mine is situated about 90 miles north of Kotzebue and 52 miles inland, northeasterly, from the Chukchi Sea. The mine produced 1,318,200 tons of zinc-lead-silver ore during the first year of its open pit operation in 1990, according to the State survey. Only 321,700 tons of lead, zinc, and bulk (ISF) lead-zinc concentrates were shipped during the short open-water season of about 100 days. The concentrates went to the Cominco Alaska Inc. (Cominco) smelter at Trail, British Columbia,

Canada, and to smelters in Europe and the Far East. The published inferred ore reserves contain 85 million st averaging 17.1% zinc, 5% lead and 2.4 troy ounces of silver per st. The zinc ore body is believed to be one of the richest and largest found to date. The deposit is owned by the NANA Regional Corp. Inc. and has been developed and equipped by Cominco, the operator, at a total cost of about $415 million. Fifty miles of the 52-mile port access road and the port facility were financed by the State-owned Alaska Industrial Development and Export Authority (AIDEA) with bond sales. The road and port project cost of about $175 million will be paid back by Cominco over a specified period of years. Any other mining or industrial projects that develop in the area that become users of the system will pay for the use on a pro rata basis. The road and port projects financed by AIDEA in this area are known as the DeLong Mountains Regional Transportation System.

The Red Dog deposit occurs in late Mississippian cherts, limestones, and black shales as relatively flat-lying, poorly bedded materials of four types: silica rock, sulfide rock, sulfide-bearing barite, and barite low in sufides. The chief sulfides are light-colored sphalerite, galena, marcasite, and pyrite. There are small amounts of boulangerite, chalcopyrite, polybasite, and tetrahedrite. The sulfides are usually present as fine intergrowths with silica. The silicification of the shale has been widespread within the ore body, and oxidation of part of the iron minerals has caused the red and brown coloration present. The deposit is about 4,400 feet long, from a few hundred feet to 1,400 feet wide and about 300 feet thick. The initial stripping ratio was about 1.2 to 1 but will decrease to about 0.8 to 1 in later years of operation. Production started out at over 4,000 st per day and the mill is scheduled to operate at 6,000 st per day as soon as the usual startup problems are solved. The bench height in the open pit is 25 feet and the bench slopes vary from 45° to 26°, depending on the local strength of the rock and permafrost. Benches are usually 80 feet wide to give a haul road width of 60 feet and a maximum grade of 8%. Blast holes are drilled 8 to 9 inches in diameter with a Drilltech D40K drill and loaded with ANFO prepared at the site with a mixer-loader truck. A Caterpillar 922C loader equipped with a 13-cubic-yard bucket fills Cat 777 haul trucks with 85 st of ore for delivery to the primary crushing plant northwest of the open pit.

The selective flotation concentrator was designed by Cominco and the Ralph M. Parsons Company, constructed as eight prefabricated units in the Philippine Islands, barged to the port on the Chukchi Sea, and moved by transporters to the mine. The mill units were assembled about one-half mile west of the primary crushing plant. A conveyor delivers the minus 8-inch crushed ore to a SAG mill, through cyclone classifiers, a ball mill, and tower mills to the 200-foot-diameter mill feed thickener. Thickener underflow goes through two Maxwell cells to remove free sulfur, then to the lead rougher flotation Maxwell cells. The lead rougher concentrate is reground in tower mills, cleaned two or three times in Maxwell cells and flotation columns, dewatered, and pressure filtered. The lead cleaner operation produces a clean lead concentrate and a bulk (ISF) lead-zinc product. Lead rougher tails go to zinc flotation. The zinc roughers are Maxwell cells and flotation columns. Zinc rougher concentrates are reground in tower mills, cleaned three times in Maxwell cells and flotation columns, dewatered, and pressure filtered. In addition to the usual methods of mill control three Outokumpu Courier on-stream analyzers monitor 15 pulp streams for lead, zinc, iron and solids content. Four Ingersoll Rand Lasta filter presses dewater flotation concentrates. Each press has 84 leaves, each 4 feet by 4 feet, said to be the largest made. One press handles the lead and the ISF concentrates, two presses are dedicated to zinc, and one press is a spare. Mill concentrates are hauled to the port by Arrow Transportation International Inc., of Seattle, using trucks that haul two 36-ton trailers each. The concentrates are stored in a building that is 1,400 feet long, 250 feet wide, and 125 feet high. This "largest building in Alaska" will hold 816,000 st of concentrates, allowing Red Dog to operate all year. The two self-unloading barges are owned and operated by Foss Maritime Co., Seattle. Each barge has a tug and can haul 6,000 tons per trip from the port to a ship anchored in 55 to 60 feet of water from 4 to 5 miles offshore. The mine and mill operates under the zero discharge regulations of the Environmental Protection Agency so must maintain monitoring and analytical laboratory facilities, and a water treatment plant that will remove heavy metals from tailings effluents and mill makeup water. The laboratory also monitors the effects of various water streams on Arctic char and trout under specified control conditions. Five Wartsila diesel generator units supply electrical energy and heat to the operation. When outside temperatures are below -45 degrees Centigrade auxiliary heat is used. When all of the waste heat from the generating plant is not required for buildings, the excess heat is used to increase the mill pulp temperatures. Employees work on site 4 weeks and spend 2 weeks away from the camp. Working shifts are from 10 to 12 hours per day while on the job site. A Boeing 737 jet aircraft flies in from Anchorage via other stops each Monday with shift change personnel and materials. Alcohol, drugs, and firearms are not allowed on the property.

Cominco explored and drilled near the Red Dog Mine. It also drilled at the Sun base metal property near the east end of the Ambler copper belt and at the Smucker deposit near the west end of the belt. Moneta-Porcupine Mines drilled three holes on the Lik zinc-lead-silver property about 12 miles west of the Red Dog Mine to obtain a fresh ore sample for metallurgical testing. Moneta is purchasing a 50% interest in the Lik deposit from General Crude Oil Minerals. The State survey reports the Lik deposit has preliminary reserves of about 18.2 million st averaging 10.2% zinc, 3.3% lead, and 1.5 troy ounces silver at a cutoff grade of 7% combined lead-zinc. Moneta has an agreement with Echo Bay

Mines Ltd., the co-owner of Lik, that would reduce Echo Bay's 50% interest to 20% in 30 years and increase Moneta's interest to 80%.

Other Metals.—No production of mercury, platinum-group metals, or tungsten was reported to the Bureau of Mines or to the State. 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, but the previous enthusiasm even for these prospects appeared to be waning. Interest in molybdenum deposits seemed to have disappeared. Only necessary assessment work was carried out on some of the more interesting nickel-copper claims. The previous interest in uranium, radioactives, and rare earths about disappeared.

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 1988 and 1990 and estimates for 1989.

Production of construction sand and gravel reported to the Bureau of Mines in 1990 was 15.1 million st valued at $41.8 million, about 11% below estimated output in 1989. The estimated production in 1989 was 17.0 million st valued at $48.5 million. The State survey reported the 1990 production of 15.0 million st valued at $40.8 million, produced by 645 employees. Usage in the North Slope oilfields has been decreasing, but there has been some improvement in the larger urban markets. There was no reported production of industrial sand and gravel in Alaska. Recent changes in the Alaska mining laws and regulations require producers of industrial minerals to pay rents and royalties and abide by more costly reclamation stipulations. The State reported five companies announced they have ceased operation in 1990 because of the overall unfavorable economic and regulatory climate. According, to the State, the northern region used more than 1.5 million st of sand and gravel. The Red Dog Mine project consumed about 900,000 st for road, tailing pond, and stream diversion work. About 400,000 st was permitted for use along the Dalton Highway and the oil pipeline by the U.S. Bureau of Land Management. B.P. Exploration used about 130,200 st for construction, maintenance and repair projects in the western part of the Prudhoe Bay area and the Duck Island unit. About 100,000 st of sand and gravel was used by ARCO Alaska for drill sites and other work; it was obtained from several pits in the Kuparuk area. The western region reported about 0.8 million st total usage, with about 720,000 st for road repairs on the Seward Peninsula and 90,000 st of gravel to repair the Teller airport. The Alaska Department of Transportation & Public Facilities (DOT&PF) took care of the road work. Tidemark Corp. did the $452,000 repair and improvement work at the Teller airport. The estimated unit value of sand and gravel in the northern and western regions was $4.00. State surveys reported industry employment was 130 people in the northern region and 25 people in the western region.

The eastern interior region consumed almost 5 million st of sand and gravel, valued at over $12.4 million, an average of $2.40 per st. The State listed industry employment at 153 people. DOT&PF reported about 950,000 st of sand and gravel was used in repair work on the Parks, Alaska, and Dalton Highways and some other roads. Some of this material may have been used in the northern region. About 530,000 st of gravel was permitted by the U.S. Bureau of Land Management from about 30 quarry and pit sites along the Dalton Highway from Fairbanks to the Yukon River. The largest single job was the Geist Road Extension, north of the Chena River and west of University Avenue in Fairbanks. It was designed to relieve traffic problems in the western part of the city. The prime contractor on the Geist Road job was Earthmovers Inc. Fairbanks Sand and Gravel Inc. recovered about 183,000 st of sand and gravel, using its barge-mounted clam shell dredge and a crew of 11 people. Douglas Management mined about 20,000 st from its pit at Peger Lake and R.B. Gravel Sales used about 500 st of sand and gravel from tailings at its mine on Ready Bullion Creek on private roads.

The south-central region producers reported mining about 5.3 million tons of sand and gravel worth almost $12.6 million and employing 160 people. Completion of modernization of the new Seward Highway near Potters Marsh, various road repair jobs by DOT&PF, and a modest increase in the construction industry raised the use of construction sand and gravel from an estimated 4.5 million st. in 1989. The Anchorage-Susitna Valley area was the outstanding user in 1990. The Alaska Railroad reported it shipped an estimated 2,560,000 st of sand and gravel in four unit trains daily from the Palmer-Wasilla area to Anchorage markets. About 1,935,000 st was shipped in 1989 by unit trains from the same area. AAA Valley Gravel Inc. continued to be one of the principal sources of sand and gravel in the Wasilla area. The State listed Jim Cline's Enterprises and Cremer Services as other suppliers in that area. Hermon Brothers Construction Co. Inc. worked its Schrock Pit in the Mendenhall Valley. Lynn Sandvik, of Sandvik Enterprises, reopened his Palmer Pit. Spring Creek Gravel Inc. operated its pit at Mile 204, Glen Highway, and marketed screened gravel products. In the Kenai-Soldotna area, Waldo Coyle produced gravel from his homestead along Beaver Loop Road. Jackson Construction and Fairwell Gravel mined sand and gravel near Soldotna. In the southwestern region Metco Inc. reported to the Bureau of Mines that it mined 43,936 st worth $106,620 in 1990. The State survey reported Metco Inc. produced 60,000 st of sand and gravel worth $63,000 from the Metco River Bar near Seward using a rubber-tired scraper.

Southeastern regional sand and gravel production was 1.4 million st valued at $3.5 million by the six companies

reporting to the State survey. The industry employed 80 people. Three companies operating six pits mined 316,620 st of sand and gravel valued at $2,016,305 in 1990, according to the Bureau of Mines. The principal uses were maintenance of roads in the Juneau, Ketchikan, and other urban areas and the construction and maintenance of logging access roads in Tongass National Forest, Native Corp., and private lands. The U.S. Forest Service indicated that more than 600,000 st of sand and gravel were used to construct logging access roads in the Tongass National Forest. Production in the Juneau area was reportedly worth $260,000 from the Acme Pit by Hildre Sand and Gravel Co. and valued at $200,000 from the Mendenhall Valley Pit by Red Samm Construction, Inc. Ritchie Transportation Co. mined pit-run sand and gravel from its Stikine River site near Wrangell.

The Alaska Peninsula region reported the production of 800,000 st of sand and gravel valued at $2,550,000, produced by 90 people. This was a significant increase over the 45,000 st valued at $45,000 produced by 5 people in 1989. The increase was triggered by construction of shore-based facilities for the expanding commercial fishing industry and should be even greater in 1991. Westwood Foods used 90,000 st of gravel in construction of a fish processing and surimi plant on Unalaska Island. The work included harbor reinforcement, foundation construction, and road improvements. Construction is being planned and scheduled for a $6.9 million Unalaska Marine Center that will also use gravel and stone in 1991. Moorecraft Construction maintained and repaired the King Salmon-Naknek (Peninsula) Highway under contract with DOT&PF. Dutch Harbor Aggregate Inc. quarried gravel from its South America Pit for various unspecified uses. Aleutian Materials (A. K. Construction Co.) produced about 100,000 st of sand and gravel on Kodiak Island for road and harbor uses. Brechan Enterprises obtained gravel from the leased Bell Flats Pit for use in the Kodiak Island Borough. About 700 st of sand was obtained from the Pillar Creek Beach by the city of Kodiak for local needs.

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 1988 and 1990 and actual data for 1989. No production of dimension stone was reported in Alaska in 1990.

Estimated production of crushed and broken stone in 1990 was 2.7 million st valued at $19.8 million. Production in 1989 was reported to have been 2.9 million st valued at $20.3 million. Surveys by the State show 1990 stone production of 3.2 million st valued at $22.1 million and in 1989 2.9 million st valued at $20.3 million. The demand for stone was generally weak but improved in 1990 over demand in 1989. Stone producers were included in the recently passed Alaska legislation that requires rents and royalties on production and stricter reclamation standards. Increasing regulatory actions by local, State and Federal agencies have also increased costs and tended to restrict production from certain formerly available sites.

About 600,000 st of crushed stone was used mostly as fill material at the Red Dog Mine project in the northern region. The Teller project and repairs to the Nome seawall required an estimated 40,000 st of stone in the western region. In the eastern interior region about 500,000 st of basalt was quarried at the Browns Hill quarry of Yutan Construction Co. Part of the output was marketed as shot rock, and the balance of it was screened to fill orders and to maintain stockpiles at the quarry. Jackson Construction quarried stone for local uses in the Soldotna area. About 1.2 million st of stone valued at $7 million were reported quarried in the southeastern region. Principal uses were for construction and maintenance of Tongass Forest, private, and State logging access roads. The U.S. Forest Service reported more than 600,000 st of stone was used to build logging access roads in the Tongass National Forest. The city of Ketchikan mined about 20,000 tons of shot rock valued at $100,000 for use in the city. Russell Construction Co. mined about 8,000 tons of riprap, worth $100,000, from a quarry leased from the village of Thorne Bay. The material was used on Prince of Wales Island. Koniag Inc. quarried about 120,000 st of riprap and pit-run rock for logging operations on Afognak Island and at Womens Bay on Kodiak Island.

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. Production in 1990 was about 5% greater than in 1989. This is the only cement plant in Alaska, therefore, the amount and value of the cement produced is withheld to avoid disclosing company proprietary data. About 800 st of agricultural limestone valued at an estimated $60,000, from his Cantwell Quarry, was mined and processed by Jim Caswell. The limestone was crushed, ground, bagged, and sold for uses in Alaska. 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 products, from 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 Bureau of Mines 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 1989 at $1.14 million and withheld the values for 1988 and 1990. The State survey listed peat production in 1990 at about 65,000 cubic yards valued at about $400,000. That was an increase over the 51,000 cubic yards valued at $352,000

estimated in 1989. 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.

[1]State Mineral Officer, Bureau of Mines, Juneau, AK.
[2]Swainbank, R.C., T.K. Bundtzen, and John Wood. Alaska's Mineral Industry 1990. Div. of Geol. and Geophys. Surv. Spec. Rep. 45, 1990, 78 pp.

TABLE 2
ALASKA: CONSTRUCTION SAND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

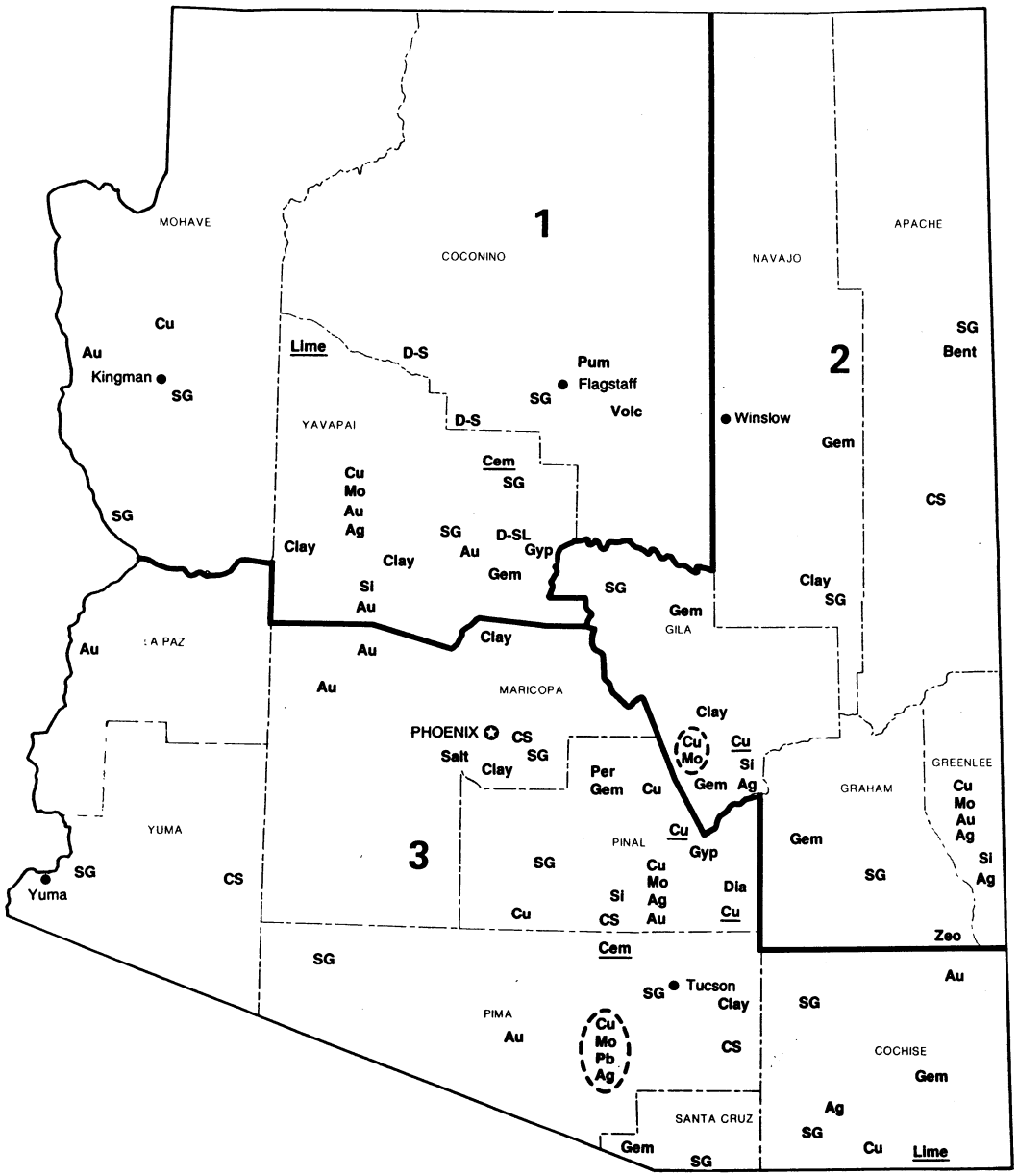
Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	1,680	$5,276	$3.14
Plaster and gunite sands	W	W	13.00
Concrete products (blocks, bricks, pipe, decorative, etc.)	W	W	11.00
Asphaltic concrete aggregates and other bituminous mixtures	1,052	3,039	2.89
Road base and coverings	832	2,718	3.27
Fill	10,956	28,987	2.65
Snow and ice control	339	1,344	3.96
Other	241	436	1.81
Unspecified:[1]			
Actual	W	W	1.50
Total or average	15,100	41,800	2.77

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	Region
Cement (portland):			
Alaska Basic Industries	1813 East First Ave. Anchorage, Ak 99501	Grind and blend	Cook Inlet- Susitna.
Gold:			
Alaska Gold Co.	Box 640 Nome, AK 99762	Placer-dredge	Seward Peninsula.
Kennecott Greens Creek Mining Co.	300 Vintage Blvd. Suite 200 Juneau, AK 99801	Lode-under ground	Southeastern.
Polar Mining Co.	4545 Woodriver Dr. Fairbanks, AK 99709	Placer	Yukon River.
Sand and gravel (construction):			
Lyden Inc.	Box 3757 Seattle, WA 98124	Pit Gravel Bar	Cook Inlet Yukon River.
U.S. Bureau of Indian Affairs	Box 3-8000 Juneau, AK 99801		Southeastern
U.S. Bureau of Land Management	Box 13, 701 C St. Anchorage, AK 99513	do.	Various.
Stone:			
Bureau of Indian Affairs	Box 3-8000 Juneau, AK 99802	Quarry	Various.
U.S. Forest Service, Region 10	Box 21628 Juneau, AK 99802	do.	Southeastern.
South Coast Inc.	Box 8620 Ketchikan, AK 99901	Plant	Southeastern.
Zinc, silver, lead:			
Kennecott Greens Creek Mining Co.	300 Vintage Blvd. Fairbanks, AK 99707	Lode-under ground	Southeastern.
Cominco Alaska Inc.	Box 1230 Kotzebue, AK 99752	Lode-open pit	Northern.

ARIZONA



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
CS	Crushed Stone
Cu	Copper
Cu	Copper plant
D-S	Dimension Sandstone
D-SL	Dimension Slate
Dia	Diatomite
Gem	Gemstones
Gyp	Gypsum
Lime	Lime plant
Mo	Molybdenum
Pb	Lead
Per	Perlite
Pum	Pumice
Salt	Salt
SG	Sand and Gravel
Si	Silica
Volc	Volcanic cinder
Zeo	Zeolite

Concentration of mineral operations

Principal Mineral-Producing Localities

THE MINERAL INDUSTRY OF ARIZONA

This chapter has been prepared under a Memorandum of Understanding between the 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 Michael N. Greeley[1] and Leroy E. Kissinger[2]

Arizona mines led the United States in the production of nonfuel minerals in 1990. The total value of output, nearly $3.1 billion, increased about 1% over that of the previous year.

The State led the Nation in copper production and was also among the top producers of gem stones, lime, molybdenum, rhenium, sand and gravel, silver, and sulfuric acid. Nearly one-quarter of the value of all metals produced in the United States in 1990 was attributed to the mines of Arizona. In terms of value, therefore, the State was the country's leading producer of metals.

Metal output valued at $2.82 billion represented more than 92% of all nonfuel mineral production in the State. Industrial mineral production for the year was $243 million or about 8% of the total mineral value in Arizona.

TRENDS AND DEVELOPMENTS

The mineral industry of Arizona exhibited a mixed character in 1990. A slight increase in the total value of nonfuel mineral production was primarily due to increased output of the two metals: copper and gold. Unit prices of essentially all the metals produced in the State declined substantially.

The value of industrial mineral production during the year fell markedly to almost 16% less than that of 1989. Although some gains in output were registered, chiefly in gypsum and lime, most commodities produced for the construction industry such as aggregates, common clays, and sand and gravel

TABLE 1
NONFUEL MINERAL PRODUCTION IN ARIZONA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	168,392	$1,590	188,211	$2,506	140,162	$2,318
Copper[2]	do.	842,728	2,238,875	r898,466	r2,593,734	978,767	2,657,649
Diatomite	do.	7,257	1,208	W	W	W	W
Gemstones		NA	3,300	NA	2,821	NA	2,098
Gold[2]	kilograms	4,549	64,106	r2,768	r34,047	5,000	62,191
Lime	thousand short tons	674	29,637	W	W	W	W
Pumice	metric tons	907	7	—	—	W	W
Sand and gravel:							
Construction	thousand short tons	32,399	123,854	e33,900	e133,900	27,915	92,166
Industrial	do.	119	3,045	W	W	W	W
Silver[2]	metric tons	152	31,974	171	30,186	173	26,836
Stone:							
Crushed	thousand short tons	e7,400	e33,000	6,649	28,552	e5,300	e13,500
Dimension	short tons	W	e1	W	W	W	W
Combined value of cement, gypsum (crude), iron oxide pigments (crude,1989-90), lead (1988-89), molybdenum, perlite, pyrites, salt, tin (1988-89), and values indicated by symbol W		XX	235,596	XX	r220,594	XX	208,690
Total		XX	2,766,193	XX	3,046,340	XX	3,065,448

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]Recoverable content of ores, etc.

experienced serious declines in both demand and price.

EMPLOYMENT

During 1990, the Arizona mining industry, including fuel minerals, increased its employment about 2% over that of 1989 to an average of 12,400 workers.[3] The average number of copper exploration and production employees increased from 10,400 in 1989 to 11,200 in 1990. The number of miners and other workers in the copper sector represented about 90% of all employees in the State's mineral industry.

Total income earned in all mining sectors of the State was $455 million. The copper industry contributed $410 million or about 90% of the total wages paid to all mineral industry employees. During the year, the average weekly earnings of all workers (including management) was $706. The average weekly earnings of an employee in the State's copper sector was $704.

REGULATORY ISSUES

At the Sierrita Mine in Pima County, Cyprus Minerals Co. continued to look for a practical way to eliminate dust blown by high winds from its mill-tailings pond. During the year, the company identified what it considered to be the principal approaches to solving the problem. Cyprus publicized the possible solutions and announced that it would thoroughly investigate each one of them.

Several exploration or development programs in the State were canceled or postponed because of adverse environmental constraints. Bond Gold Corp. planned a drilling program in the Prescott National Forest, but after lengthy regulatory delays and issuance of an exploration permit that it considered too restrictive, the company terminated its interest in the area. Strong local opposition to a proposed exploration program in the vicinity of Portal in the Coronado National Forest forced Newmont Mining Corp. to postpone for at least one year the drilling for gold on its claims.

Late in the year, Phelps Dodge Corp. announced that it had withdrawn its request to trade land with the Forest Service to eventually develop the Copper Basin deposit in Yavapai County. Earlier the company had agreed to pay for an environmental impact study of the proposed mine, but after spending $93,000, decided the projected cost of $2.5 million for the study was unacceptable at this time.

During the year, the Environmental Protection Agency (EPA) continued to investigate ground water contamination of an area by an explosives and fertilizer plant located near St. David in Cochise County. The manufacturing plant, owned and operated by the Apache Powder Co. since 1922, sells most of its explosives to the mining industry. The area has been extensively farmed for many years. The EPA investigation has been conducted to determine the type and extent of contamination.

EXPLORATION ACTIVITIES

The level of exploration effort for nonfuel minerals continued to be relatively low in Arizona. According to the U.S. Bureau of Land Management (BLM), however, the State ranked third in the Nation for the number of unpatented claims considered active in 1990.

Gold targets were investigated throughout southern and western Arizona, with activity generally centered around properties in Cochise, La Paz, Maricopa, Mohave, Pinal, and Yavapai Counties. Several targets within each of these counties were drilled.

Most of the interest in copper exploration focused on locating deposits that would be amenable to low-cost production by solvent extraction-electrowinning (SX-EW) technology. Several oxide copper properties were investigated extensively during the year.

LEGISLATION AND GOVERNMENT PROGRAMS

Federal legislation created the Arizona Desert Wilderness Act of 1990. This legislation incorporated about 1.1 million acres of BLM land and 1.3 million acres of Fish and Wildlife Service land into the National Wilderness Preservation System. In addition, the legislation retained about 57,800 acres in Cactus Plain (La Paz County) and 4,800 acres in Baker Canyon (Cochise County) as BLM wilderness study areas. The Gila Box (Graham County) received special designation as a riparian national conservation area. With Arizona's San Pedro Riparian National Conservation Area, the Gila Box is the second area in the Nation to receive this management designation.

A large number of bills that addressed environmental issues, particularly in the areas of hazardous waste and air and water pollution, were introduced during the 1990 session of the Arizona legislature. One of the most significant bills that became law was House bill 2007 that established a civil penalty of up to $10,000 per day for each violation of air pollution control laws committed by anyone engaged in metalliferous mining. Attempts to increase severance taxes on minerals were defeated.

The Arizona Department of Mines and Mineral Resources (ADMMR) continued to compile and evaluate data to encourage the development of industrial mineral deposits in the State. Investigations in this program were centered on the cultured marble and cultured granite industries. Several publications issued in 1990 by the ADMMR and designed to promote mineral development in the State included SR-16, The Primary Copper Industry of Arizona, 1989; C-29, Arizona Mining Update; MR-7, Gold Panning In Arizona; and C-30, Arizona Mining Law Change.

In 1990, the Arizona Geological Survey issued two reports that specifically addressed mineral resources of the State: OFR 90-9, Geology and Mineral Resources of the Bouse Hills, La Paz County, west-central Arizona; and OFR 90-10, The Geology and Mineral Deposits of the Northern Plomosa Mineral District, La Paz County, Arizona.

During the year, the U.S. Bureau of Mines (USBM) continued to investigate

an area in west-central Arizona characterized by gold mineralization associated with extensional detachment faulting. The Bureau also conducted extensive evaluations of known mineral occurrences in the Coconino, Coronado, and Kaibab national forests.

The USBM continued its in situ copper mining research project in cooperation with the Santa Cruz Joint Venture. Hydrologic modeling of the Santa Cruz Test Site, located near Casa Grande, was conducted during 1990 using the Bureau's computer program, MINEFLO. Water injection tests and interference tests were made in a single five-spot well pattern. Three monitor wells were drilled and equipped through the aquifer that overlies the copper deposit. A detailed comparison of geologic characteristics obtained from oriented core samples and borehole video surveys was completed and a cost model for the design of an in situ copper mine was developed.

The Bureau also maintained its supervision of the administration of the Arizona Mining and Mineral Resources Research Institute (MMRRI). The Institute, housed at the University of Arizona, was administered by a faculty member of the Department of Materials Science and Engineering. Total funds allocated by the Bureau to the MMRRI and to other research programs at the University in 1990 were approximately $281,000.

FUELS

Coal, uranium, and minor amounts of oil and gas were produced in Arizona during the year. Peabody Coal Co. mined coal from two surface mines on the Hopi and Navajo Reservations. In 1990, according to the 1990-91 annual report of the ADMMR, Peabody produced about 12 million short tons of coal that had an approximate value of $240 million. Energy Fuels Nuclear Inc. produced 1.25 million pounds of uranium valued at approximately $11.2 million from its northern Arizona underground mines. About 14% of the Nation's domestically produced uranium was mined in the State. By the end of the year as uranium prices remained low, Energy Fuels began to curtail operations significantly.

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Copper.—The mines of Arizona combined to produce more copper during 1990 than those of any other state in the Nation. This output was 62% of the total domestic production. The State has ranked first for more than 80 years and has been responsible for over 50% of U.S. production since 1959. Seven of the top 10 copper-producing mines in the United States were in Arizona during 1990.

There were 16 principal copper mining operations in the State during the year. These facilities produced more than 2.1 billion pounds, an increase of about 9% over that of 1989.

The producer copper price dropped from a 1989 average of $1.31 per pound to $1.23 in 1990. The drop in price was moderate because the supply and demand for copper remained fairly balanced during the year. Increased production in Arizona and the relatively strong price raised the total value of the metal produced in the State by about two and one-half percent compared with that of the previous year. The total value of this copper, about $2.7 billion, represented approximately 87% of the value of all nonfuel mineral production in the State.

A publication issued annually by the ADMMR reported that almost 28% of all copper produced in the State was recovered by leaching oxide ores and low-grade dumps. Ninety-seven percent of this leached copper was recovered by electrowinning; the balance was recovered by cementation.[4] (In the rest of this chapter, all production statistics for copper and molybdenum have been taken from the ADMMR publication referred to in the preceding statement, unless specified otherwise.)

The Morenci Mine in Greenlee County, 85% owned by the Phelps Dodge Corp., continued as the Nation's largest producer of copper in 1990. According to Phelps Dodge's 1990 annual report, a record 304,500 metric tons (335,700 short tons) was produced at the mine. About 30% of this amount was electrowon copper recovered at the expanded SX-EW plant that was operated for its first full year in 1990.

Phelps Dodge and its minority partner, Sumitomo Metal Mining Arizona Inc., continued to expand the mining and processing facilities at Morenci. Construction maintained during the year in the Northwest Extension project included extending the ore crushing and conveying system and enlarging the capacity of the SX-EW plant. The project will add 63,500 metric tons (70,000 short tons) of electrowon copper per year. Toward yearend, the discovery of an additional ore reserve north of the present Morenci pit was announced. In its first quarter report and report on the annual meeting of shareholders, May 1, 1991, Phelps Dodge stated this reserve, known as the Coronado deposit, has combined sulfide and oxide mineralization in excess of 210 million short tons grading 0.71% copper.

The company's Copper Queen facility, composed of a dump-leaching and precipitation operation in Bisbee (Cochise County), produced 1,400 metric tons (1,500 short tons) of cement copper. At the nearby Cochise Copper project, bulk sampling and metallurgical testing of ores were conducted during the year. The results of the tests were being evaluated to estimate copper recovery by SX-EW.

The second largest producer of copper in Arizona, Cyprus Minerals Co., recovered 281,500 metric tons (310,300 short tons) of copper from its six properties in 1990. More than 30% of the company's production was electrowon copper.

The Bagdad Mine in Yavapai County produced about 97,500 metric tons (107,500 short tons) and was Cyprus' largest source of copper. Almost 11% of this copper was electrowon. A $17 million expansion program was completed in 1990, which added a fifth grinding line to the existing mill and increased milling

capacity by approximately 20% to 68,000 metric tons (75,000 short tons per day).

Cyprus' Sierrita Mine in Pima County produced 74,600 metric tons (82,200 short tons) of copper in 1990. Sulfide ore mined at the nearby Twin Buttes property (Pima County) was transferred to the Sierrita concentrator via an overland conveyor belt and truck haulage. Total copper production from the Twin Buttes Mine was 51,200 metric tons (56,400 short tons), an increase over the previous year of nearly one-third. Much of this increase is attributed to copper recovered in the Twin Buttes SX-EW plant that operated for its first complete year since Cyprus restarted the facility in 1989. More than 27% of the copper extracted from Twin Buttes ore was electrowon.

The balance of copper recovered by Cyprus was by leaching processes applied to ores at the Casa Grande (Pinal County), Miami (Gila County), and Mineral Park (Mohave County) properties. The largest of these was the operation at Miami, which produced 55,200 metric tons (60,900 short tons) of cathode copper in a SX-EW plant. At the Casa Grande property, approximately 1,100 metric tons (1,200 short tons) of copper was produced in a SX-EW plant. Solutions for this plant were derived from in situ mining of both previously broken ore and undisturbed ground that compose the mineralized deposit and from leaching roasted calcines produced on site by roasting copper concentrates from other Cyprus operations. At the Mineral Park Mine, 1,800 metric tons (2,000 short tons) of cement copper was precipitated from solutions recovered from both in situ and dump-leach operations.

During the year, Cyprus announced a $92.5 million modernization and expansion of its smelter in Miami, scheduled for completion in 1992. The company expected the project to cut power costs significantly and increase annual smelter capacity approximately 45%, from 408,000 metric tons (450,000 short tons) to 590,000 metric tons (650,000 short tons). According to its annual report, Cyprus processed about 409,000 metric tons (451,000 short tons) of concentrates at the smelter in 1990.

Throughout the year, the Magma Copper Co. operated the underground San Manuel Mine (Pinal County) and the open pit Pinto Valley Mine (Gila County), with ancillary production facilities at both properties. The San Manuel operation produced 120,500 metric tons (132,800 short tons) of copper and was one of the world's largest underground copper mines in terms of production in 1990. More than 30% of this total amount or 36,500 metric tons (40,200 short tons) was recovered as cathode copper in the SX-EW plant. Solutions treated by solvent extraction included those recovered by heap leaching and by in situ mining. The in situ leaching operation which extracts copper from underground oxide ore reserves was originally plagued with solution recovery problems. According to Magma's 1990 annual report, however, the in situ segment had record production of 11,300 metric tons (12,500 short tons) of copper, nearly triple the production of 1989. This improvement was due primarily to the development of innovative well-to-well leaching technology.

During the year, the company continued limited development of the deep Kalamazoo ("K") sulfide deposit that is offset from the San Manuel ore body. Production from the "K" deposit began in the third quarter and achieved the designed capacity of 5,400 metric tons (6,000 short tons) per day by yearend. If proven economical, according to the company, additional mining of the "K" deposit could prolong sulfide operations beyond the scheduled cessation of sulfide production from the San Manuel ore body in 1997.

Magma's 1990 annual report stated that 76,200 metric tons (84,000 short tons) of copper was produced at the Pinto Valley operation. Of this amount, 14,500 metric tons (16,000 short tons) was recovered in two SX-EW plants. This electrowon copper represented a 52% increase over that of 1989. The SX-EW plants treated solutions recovered from in situ leaching, dump leaching, and mill tails leaching. The Miami No. 2 tailings pile was hydraulically mined for the first complete year in 1990 and produced about one-quarter of the electrowon copper recovered at Pinto Valley. Approximately $22.4 million was spent to bring the hydraulic mining project on line and operations were expected to continue until 1997.

Late in 1990, ore production was resumed by the company at its underground Magma Mine at Superior (Pinal County). According to Magma's 1990 annual report, approximately $14.3 million was expended to bring the mine and mill back into operation. During the year, the mine produced ore averaging 6% copper at the rate of about 900 metric tons (1,000 short tons) per day. After milling and flotation, the copper concentrates were trucked to the company smelter in San Manuel. The mine was credited with production of about 2,700 metric tons (3,000 short tons) of copper in 1990.

Magma's 1990 annual report stated that its flash furnace and complementary components has 21% of the copper smelting capacity in the United States. According to the company, the smelter is the lowest cost smelting facility in the Nation and is among the lowest cost in the world. During the year, the smelter processed 903,600 metric tons (996,000 short tons) of copper concentrates from company mines and from other sources, including purchased concentrates and tolled concentrates. Approximately 37% of the smelter feedstock was from outside sources.

Total copper production at mines in Arizona, operated by Asarco Inc. and reported in its 1990 annual report, was 186,700 metric tons (205,800 short tons). The largest of its operations was the Ray Mine in Pinal County, which produced 73,400 metric tons (80,900 short tons) of copper in concentrates and 37,100 metric tons (40,900 short tons) of copper in electrowon cathodes. Production at the Mission Complex, composed of the Eisenhower, Mission, Pima, and San Xavier properties in Pima County, was 72,400 metric tons (79,800 short tons) of copper. The Silver Bell Mine (Pima

County) produced 3,800 metric tons (4,200 short tons) of cement copper.

During the year, Asarco continued implementation of its program to expand and modernize its copper production facilities. When the program is completed in 1992, annual output at the Mission Complex will be raised 42% to 112,500 metric tons (124,000 short tons) and at the Ray Mine, 58% to 165,100 metric tons (182,000 short tons). In 1990, the company announced plans to construct a new, $54 million SX-EW plant at the Silver Bell Mine. Annual capacity of this facility was expected to be 16,300 metric tons (18,000 short tons) of cathode copper.

Arimetco's Emerald Isle Mine (Mohave County) produced 11.8 metric tons (13 short tons) of cement copper recovered by in situ mining and precipitation. Operations at the mine were terminated early in the year. Later, according to the company's 1990 annual report, an agreement was reached to sell the Emerald Isle property for $3.75 million to Holcorp Gold Mines. Arimetco decided to dispose of the mine after determining that the ore reserves were inadequate to meet corporate production objectives.

Construction of a SX-EW plant and ancillary facilities at Arimetco's Johnson Camp Mine (Cochise County) was completed in September, 1990, at a cost of $3.3 million. Initially, production was derived by leaching copper that remained in existing ore heaps. Output for the balance of the year was 1,294 metric tons (1,426 short tons) of cathode copper.

During the second quarter, Arimetco purchased the Van Dyke Mine in Gila County. The most recent production from this mine, by Kocide Chemical Corporation in 1988 and 1989, totaled 340 metric tons (375 short tons) as reported in Arimetco's annual report. Arimetco planned to begin construction of a SX-EW plant in 1991.

South Atlantic Ventures Ltd. continued construction of the concentrator and development of the underground mine at its Oracle Ridge property in Pima County. Although construction was essentially completed in mid-November, 1990, additional work was required to properly align the ball mill before mineral beneficiation could proceed. According to the company, the concentrator incorporates the world's first all column flotation circuit for processing copper ores.

Gold.—The production of gold in Arizona rebounded sharply from that of 1989. Total output increased more than 80% to 5,000 kilograms (160,737 troy ounces) and was the highest since 1943, a span of 47 years. About 78% of the gold was recovered either on-site at primary lode mines or from primary ores shipped to copper smelters. Most of the remaining gold was recovered as a byproduct of copper ores.

Largest among the primary gold producers was the Copperstone Mine (La Paz County) owned by Cyprus. According to the firms's 1990 Form 10-K, the open pit mine produced 3,312 kilograms (106,500 troy ounces) during the year, an increase of more than 45% over the output of the previous year. This increase was due chiefly to a higher grade of ore mined and higher metal recovery. The mine's production represented virtually two-thirds of all gold recovered in Arizona.

A. F. Budge (Mining) Ltd. operated two gold mines in the State. The company's principal operation was the underground United Verde Extension Mine in Yavapai County. Production was maintained through the year, the first full year of operation since mining began in 1989. Siliceous mine-run ore was shipped as flux to the Hidalgo copper smelter owned by Phelps Dodge in southwestern New Mexico. At the historic Vulture Mine (Maricopa County) where mill tailings were leached by Budge, production of gold was terminated in May 1990.

Construction of a mill at the Congress Mine (Yavapai County) was completed by Malartic Hygrade Gold Mines Ltd. in August and ore treatment began on October 1. In its 1990 annual report, Malartic stated that the mine produced 179.6 kilograms (5,775 troy ounces) of gold from 31,244 short tons of ore.

Queenstake Resources Ltd. produced 26.7 kilograms (860 troy ounces) at the underground Gold Prince Mine in Cochise County according to Bureau of Mines statistics. The mine product was sold as silica flux to the Hidalgo smelter. Although Queenstake conditionally sold its 100% interest in the mine during the year, small scale mining was continued by the company under contract with its employees.

Byproduct gold was recovered from copper ores produced at the following mines: Pinto Valley (Gila County); Climax and Morenci (Greenlee County); San Xavier (Pima County); and Ray, San Manuel, and Magma (Pinal County). Gold production was also reported from silver-bearing flux ore extracted at the Ash Peak Mine in Greenlee County.

Molybdenum.—In 1990, Arizona was the second largest producer of molybdenum in the United States. Total output was 13,306 metric tons (29.3 million pounds).[5] This amount represented about 22% of all domestic production.

For years, all molybdenum produced in the State has been a byproduct or coproduct of primary copper ores. In 1990, molybdenite concentrates were recovered at six mines. According to its Form 10-K for 1990, Cyprus produced 11,113 metric tons (24.5 million pounds) of molybdenum at its Arizona mines. The company was the largest domestic producer of molybdenum during the year, and its output of the metal in Arizona was approximately 18% of the Nation's total production.

The Sierrita Mine (Pima County), owned and operated by Cyprus, was the largest producer. This property was also the only one in Arizona that operated a molybdenum sulfide roaster to produce molybdenum oxide. Molybdenum output at the Sierrita Mine, according to the ADMMR, was about 6,606 metric tons (14.6 million pounds).

The second largest producer of molybdenum in Arizona was the Cyprus-owned Bagdad Mine in Yavapai County. Output at the mine was 3,992 metric tons (8.8 million pounds) according to the company's 1990 Form 10-K. Other

properties that produced molybdenum were the Twin Buttes Mine operated by Cyprus, the Pinto Valley and San Manuel Mines owned by Magma, and the Morenci Mine owned by Phelps Dodge. Production at each of these mines, respectively, was 515 metric tons (1.1 million pounds), 548 metric tons (1.2 million pounds), 1,451 metric tons (3.2 million pounds), and 215 metric tons (474,000 pounds).

Silver.—Arizona continued its fifth-place ranking for domestic silver production in 1990. Output increased about 1% over that of the previous year to approximately 173 metric tons (5.6 million troy ounces). This quantity was eight percent of the total silver produced in the United States.

Five mines in the State were among the 25 leading silver operations in the Nation. These mines plus two others, all primary copper producers, were responsible for 92% of Arizona's output. Cyprus' Sierrita Mine, including the Twin Buttes property, was the largest producer of byproduct silver. Asarco's Mission Complex, ranked second, produced 41.2 metric tons (1,324,000 troy ounces) according to the company's 1990 annual report. Production of silver at Asarco's Ray Mine was reported to be 13.2 metric tons (425,000 troy ounces). Magma recovered silver from copper ores extracted from its San Manuel, Pinto Valley, and Magma Mines. Cyprus' Bagdad and Mineral Park Mines and Phelps Dodge's Morenci Mine were also producers of byproduct silver.

Silver was also recovered at primary gold operations including Malartic's Congress Mine and Cyprus' Copperstone Mine. Approximately 0.12 metric tons (4,000 troy ounces) of byproduct silver was produced at the Cyprus operation.

Most of the balance of silver production in the State was recovered from siliceous ores shipped to copper smelters. The largest of these producers was the underground Ash Peak Mine operated by Arizona Flux Mines Inc. in Greenlee County. Other sources of silver-bearing flux were the United Verde Extension, Gold Prince, and Climax lode mines and the Mammoth tailings (Pinal County).

Other Metals.—Arizona was the only State in which rhenium was recovered in 1990. It was produced by Cyprus at the Sierrita Mine. The metal, occurring as a trace element in molybdenite, was recovered as ammonium perrhenate by roasting molybdenum concentrates. There was no recorded production of other metals during the year except trace metals recovered at copper refineries.

Industrial Minerals

Cement.—Arizona ranked in the top half of all cement-producing States in 1990. Output, however, of masonry cement has continued to decline since 1987, and in 1990, was about 4% less than that of the previous year. The production of portland cement increased slightly more than 3% over that of 1989. The average price of both types of cement rose slightly from 1989 levels.

Arizona Portland Cement Co. was the largest producer of cement in the State. In September, the company, including its limestone quarry and cement manufacturing facility at Rillito (Pima County), was sold by the CalMat Co. for approximately $310 million to Onoda California Inc. Onoda is an indirect, wholly-owned subsidiary of Onoda Cement Company Ltd. of Japan. According to CalMat's 1989 form 10-K, the Rillito cement plant has an annual production capacity of 900,000 short tons of clinker.

Serving the needs for cement in northern Arizona is a facility at Clarkdale in Yavapai County. This facility is owned and operated by the Salt River Pima-Maricopa Indian Community.

Clays.—In 1990, production of all clays dropped nearly 26% compared to that of 1989. Most of this decline was due to a major reduction of common clay and shale output used to manufacture building materials. Bentonite production, however, increased slightly from about 36,900 metric tons (40,700 short tons) in 1989 to about 37,600 metric tons (41,400 short tons) in 1990. Almost all of the bentonite produced in Arizona was the low-swelling calcium variety.

Gemstones.—During the year, Arizona regained its third-place ranking in the value of domestic production of natural gem stones. The State ranked first in the Nation as a source of inorganically derived gem materials and produced a greater variety of gem stones than any other state. Output included agate, amethyst, antlerite, azurite, chrysocolla, fire agate, fluorite, garnet, jade, jasper, malachite, obsidian, onyx, peridot, petrified wood, precious opal, shattuckite, smithsonite, and turquoise. Arizona was the world's largest producer of peridot and turquoise.

Gypsum.—Mine production of gypsum in the State increased 21% during 1990 over that of the previous year. This increase was due primarily to the opening of the Snowflake Mine in northern Mohave County, operated by the Western Gypsum Co., and the Salome Mine in La Paz County, owned by Western Organics Inc.

Five companies operated six mines during the year and supplied agricultural, cement, and wallboard customers. Most of the production was in Pinal County.

The National Gypsum Co. was the largest producer of crude gypsum in the State. According to its 1990 Form 10-K, output at the company's Feldman Mine (Pinal County) was 130,000 short tons. National Gypsum's subsidiary, the Gold Bond Building Products Division, calcined gypsum and manufactured wallboard and joint treatment products at its plant in Phoenix. In October, National Gypsum filed for protection under Chapter 11 of the Federal Bankruptcy Code.

Lime.—Arizona was the ninth largest producer of lime in the Nation during 1990. The State's output rose about nine percent and average prices increased about eight percent over that of 1989. The entire commercial production was

from two plants owned by Chemstar Inc., one at Paul Spur in Cochise County and the other at Nelson in Mohave County. Magma Copper produced hydrated lime for its own use at the company's San Manuel division in Pinal County.

Chemstar, a subsidiary of the Texas-based Chemical Lime Group, was the largest producer of hydrated lime and quicklime in the western United States. The Nelson facility, one of the firm's largest, had a rated capacity of 1,800 short tons of high-calcium quicklime per day. The Paul Spur plant was rated at 1,000 short tons per day.

Perlite.—Nationally, Arizona was the second leading producer of perlite during 1990. Although production dropped about 6% below that of the previous year, average prices increased approximately 15%, from $26.79 per short ton in 1989 to $30.85 in 1990. Surface mines near Superior (Pinal County) were operated by the Harborlite Corp. and the Nord Perlite Co. Expanded perlite was produced primarily for horticultural purposes by Therm-O-Rock Industries Inc. in Maricopa County.

Pumice.—A significant amount of pumice was produced in the State during the year. Arizona Tufflite Inc. and Mountain View Mining Inc. operated mines in Coconino County. Most of the material was used by the garment and building block industries. The average price in 1990 was $55.48 per metric ton.

Sand and Gravel.—**Construction.**—Construction sand and gravel production is surveyed by the Bureau of Mines for even-numbered years only; data for odd-numbered years are based on annual company estimates. This chapter contains estimates for 1989 and actual data for 1988 and 1990.

Arizona construction sand and gravel statistics are compiled according to geographical districts as depicted on the State map. Table 3 presents end-use data for this commodity, by district, in 1990.

During the year, the State ranked tenth nationally in the domestic production of construction sand and gravel. Arizona's output in 1990 dropped about 14% from that of 1988 as construction projects continued to decline in number. Average prices also fell; in 1990, a short ton of material sold for about $3.30.

Nevertheless, the construction sand and gravel industry was a major contributor to the State's economy. In 1990, its total dollar value was second only to copper. District 3 sand and gravel mines, encompassing the two principal population centers of Phoenix and Tucson, produced 83% of the total output in Arizona.

Industrial.—Production of industrial sand continued at the Houck Mine in Apache County. The sand, composed of well-rounded and well-sorted quartz grains, was produced by the Arizona Silica Sand Co. and sold chiefly for hydraulic fracturing and construction of molds. In 1990, the average price per short ton was about $17.

Stone.—Stone production is surveyed by the 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 1989 and estimates for 1988 and 1990.

Crushed.—During 1990, production of crushed stone in Arizona was estimated to have decreased approximately 20% from the actual output of 1989. This estimate reflected the general decline experienced by the construction industry in the State.

Major types of rock mined included limestone, granite, volcanic cinder, quartzite, and marble. The Santa Rita marble mine in Pima County began regular production in early 1990 under the direction of Calcium Products of Arizona.

Dimension.—Seven companies quarried dimension stone in Arizona during the year. A diversity of products, including onyx marble, sandstone and schist, were mined principally in the counties of Coconino, La Paz, Maricopa, Mohave, and Yavapai.

Other Industrial Minerals.—Arizona was one of only five states in which diatomite was produced in 1990. Output during the year was about the same as the previous year. The State's sole source of the relatively high-value commodity was the Whitecliffs Mine in Pinal County, operated by Whitecliffs Industries. The company ceased production at mid-year.

Swansea Minerals Inc. shipped iron oxide pigment from the Swansea Mine in La Paz County. The pigment, occurring as specular hematite, was used in paint and coatings. The recovery of pyrite continued at the Magma property operated by Magma Copper in Pinal County. Output in 1990 remained at about the same level as in the previous year.

Solution mining and processing of salt continued at the Luke facility owned by the Morton Salt Co. Production and average prices rose slightly during the year.

Arizona was the Nation's largest producer of sulfuric acid as a byproduct of base metal smelters and roasters. All of the production was from the State's copper facilities. In 1990, Arizona's output was about 41% of the acid domestically produced in this manner. Production in the State, 1.8 million short tons, increased by about 12% more than that of 1989. Most of the acid was used by the copper industry in SX-EW plants.

Exfoliated vermiculite was produced by Therm-O-Rock Industries and W. R. Grace and Co. at their plants in Maricopa County. Crude vermiculite was shipped into Arizona from outside sources.

Arizona led the Nation in the production of natural zeolites. Four companies mined the chabazite variety of zeolite from the Bowie deposit that straddles the Cochise-Graham County line.

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[1]State Mineral Officer, Bureau of Mines, Tucson, AZ. He has covered the mineral activities in Arizona for 17 years. Assistance in the preparation of the chapter was given by Barbara Moore, editorial assistant.

[2]Director, Arizona Department of Mines and Mineral Resources, Phoenix, AZ.

[3]Leaming, G. F. The Copper Industry's Impact on the Arizona Economy 1990, West Econ. Anal. Cent. (Marana, AZ), 1991, 44 pp.

[4]Beard, R. R. The Primary Copper Industry of Arizona in 1990, AZ Dep. Mines & Miner. Resour. (Phoenix, AZ), in press.

[5]Reference cited in footnote 4.

TABLE 2
ARIZONA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,198	$11,788	$3.6 9
Plaster and gunite sands	878	1,632	1.86
Concrete products (blocks, bricks, pipe, decorative, etc.)	379	1,538	4.06
Asphaltic concrete aggregates and other bituminous mixtures	2,586	8,973	3.47
Road base and coverings[1]	3,768	8,518	2.26
Fill	345	1,065	3.09
Railroad ballast	289	927	3.21
Other	184	400	2.17
Unspecified:[2]			
Actual	12,107	44,946	3.71
Estimated	4,181	12,380	2.96
Total or average	27,915	[3]92,166	3.30

[1]Includes road and other stabilization (cement).
[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.

TABLE 3
ARIZONA SAND & GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	425	2,011	262	1,171	2,510	8,605
Plaster and gunite sands	46	209	11	49	821	1,375
Concrete products (blocks, bricks, etc.)	W	W	—	—	W	W
Asphaltic concrete aggregates and other bituminous mixtures	408	1,209	539	1,947	1,639	5,817
Road base and coverings[1]	948	2,337	685	1,588	2,135	4,593
Fill	73	208	60	140	213	716
Railroad ballast		—	—	—	289	927
Other miscellaneous	59	73	—	—	504	1,865
Actual	26	104	—	—	12,081	44,842
Estimated	1,142	2,922	63	244	2,976	9,215
Total	3,126	9,073	1,620	5,139	23,169	77,954

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes road and other stabilization (cement).
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Arizona Portland Cement Co., a subsidiary of Onada Cement Co. Ltd.[1 2]	Box 338 Rillito, AZ 85654	Quarry and dry-process, four-rotary-kiln plant	Pima.
Salt River Pima-Maricopa Community[1 2]	Box 428 Clarkdale, AZ 86324	Quarry and dry-process, three-rotary-kiln plant	Yavapai.
Clays:			
Building Products Co.	4850 W. Buckeye Rd. Phoenix, AZ 85043	Open pit mines	Maricopa, Navajo, Yavapai.
Clinton-Campbell Contracting Inc.	1814 S. 7th Ave. Phoenix, AZ 85007	do.	Maricopa and Pima.
Engelhard Corp.	Box 155 Sanders, AZ 86512	Surface strip mine	Apache.
McKusick Mosaic Co.	Rt. 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:			
ASARCO Incorporated:			
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 6]	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 Metals Co., a division of Cyprus Minerals Co.:			
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 C-9 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.	Box 6249 Kingman, AZ 86401	Dump-leach and precipitation plant	Mohave.
Cyprus Sierrita Corp.[3 5 6]	Box 527 Green Valley, AZ 85622	Open pit mines, mill, leach dumps, SX-EW plants	Pima.
Magma Copper Co.:			
Corporate Headquarters	7400 North Oracle Rd. Tucson, AZ 85704	Offices	Pima.
Pinto Valley Div.[3 5 6]	Box 100 Miami, AZ 85539	Open pit mine, mill, leach dumps, in situ leach, SX-EW	Gila.
San Manuel Div.[2 3 5 6 7]	Box M San Manuel, AZ 85631	Underground mine, mill, in situ and heap leaching, SX-EW	Pinal.
Superior Div.[3 5]	Box 37 Superior, AZ 85273	Underground mine and concentrator	Do.
Phelps Dodge Corp.:			
Corporate Headquarters	2600 N. Central Ave. Phoenix, AZ 85004-3015	Offices	Maricopa.
Copper Queen Branch	Highway 92 Bisbee, AZ 85603	Leach dumps, in situ leaching, precipitation plant	Cochise.

See footnotes at end of table.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Phelps Dodge Corp.—Continued:			
Morenci Branch[3,5,6]	Box 4521 Morenci, AZ 85540	Open pit mine, mills, dump-leach, precipitation, and SX-EW plants	Greenlee.
Diatomite:			
Whitecliffs Industries	7400 N. Oracle Rd., #371 Tucson, AZ 85704	Surface mine and plant	Pinal.
Gold:			
A. F. Budge Ltd.	4301 N. 75th St. #101 Scottsdale, AZ 85215	Underground mine and tailings leach	Maricopa and Yavapai.
Cyprus Copperstone Gold Corp.	Box A1 Parker, AZ 85344	Open pit mine, agitation leach	La Paz.
Malartic Hygrade U.S. Inc.[5,8]	Box 361 Congress, AZ 85332	Underground mine	Yavapai.
Gypsum:			
National Gypsum Co:			
Gold Bond Building Products Div.	Box 20863 Phoenix, AZ 85036	Plant	Maricopa.
Feldman Quarry	Star Rt., Box 3990 Winkelman, AZ 85292	Open pit mine andcrushing plant	Pinal.
Pinal Gypsum Co.	Box 99 Coolidge, AZ 85228	Open pit mine	Do.
Superior Companies[1,2]	100 W. Coolidge Phoenix, AZ 85013	Quarries and plant	Apache, Pinal, 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 W. Willis Rd. Chandler, AZ 85226	Plant	Maricopa.
Pumice:			
Arizona Tufflite Inc.	2432 W. Peoria, #1081 Phoenix, AZ 85029	Open pit mine	Coconino.
Mountain View Mining Inc.	2215 W. Mountain View Phoenix, AZ 85021	do.	Do.
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):			
Arizona Crushers Inc.	Box 9129 Phoenix, AZ 85024	Pits	Do.
Blue Circle West Inc.	2625 S. 19th Ave. Phoenix, AZ 85009	do.	Do.

See footnotes at end of table.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel (construction)—Continued:			
CalMat Co. of Arizona, a subsidiary of CalMat Co.	Box 52012 Phoenix, AZ 85072	Pits and plants	Do.
Earth Products Inc.	Box 278 Humboldt, AZ 86329	do.	Yavapai.
FNF Construction Inc.	Box 5005 Tempe, AZ 85280	Pits	Gila and Mohave.
Granite Construction Co.	Box 27557 Tucson, AZ 85726	do.	Pima.
Peter Kiewit Sons Co.	2525 West Beryl Ave., #100 Phoenix, AZ 85021	do.	Maricopa and Pima.
Phoenix Redi-Mix Co.	3635 S. 43rd Ave. Phoenix, AZ 85009	do.	Do.
Salt River Sand & Rock	Box 728 Mesa, AZ 85211	do.	Do.
The Tanner Companies	Box 52124 Phoenix, AZ 85072	Pits and plants	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.
Stone (crushed):			
Arizona Quality Granite	7401 W. Villa Rita Dr. Peoria, AZ 85345	Quarry and plant	Maricopa.
Madison Granite Supplies	7050 Grand Ave. Glendale, AZ 85301	do.	Do.
Perkins Cinders Inc.	Rt. 1, Box 3125 Show Low, AZ 85901	do.	Navajo.
Red Mountain Mining Inc.	4250 N. Bush Highway Mesa, AZ 85205	do.	Do.
Superlite Block Co.	Box 23163 Phoenix, AZ 85063	Quarry	Coconino.
Stone (dimension):			
Blaser Corp.	N. Hwy. 89 Chino Valley, AZ 86323	Quarries and plant	Coconino and Yavapai.
Dunbar Stone Co.	Box 246 Ash Fork, AZ 86320	do.	Coconino, Maricopa, Mohave, Yavapai.
Western States Stone Co.	2830 Grand Ave. Phoenix, AZ 85017	do.	Coconino, La Paz, Maricopa, Mohave, Yavapai.
Stone (smelter flux):			
Arizona Flux Mines Inc.[5]	Box 26706 Tucson, AZ 85726	Underground mine	Greenlee.
Little Hill Mines Inc.[5 8]	Box 332 Oracle, AZ 85623	Open pit mine	Pinal.
Queenstake Resources Ltd.[5 8]	Box 217 Willcox, AZ 85644	Underground mine	Cochise.
Triple Nichol Inc.[5]	R.R. 1, Box N123 Globe, AZ 85501	Surface and underground mines	Gila and Pinal.
Vermiculite (exfoliated):			
W. R. Grace & Co., Construction Products Div.	4220 W. Glenrosa Phoenix, AZ 85019	Plant	Maricopa.

See footnotes at end of table.

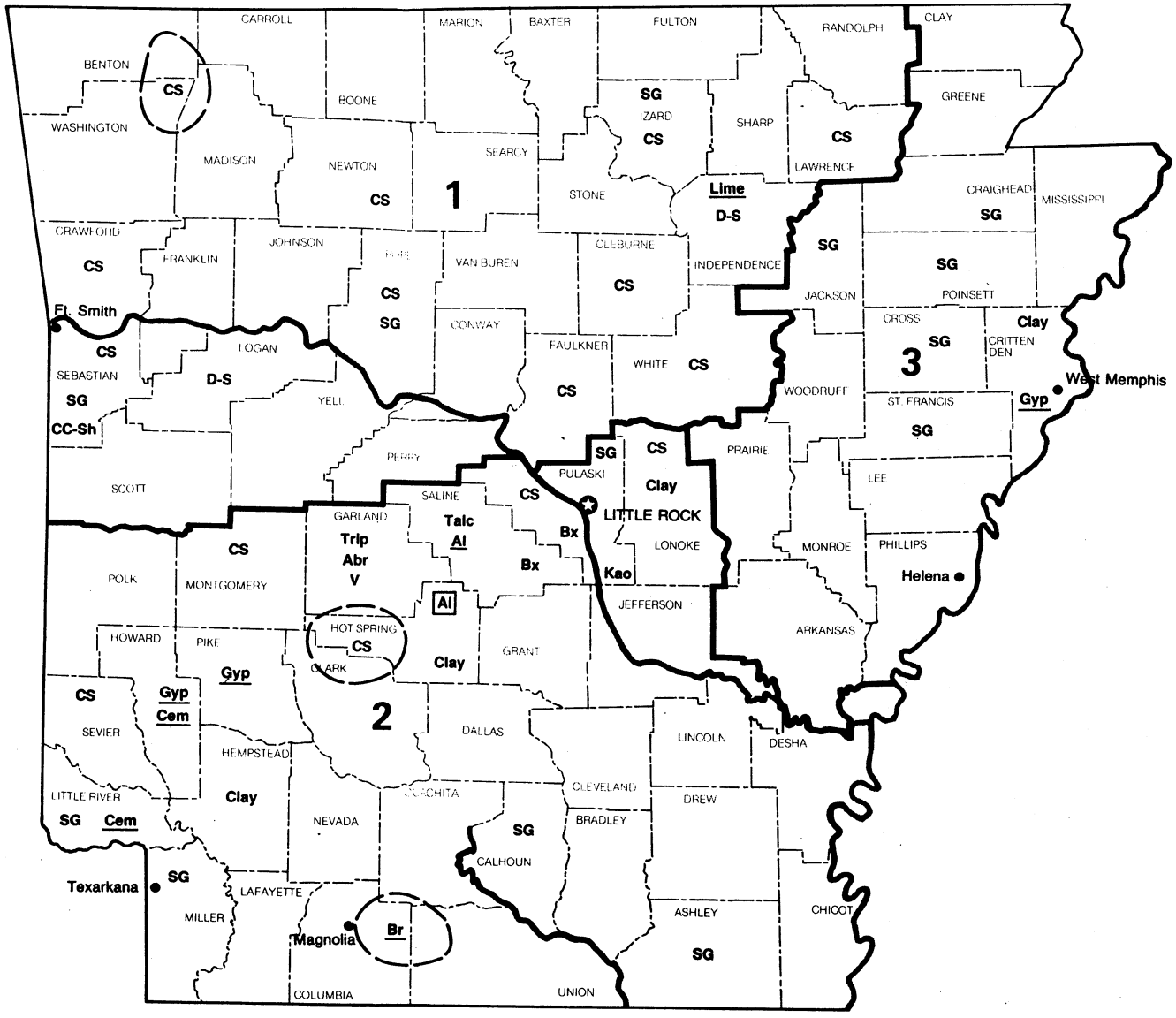
TABLE 4-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Zeolite:			
GSA Resources[1]	Box 16509 Cortaro, AZ 85652	Surface strip mine	Cochise.
Union Carbide Corp.	Box 1029 Grand Junction, CO 81502	do.	Do.

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

ARKANSAS



LEGEND

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

MINERAL SYMBOLS

Abr	Abrasives
Al	Alumina plant
Al	Aluminum plant
Br	Bromine plant
Bx	Bauxite
CC-Sh	Common Clay & Shale
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
D-S	Dimension Shale
Gyp	Gypsum plant
Kao	Kaolin
Lime	Lime plant
SG	Sand and Gravel
Talc	Talc minerals
Trip	Tripoli
V	Vanadium
	Concentration of mineral operations

Principal Mineral-Producing Localities

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's mineral output in 1990 reflected the downturn experienced in other segments of the State's economy; the value of the State's mineral output was $302.6 million, $79.3 million below that reported by industry in 1989. Reports from the State's 175 mineral producers indicated a slump in production for 6 of the 18 minerals produced in-State. Historically, bromine, cement, and stone have been the principal mineral commodities produced in Arkansas, accounting for more than 75% of the mineral value. The value of these three in 1990 fell almost 30% below the 1989 level, which accounted for the decline in total mineral sales. Bromine output rose slightly, but value decreased significantly, while cement producers reported a moderate gain and crushed stone demand was flat.

Arkansas fell from 26th to 33d in its national ranking of total mineral value. The State was the only one reporting bromine, diamond, and vanadium production.

TRENDS AND DEVELOPMENTS

Historically, bromine has been the leading mineral commodity produced in Arkansas and has accounted for more than 70% of the State's total mineral value. Although many of bromine's end-use markets exhibited growth during 1990, the petroleum additive and halon fire extinguisher markets declined. The petroleum additive market was affected by the reduction in leaded gasoline output; ethylene dibromide is a major component in leaded gasoline. Findings that fully halogenated halons were contributors to the deterioration of the ozone layer led to regulations that brought about a steep decline in demand for bromine-containing halon fire extinguishers.

On the positive side, research continued on the use of zinc bromides in storage battery electrolytes. Zinc bromide batteries have a potential for powering electric vehicles, and such a use would provide bromine producers with a major new market.

The year witnessed the final chapter in the trend of diminishing bauxite production. The Aluminum Co. of America closed its last bauxite mine in

TABLE 1
NONFUEL MINERAL PRODUCTION IN ARKANSAS[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasives[2]	metric tons	1,120	$429	W	W	W	W
Bromine*	thousand kilograms	W	W	W	W	177,000	$97,350
Clays	metric tons	844,466	15,376	871,313	$17,391	989,383	21,578
Gemstones		NA	2,300	NA	4,041	NA	1,503
Sand and gravel:							
Construction	thousand short tons	7,722	26,201	*7,500	*25,500	9,663	35,475
Industrial	do.	669	6,784	545	5,507	742	7,209
Stone:							
Crushed	do.	*17,100	*70,100	[3]18,791	[3]76,419	*[3]17,800	*[3]76,900
Dimension	short tons	*10,541	*629	W	W	W	W
Combined value of bauxite, cement, gypsum (crude), lime, stone (crushed slate and dolomite, 1989-90), talc and pyrophyllite, tripoli, vanadium (1989-90), and values indicated by symbol W		XX	184,785	XX	253,051	XX	62,625
Total		XX	306,604	XX	381,909	XX	302,640

*Estimated. 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]Grindstones, pulpstones, and sharpening stones; excludes mill liners and grinding pebbles.
[3]Excludes certain stones; kind and value included with "Combined value" data.

Saline County. The closure was due to depleted reserves; remaining reserves were high in silica and uneconomical to process. Bauxite mining, which began in the late 1800's, produced more than 92 million tons of bauxite for alumina manufacture. A limited tonnage of bauxite remained in stockpiles.

In other developments, Freeport-McMoRan Resources Partners Ltd. announced plans to sell its Blytheville nitrogen fertilizer facility. The Blytheville plant obtained phosphate rock for fertilizer manufacture from Florida.[3] Nucor Corp. announced plans to build its second flat-roll minimill in Mississippi County. The company constructed a mill in Armorel in 1988.

At midyear, sand and gravel shipments were outpacing all other traffic on the McClellan-Kerr Arkansas River Navigation System. Through July, 1.13 million tons of aggregate material had been shipped, a 2% increase over the first 7 months of 1989. The 1.13 million tons moved through midyear was 23.7% of the systems 4.72 million tons. Stone shipments through July totaled 28,834 tons compared with 29,687 tons for all of 1989.[4]

Arkansas river transportation personnel continued their quest for a lock and dam at the junction of the White River channel and the Mississippi River. When the Mississippi River is low, water is drawn from the 10.3 mile White River entrance channel, creating a low-water navigation problem in the White. A lock and dam would form a pool sufficiently deep for year-around navigation. The Corps of Engineers has located a lock and dam site and completed the design work; funding remained the major problem.

Several companies announced plans to fund recycling projects. One project in Springdale would involve the reprocessing of old tires and extracting a usable oil product. Another project by a second company involved the shredding and recycling of plastics to produce building materials. Window and door sills made from the recycled plastic look like wood and are almost indestructible.

EMPLOYMENT

Arkansas employment in 1990 was 1.056 million, a minuscule increase over the 1.053 million reported in 1989. Mining employment during 1989-90 remained at approximately 4,100.

REGULATORY ISSUES

Reynolds Metals Co. was seeking Federal and State permits that would allow construction of an industrial-scale plant to render spent potliners from aluminum smelters nonhazardous and suitable for landfill disposal. The proposed facility would be at Reynolds' closed smelter at Arkadelphia. Potliners in aluminum manufacture deteriorate after several years of use and have to be replaced. During use they adsorb small amounts of cyanide and fluoride. Reynolds' proposed process would blend sand and limestone with the liners and then "cook" the resulting mixture in a rotary kiln. The cyanides are destroyed in the roasting, and the fluoride becomes calcium fluoride, which the company claimed was stable, harmless, and insoluble.

U.S. Vanadium Corp., a Strategic Minerals Corp. (Stratcor) subsidiary, filed an appeal with the Arkansas Department of Pollution Control and Ecology (PCE) over a water permit issued to the company. The permit granted the firm authority to discharge effluents into Lake Catherine, but increased limitations on the discharges and altered other aspects of the pollution control monitoring process. Ammonia discharge was limited in the permit, and the company contended that the technology needed to limit ammonia discharge was not available. PCE engineers researched other vanadium mining operations and noted that the limits recommended were appropriate for the Stratcor operation.[5]

EXPLORATION ACTIVITIES

Three Federal prospecting permits were on record for 1,420 acres in the Ouachita National Forest. The permits, which were inactive, were for copper, gold, and silver.

LEGISLATION AND GOVERNMENT PROGRAMS

The 1990 Arkansas Legislature enacted no laws directly impacting the State's mineral industry.

The Arkansas Geological Commission (AGC) continued on several projects that involved the mineral resources of the State. Moving cores and cuttings to AGC's new well sample library began. When the move is completed in 1991, the library will contain more than 300,000 feet of core and cuttings from approximately 3,000 wells. These samples have been donated over the years by mining and oil and gas companies, water well contractors, and some individuals.

The AGC completed 6 years of a multiyear mapping program in the Ouachita Mountains to refine knowledge of the geology of this extremely complex province and to better evaluate its economic potential. This project covers 177, 7.5-minute quadrangles, or almost 10,000 square miles. Mapping should be completed in 1992, and the publication scale of the maps will be 1:250,000. The 7.5-minute quadrangles on which the geology was mapped will be open filed at the AGC office. This work is part of a cooperative geologic mapping program with the U.S. Geological Survey (USGS).

During the year, compilation continued of data obtained during the Harrison Conterminous United States Mineral Appraisal Program, a cooperative mineral appraisal program between the USGS, Missouri Geological Survey, and the AGC. The resulting reports and maps will be published by USGS.

The AGC participated in the planning session of an industrial minerals workshop to be held in 1991 in the midcontinent region. This workshop is designed to highlight the importance of industrial minerals and the inclusion of industrial mineral mining and processing activity in the planning for major

metropolitan areas. Participants in the meeting will include the USGS and nine State geological surveys in the midcontinent area. The meeting will take place in the fall of 1991 in St. Louis, MO. Presentations and discussions of the workshop will be published in the USGS Bulletin series.

Other activities of the AGC included: the preparation of a three-volume National Gas Atlas prepared under an agreement with the Texas Bureau of Economic Geology and the Gas Research Institute; the preparation of a comprehensive report on lignite resources of the State; and the provision of geologic information to aid in the orderly development of the mineral resources of the State.

The Surface Mining and Reclamation Division of the Department of Pollution Control and Ecology regulated both nonfuel and fuel mining. In 1990, there were more than 106 active noncoal mining permits and 35 permitted coal mines. During the year, approximately 170 acres of noncoal mined land and 129 acres of coal lands were reclaimed.

Core drilling at the Crater of Diamonds State Park was halted by a Federal judge after several exploratory holes were completed. The exploration work was funded by Arkansas Diamond Development Co., Continental Diamonds Inc., Kennecott Corp., and Capricorn Diamonds Pty. Ltd. The companies had hoped that if the drilling results indicated that commercial diamond mining was feasible, much of the diamond pipe would have been leased for mining. An area would have been preserved for tourists to search for diamonds. The drilling was opposed by three environmental groups. At yearend, the U.S. Department of the Interior was appealing the judge's ruling. The park was established, in part, with a grant from the Interior Department.[6]

The University of Arkansas, Fayetteville, received patents on relatively high-temperature superconductors jointly invented by a research professor and the former chairman of the physics department. Two superconductors composed of thallium-barium-copper oxide and thallium-calcium-barium-copper oxide were developed.[7]

A proposed gold mine in the Ouachita National Forest was killed by a U.S. Forest Service ruling that denied a Texas-based company permission to take bulk samples in the forest. The Texas company, Arkansas American Mining and Exploration Inc., proposed to remove a 10,000-ton bulk sample from the Bee Mountain area. The Forest Service denied the request on the grounds that it had sampled the area in 1984 and the samples, assayed by the U.S. Bureau of Mines, showed no gold traces.[8]

The State received $1.5 million for a detailed environmental assessment and engineering study for the proposed Arkansas-Mississippi Great River Bridge that would connect Arkansas Highway 1 in Desha County with Mississippi Highway 8. The project would create a new mid-South transportation corridor across the Mississippi River and open new markets for both States' mineral producers.[9]

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Abrasives (Natural).—Arkansas maintained its second place ranking among the four natural abrasive-producing States. Novaculite, a fine-grained metamorphic variety of chert, was produced by several firms in Garland and Hot Springs Counties. Standard quarrying methods were used to mine the raw material. Diamond saws were used to cut the crude novaculite into 2-, 4-, or 6-inch blocks. These blocks were later cut into smaller sizes and shapes for final finishing. Crude material was exported to Europe and Japan. Domestic output consisted of whetstones, hones, scrapers, and files. Both output and value increased significantly in 1990.

Bromine.—Arkansas remained the only bromine-producing State and the world's largest bromine producer. Approximately 40% of the world's bromine output came from Arkansas, 31% came from Israel, 14% from the U.S.S.R., and 6% from England. U.S. production in 1990 was 385 million pounds, the same as in 1989.[10]

Bromine was recovered by three companies in Columbia and Union Counties. Recovery was through wells drilled 7,000 to 8,000 feet deep into the bromine-bearing Smackover Formation. Bromine was recovered from the brines by reaction with chlorine-laden steam. A fraction was refined and marketed as elemental bromine with major sales to chemical companies. Bromine was also converted into compounds and used for flame-retardants (28%), agricultural uses (20%), petroleum additives (14%), well drilling fluids (11%), and other (27%). Included in the other category are dyes, pharmaceuticals, photographic chemicals, sanitary preparations, halons, bromobutyl rubber, and miscellaneous products. Bromine output increased slightly, but value declined drastically, a result of a drop in artificially high prices during the latter part of the 1980's.

Cement.—The State retained its ranking of 27th among the 38 portland cement-producing States and 17th among the 38 masonry-producing States. Arkansas Cement Corp. and the Ideal Cement Co. used the wet process to produce both portland and masonry cements. The two companies operated five kilns. Masonry output increased, and portland cement production was up 3% despite the recession.

Clays.—Arkansas retained its 14th position ranking among the 44 clay-producing States. The 10 firms comprising the State's clay industry produced both common clay and kaolin. Arkansas's 1990 clay production was 989,000 metric tons valued at $21.6 million. This was an 118,000-metric-ton increase over the 1989 level, and value increased $4.2 million above that reported for 1989.

Common clay and/or shale production, 71% of the total, was valued at $2.8 million. Production was reported by 7 companies operating 14 mines. The three

leading counties, in descending order of tonnage, Hot Springs, Crittenden, and Montgomery, accounted for almost 88% of the common clay-shale production. Major end uses, as reported by the producers, were for (1) common brick, (2) concrete block, (3) roofing granules, (4) structural concrete, and (5) firebrick. These five accounted for 90% of the production.

Arkansas ranked third nationally in kaolin production (Georgia and South Carolina produced more than 90% of the U.S. total). Kaolin was produced by three companies operating four mines in Pulaski County. Output totaled 284,000 metric tons valued at $18.8 million.

Gemstones.—The Crater of Diamonds State Park remained the focal point of gem production in Arkansas. Tourists "mined" several hundred diamonds during the year. The continuing controversy over commercial mining in the park is summarized in the Legislation and Government Programs section.

Quartz crystal collecting rivaled diamond "mining" in popularity, and many commercial mines allowed interested persons to search for crystals. The mines also produced crystal groupings for in-State and out-of-State rock shops. Arkansas' varied mineral assemblage attracted both amateur and experienced mineral collectors from many parts of the country.

Gypsum.—The State ranked 9th among the 21 States with gypsum output. Two companies mined gypsum in-State and a third purchased out-of-State gypsum for wallboard fabrication. Harrison Gypsum Co., Pike County , and Briar Gypsum Co., Howard County, were the two producers. Harrison mined and sold crude gypsum to cement companies for use in clinker manufacture, and Briar Gypsum mined and calcined gypsum for wallboard manufacture. Temple Inland Forest Products Co. purchased Oklahoma-mined gypsum for use in wallboard production. Production and value of gypsum mined in-State fell 4% and 1%, respectively, below those reported by industry in 1989.

Lime.—Hydrated and quicklime were produced by Arkansas Lime Co. in Independence County. Limestone mined locally provided the raw material. Output and value decreased 19% and 16%, respectively, below those reported by Arkansas Lime in 1989.

Quartz.—Arkansas ranks as the leading State in quartz crystal production. The crystals occur in an east-west trending belt extending from a few miles west of Little Rock into Oklahoma, and much of the crystal zone underlies the Ouachita National Forest. Quartz crystal mining was administered by the U.S. Forest Service.

A quartz crystal cluster from the Hot Springs area was presented to the President of the United States during a ceremony for the 1990 President's Volunteer Action Award winners.[11]

Sand and Gravel.—Construction and industrial sand and gravel were produced in-State during 1990. Output, 10.4 million short tons, exceeded the 1989 estimate by 2.4 million short tons, and value increased almost $11.6 million over the $2.5 million estimated in 1989.

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 1988 and 1990 and estimates for 1989.

In 1990, 40 companies operated 68 mines in 33 counties. The industry operated 23 stationary and 23 portable processing plants. The three leading counties were Little River, Ouachita, and Sevier.

Construction sand and gravel production for construction utilization totaled 9.7 million short tons valued at $35.5 million, an increase of 2.1 million short tons and almost $10 million.

Arkansas construction sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 3 presents end-use statistics for Arkansas' three districts.

Industrial.—The production of industrial sand was reported by four firms extracting sand from pits in Crawford, Hempstead, Izard, and Miller Counties. Primary sales were for foundry, glassmaking (both containers and flat glass), roofing granules, and sandblasting applications. Approximately 92% of the production was sand; the remainder was gravel. Output and value increased 197,000 short tons and $1.7 million, respectively.

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 1988 and 1990 and actual data for 1989.

Crushed.—Arkansas maintained its 32d position ranking among the 48 States reporting production of crushed stone. Crushed stone sales continued to rank second behind bromine and accounted for approximately 25% of the State's mineral value. Production and value were estimated at 17.8 million short tons and $76.9 million. In 1989, the last year that a complete industry canvass was made, 33 companies operated 46 quarries in a 27-county area.

Dimension.—Two companies reported dimension sandstone output. Production was reported as cut and veneer stone by one company; the second firm did not specify the final product. Output and value were the same as reported in 1989.

Talc.—The Milwhite Co. operated the Congo surface mine in Saline County in central Arkansas. Crude talc was trucked to the Bryant mill near Benton where it was dried, ground, and bagged. The company also milled soapstone from Texas. Primary talc markets were the filler, roofing, tennis court resurfacing, pipeline coating, and brakeshoe industries. Soapstone sales were for an insecticide carrier and ceramic manufacture. Production was the same as reported in 1989; however, value

increased four-fold. The 1990 value was adjusted to more accurately reflect industry pricing.

Tripoli.—Malvern Minerals Co. mined a 40-foot thick tripoli bed near Hot Springs. The tripoli, a microcrystalline, friable, high-purity silica, was trucked to a mill in Hot Springs for drying, grinding, and air classification. The State was one of four with tripoli production; output increased slightly, less than 1%, while value increased 122 over that reported for 1989.

Other Industrial Minerals.—In addition to the commodities listed in table 1, several minerals were recovered as byproducts from other mineral processing, manufactured from materials mined in-State, or shipped into Arkansas for processing into higher value products.

Bauxite was the principal mineral in the manufacture of proppants used by the oil and gas industry. Norton-Alcoa Proppants, Fort Smith, purchased stockpiled bauxite and novaculite from the Hot Springs area for proppant production.

Byproduct sulfur was recovered by two companies. MKP Operating Co., Lafayette County, recovered sulfur during petroleum refining, and the Ethyl Corp. recovered sulfur during bromine extraction in Columbia County. Arkansas was one of 26 States with byproduct sulfur recovery.

Synthetic graphite produced by Great Lakes Carbon Group, Ozark, and Superior Graphite Co., Russellville, used petroleum coke to manufacture graphite electrodes. Arkansas ranked 7th among the 13 synthetic graphite-producing States.

Vermiculite was exfoliated by Strong-Lite's Pine Bluff plant; about 70% of the raw material was imported from the Republic of South Africa. The exfoliated material was sold to the paint, aggregates, insulation, agricultural, and fireproofing industries.

Metals

Two ores, bauxite and vanadium, were mined in Arkansas during 1990. Scrap metal was reprocessed into other metals at plants across the State.

Aluminum.—Alcoa continued operations at its Saline County chemical plant. The facility used alumina as a feedstock to produce a variety of aluminum chemicals.

Bauxite.—Alcoa closed its last bauxite mine in the early part of the summer. The Saline County deposits, first mined in 1899, were the last in the United States producing bauxite for alumina manufacture. A limited amount of stockpiled bauxite remained in-State.

Iron and Steel.—Arkansas Steel Associates and Nucor-Yamato Steel Co. composed Arkansas's steel industry. Each company operated a single minimill; the two were equipped with four electric furnaces with an annual capacity of 870,000 short tons. Nucor's minimill in Blytheville had the company's highest productivity and earning levels. The mill, designed to produce 650,000 short tons of steel per year, produced 1.1 million short tons in 1990.[12]

In April, Nucor announced that it would expand into 30-inch beam production. The expansion is designed to produce 650,000 short tons of steel beams annually.[13]

During the year, Nucor announced plans to construct a second minimill in Mississippi County. The company placed an order for a thin-slab caster from SMS Schloemann-Siemag AG of Germany. The thin-slab caster will produce 2-inch-thick slabs at a maximum casting rate of 18 feet per minute. The new mill will have the capacity to produce coils with a maximum weight of 31 short tons in widths ranging from 51 inches to 61.5 inches. The caster is expected to come on-stream in 1993.[14]

Vanadium.—U.S. Vanadium Corp. continued to operate the Nation's only vanadium mine and mill in the Hot Springs area. Much of the vanadium ore was purchased from the Republic of South Africa. The company also processed vanadium-rich boiler residues and spent, vanadium-bearing catalysts using the salt roast process. Much of the output was sold to the steel and chemical industries.

Early in the year, the company received approval from the Arkansas Department of Pollution Control & Ecology to conduct experimental operations to determine the feasibility of processing tungsten scrap on a commercial scale.[15]

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 30 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]The Ledger (Star City). Freeport-McMoRan Sells Its Nitrogen Fertilizer Assets. Feb. 13, 1990.

[4]Little Rock Democrat. Sand, Gravel Top River Cargo at 1.13 Million Tons for Year. Aug. 26, 1990.

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[6]Little Rock Arkansas Gazette. Interior Department Appeals Diamond Ban. Nov. 23, 1990.

[7]El Dorado News-Times. UA to Receive Superconductor Patents. Apr. 8, 1990.

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[10]Mining Engineering. V. 43, No. 6, June 1991, p. 594.

[11]The Sentinel-Record (Hot Springs). Crystal Formation Chosen as Presidential Gift. Apr. 30, 1991.

[12]Update. Arkansas a 'Natural' for Business. No. 2, 1991, p. 52.

[13]American Metal Market. Inland Plans to Exit Structural Business. V. 98, No. 215, Nov. 2, 1990, p. 1.

[14]———. Nucor Orders Second SMS Thin-slab Caster. V. 98, No. 250, Dec. 27, 1990.

[15]The Sentinel-Record (Hot Springs). Despite Experts' Objections PC & E OKs 'Pilot Plant' Operation. Apr. 20, 1990.

TABLE 2

ARKANSAS: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	2,299	$7,448	$3.24
Plaster and gunite sands	3	12	4.00
Concrete products (blocks, bricks, pipe, decorative, etc.)	143	390	2.73
Asphaltic concrete aggregates and other bituminous mixtures	476	1,633	3.43
Road base and coverings	833	2,511	3.01
Fill	52	182	3.50
Snow and ice control	W	W	3.00
Other	45	222	4.93
Unspecified:[1]			
Actual	4,474	19,308	4.32
Estimated	1,338	3,769	2.82
Total or average	9,663	35,475	3.67

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 3

ARKANSAS SAND & GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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]	937	2,793	1,040	3,344	467	1,714
Asphaltic concrete aggregates and other bituminous mixtures	173	603	207	733	96	297
Road base and coverings	284	1,131	467	1,135	82	244
Fill	36	152	W	W	W	W
Snow and ice control	W	W	—	—	—	—
Other miscellaneous	43	213	7	19	12	20
Unspecified:[2]						
Actual	181	557	3,380	14320	913	4,430
Estimated	569	1,262	769	2,507	—	—
Total[3]	2,224	6,712	5,870	22,059	1,570	6,705

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes plaster and gunite sands.
[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.

TABLE 4
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.
Weyerhaeuser Co., Dierks Div.	Route 4, Box 78 Nashville, AR 71852	Mine and plant	Howard.
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 (1987):			
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.
Silica Products Co. Inc.	Box 29 Guion, AR 72540	do.	Izard.

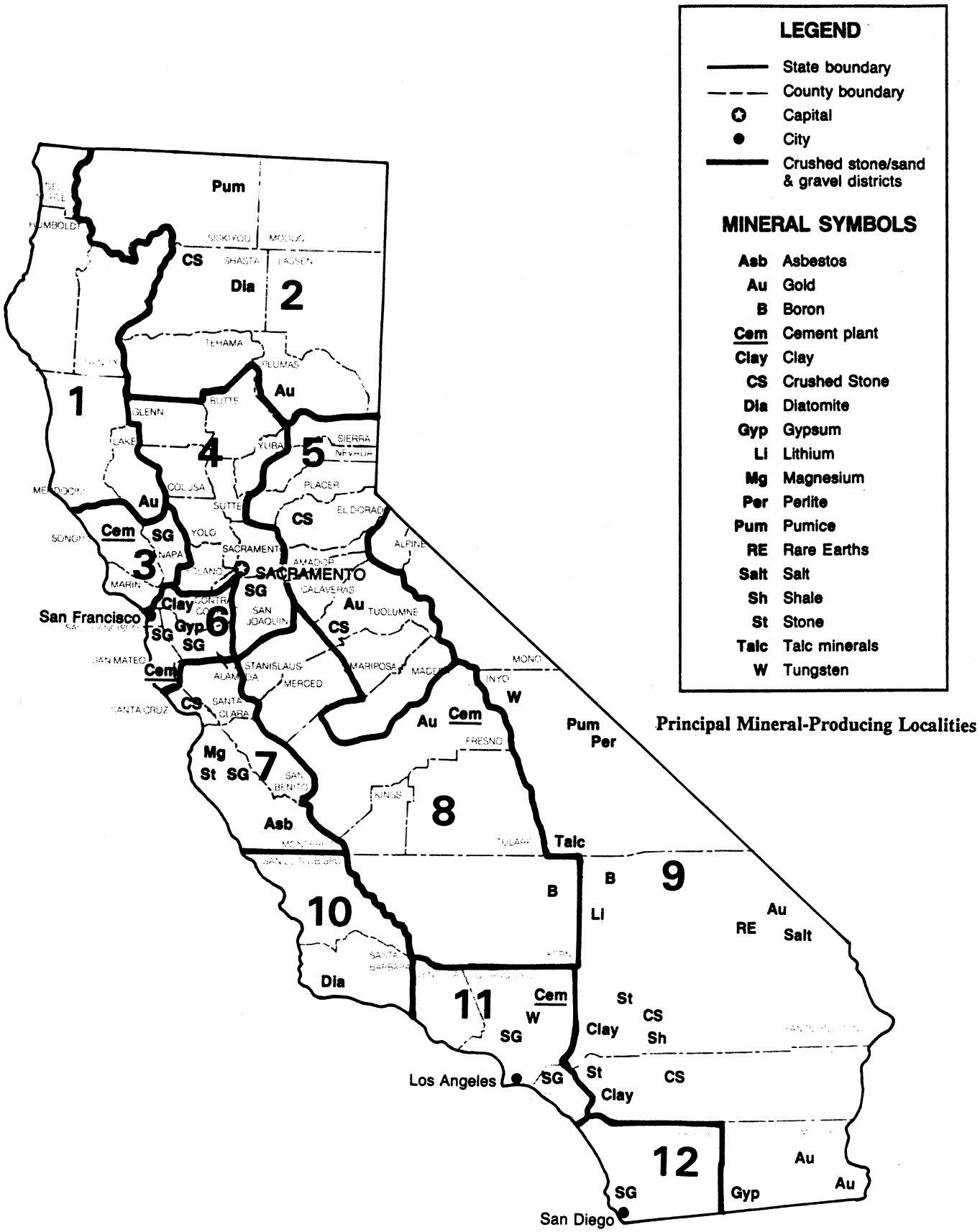
See footnotes at end of table.

TABLE 4-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	Do.
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.

CALIFORNIA


LEGEND
State boundary
County boundary
Capital
City
Crushed stone/sand & gravel districts
MINERAL SYMBOLS
Asb Asbestos
Au Gold
B Boron
Cem Cement plant
Clay Clay
CS Crushed Stone
Dia Diatomite
Gyp Gypsum
Li Lithium
Mg Magnesium
Per Perlite
Pum Pumice
RE Rare Earths
Salt Salt
Sh Shale
St Stone
Talc Talc minerals
W Tungsten
Principal Mineral-Producing Localities
1
2
3
4
5
6
7
8
9
10
11
12
SACRAMENTO
San Francisco
Los Angeles
San Diego
Pum
CS
Dia
Au
Cem
SG
Clay
Gyp
Mg
St
Asb
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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 L. Burnett[3]

California ranked second among the States in the value of nonfuel minerals produced in 1990, accounting for just over 8% of the U.S. total. The value of the commodities produced during the year decreased about 4% to $2.78 billion, after a steady growth in the State's mineral industries from 1982 to 1989. California led all States in the production of asbestos, boron minerals, portland cement, diatomite, calcined gypsum, rare-earth concentrates, construction sand and gravel, and tungsten.

Nearby residents' opposition to new mining continued to impede issuing of new mining permits throughout the State, but three county referendums restricting mining in Nevada, Tuolumne, and Yolo Counties were defeated at the polls. Industrial mineral production reflected the leveling off of construction activity in the State, with declines in the production of portland cement, lime, sand and gravel, and crushed stone. Increased gold production retained California's standing as the second largest gold production State despite lower precious metals prices, which closed several of the smaller marginal gold and silver mines.

TRENDS AND DEVELOPMENTS

Industrial minerals comprised 84% of the State's nonfuel mineral production value. In 1990, 31 mineral commodities, including 9 metals, were produced in California. Lower industrial minerals prices and a reduction in the State's construction activity caused the first reduction in total production value since 1981.

Gold production in California decreased slightly from that of 1989 to 29,607 kilograms (951,866 troy ounces) valued at $368.3 million. Production was reported from 20 lode and 4 placer mines.

EMPLOYMENT

According to the California Department of Employment Development, the California nonfuel mining industry employed approximately 9,000 workers in December 1990, down about 4% from that of the previous year. Of these, 1,900 were metal mining jobs and 7,100 were nonmetallic mineral mining jobs.

REGULATORY ISSUES

The State Regional Water Quality Control Board met in March to discuss the cleanup of the Sulphur Bank Mine near Clear Lake where concentrations of mercury were poisoning fish in the lake. Erosion control construction was scheduled, which began immediately and should be finished by October 1, 1995. The U.S. Environmental Protection Agency (EPA) officially listed the site on its Superfund for Toxic Waste Cleanup in August, clearing the way for EPA oversight of the cleanup.

The U.S. Bureau of Land Management (BLM) announced in August implementation of a new policy requiring mandatory reclamation bonds for exploration and mining operations plans.

EXPLORATION ACTIVITIES

Exploration for precious metals continued in several areas of California, helping it to retain its ranking as the second largest gold production State in the Nation. Exploration for boron in the Mojave Desert area was limited in 1990 because pending wilderness legislation threatened withdrawal of some of the areas undergoing exploration.

Exploration activities were also reported in the Kelso Dunes area of San Bernardino County, where the BLM reviewed a proposal to conduct a mining operation within the BLM Wilderness Study Area. Sacramento County supervisors reported evaluations of aggregate and incidental gold at Mather Air Force Base, which was scheduled to become county property in 1993 after relinquishment by the Air Force.

LEGISLATION AND GOVERNMENT PROGRAMS

Two bills concerned with mining reclamation were passed in September. Assembly Bill 3551 and Assembly Bill 3903 require local lead agencies to conduct inspections of all surface mining operations and require an annual report on mining operations to be forwarded by the mine operator to the State Geologist. They also require mine operators to provide financial assurance for costs associated with carrying out a reclamation plan and require that the State Mining and Geology Board adopt minimum, verifiable reclamation standards.

During fiscal year 1990, the University of California received allotment grants of $389,116 under the Mining and Minerals Research Institute program (MMRI). Programs under MMRI included Generic Mineral Technology Centers, communication, and mineral industry waste treatment and recovery.

The U.S. Department of the Interior's Minerals Management Service Offshore Operations signed a long-term lease to establish a new office in Camarillo. The new location consolidated offices in Ventura, Santa Maria, and Los Angeles, which supervised Outer Continental Shelf minerals exploration and production operations for (California, Hawaii, Oregon, and Washington.)

The California Division of Mines and Geology released a series of maps entitled "Mineral Land Classification Maps for Nevada County." The two sets of maps denote (1) all land likely to contain precious metals and aggregates, and (2) aggregate resources available for mining. Three special publications were issued during the year: Special Publication 103, Mines and Mineral Producers Active in California (1988-1989), by J. S. Rapp and others; Special Publication 105, Industrial Minerals in California: Economic Importance, Present Availability, and Future Development, compiled by E. W. Tooker and D. J. Beeby; and Special Publication 107, Mineral Commodity Report: Bentonite and Fuller's Earth by M. A. Silva and D. T. Eyde.

FUELS

California continued to rank fourth among oil producing States, although production of crude oil decreased for the fifth year in a row. Total production of 350.7 million barrels (one barrel equals 42 gallons) compared with 364.3 million barrels in 1989. The total State production continued to decline during the year, largely due to low crude oil prices. Production decreased in both the Federal and State offshore areas. The State total include 297.2 million barrels of oil produced from onshore fields and 53.4 million barrels from offshore wells. Production from Federal offshore fields decreased by 3.2 million barrels to 29.9 million barrels.

In spite of the overall decline in both onshore and offshore fields, significant production increases were posted in four California onshore fields: Midway-Sunset, Coalinga, Kern Front, and Lost Hills. Most of the production increases were due to enhanced, heavy oil recovery operations, using steam injection. Midway-Sunset Oilfield became the top oil producer in the State and also the top producer in the lower 48 States, reaching a cumulative production of almost 2 billion barrels.

California's total net natural gas production decreased from 376.8 billion cubic feet in 1989 to 364.8 billion cubic feet in 1990, the lowest total since 1983. The 1990 total includes 44.5 billion cubic feet from Federal offshore fields, up 3.8 billion cubic feet from that of 1989.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Asbestos.—California's 1990 asbestos production was 24% higher than that of 1989. KCAC Inc.'s Joe Asbestos Mine near King City in San Benito County was the sole producer. Production was limited to short fiber chrysotile, one of six commercial varieties of asbestos. The ore was stripped, and wet processing was used to beneficiate the fiber.

Boron Minerals.—California continued to be the sole source of domestic boron mineral production. Boron minerals sales valued at almost $436.2 million were 2% higher than those in 1989. Production of mineral concentrates and chemicals increased from 562,311 metric tons in 1989 to 1,093,919 metric tons in 1990. Production from four California plants was principally from Kern County, with the balance from San Bernardino County.

United States Borax and Chemical Corp., a subsidiary of RTZ Corp. PLC of London, United Kingdom, was California's largest producer and the primary supplier of sodium borates. U.S. Borax mined and processed crude and refined borax products at its plant at Boron in Kern County. North American Chemical Corp. recovered borates from its Westend and Trona plants in San Bernardino County. American Borate Co. reported a small amount of production from its Billie Mine in Death Valley National Monument, which had been shut down since 1986.

Anaconda Minerals Co. sold its rights to the southern section of Searles Lake to North American Chemical, thus giving it the rights to all of the brine underlying Searles Lake. North American's boron production included boric acid, pentahydrite and decahydrate borax, and anhydrous borax.

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.—California continued to lead all States in the production of cement. Portland cement was this State's second most valuable mineral commodity in 1990, with a reported value of more than $604 million. Production of 10,032,000 short tons ranked it first among the States in the manufacture of finished portland cement, furnishing about 11% of the U.S. total from 11 active plants.

Cementos Mexicanos, Mexico's largest cement company, purchased the remaining 50% interest in Pacific Coast Cement Co., owners of an import terminal in Long Beach. Onoda Cement Co. of Japan acquired the Los Angeles-based CalMat Co., one of the largest owners of plants and terminals in California.

In August, the International Trade Commission (ITC) issued a final determination on a petition filed by California cement producers, concluding that the industry was being materially injured by Mexican imports. Consequently, antidumping duties ranging from 3.7% to 58.4% were placed on cement imported from Mexico. Concurrent with ITC's final investigation of Mexican imports, an ad hoc committee of Southern California producers of gray portland cement filed a petition against

imported cement from Japan and instituted a preliminary investigation.

Calaveras Cement Co. continued construction of additional facilities at its new cement plant at Monolith in Kern County, including a "stacker-reclaimer" storage dome and a new kiln. In September, CBR Group of Belgium acquired Standard Concrete Products, a ready-mix concrete company with several California operations.

Clays.—Clay production decreased slightly from that of 1989 to 2.16 million metric tons (2.4 million short tons) valued at more than $190 million. Common clay and shale comprised the bulk of the clays produced, with 10 companies also reporting bentonite, kaolin, or fuller's earth production.

Diatomite.—California continued to lead all other States in diatomite production during 1990. As in previous years, the major producer was Manville Products Corp. from its operations near Lompoc in Santa Barbara County. Grefco Inc. was the only other producer from its mine and plant near Burney in Shasta County and from its mine and plant in Santa Barbara County near Lompoc. Diatomite was used principally for fillers and in filtration.

Feldspar.—California ranked third nationally in the production of feldspar and second in the value of its production. The quantity of feldspar sold decreased about 15% over that of 1989. Production was reported from two companies in San Bernardino and San Diego Counties.

Gypsum.—Calcined gypsum output from six plants was reported to be 2.03 million short tons valued at $32.2 million in 1990, continuing California's ranking as the number one producing State. The quantity of crude gypsum produced in 1990 was below last year's record high, and the State ranked only sixth in total mined output of crude gypsum.

U.S. Gypsum Co.'s Plaster City Mine in Imperial County was the State's and Nation's leading gypsum producer. H. M. Holloway Inc.'s Lost Hill Mine in Kern County was also among the Nation's top 10 producers. Crude gypsum was mined in Imperial, Kern, San Bernardino, and San Luis Obispo Counties. Gypsum was calcined in Alameda, Contra Costa, Imperial, and Los Angeles Counties.

Lime.—Lime production of 345,000 short tons was 50,000 short tons below 1989's reported production. Lower prices also resulted in a decrease in value from $24.5 million in 1989 to $19.4 million in 1990. Chemstar Inc., with plants in Contra Costa and Los Angeles Counties, was the State's largest producer of hydrate and quicklime. Quicklime was also produced in Monterey County at the National Refractories and Minerals Natividad plant.

Holly Sugar Corp. used quicklime at four plants in Santa Barbara, Imperial, San Joaquin, and Glenn Counties. Spreekles Sugar Co. used quicklime at its Woodland plant, and Delta Sugar Corp. used hydrate at its Clarksburg plant. Marine Magnesium Co., formerly Merck Chemical Co., used quicklime from its Sonora plant.

Pumice.—California ranked second among the States in pumice production. A 9% drop in production to 71,739 metric tons still resulted in a 10% increase in value to $5.1 million, as reported by the three companies selling processed pumice in the State. Pumice or pumicite was mined in Madera, Modoc, and Siskiyou Counties and was used in landscaping, as an abrasive, and in agriculture. U.S. Pumice Co. in Mono County was the largest producer.

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 1988 and 1990 and estimates for 1989.

California construction sand and gravel and crushed stone statistics are compiled by geographical districts as depicted in the principal mineral-producing localities map. At the request of the State, the number of districts was increased from 3 to 12, beginning in 1988.

California remained the Nation's number one construction sand and gravel producing State, with 1990 production estimated at 132,214,000 short tons valued at $626,000,000 reported from 272 active operations.

In January 1990, Colonial Sugar Refineries (CSR) Ltd., of Sydney, Australia, completed the acquisition of ARC America Corp. of Newport Beach, CA, and all its subsidiaries. At midyear, C. H. Beazer PLC reorganized its American subsidiaries into two separate companies. All Beazer California operations, including Gifford-Hill & Co. operations, became part of Beazer West Inc. of Dallas, TX. Beazer West acquired all assets of Crystal Hills Sand and Gravel Co. of Lucerne, CA. The acquisition included a long-term lease for the sand and gravel operation as well as a ready-mix plant and a hot-mix asphalt plant at that site.

Permits were issued for several controversial sand and gravel operations. Azusa Rock Co. renewed its permit to mine its Fish Canyon Road Quarry in Los Angeles County. Placer County supervisors approved a use permit for R. C. Collet Inc. to begin aggregate mining near the Stanford Ranch in Rocklin. Ventura County supervisors approved a new sand and gravel mining operation on an 80-acre site north of Moorpark.

Industrial.—Production of industrial sand and gravel in 1990 rose slightly to 2,452,000 short tons, while higher prices resulted in a 9.6% increase in value to $48,055,000. Industrial sand production was reported from nine operations in eight counties. Unimin Corp. was the State's largest producer, followed by Owens-Illinois Inc. and Industrial Sand Co. Industrial sand was used primarily in containers and sandblasting.

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 1988 and 1990 and actual data for 1989.

Crushed stone production in 1990 was estimated to be about 42 million short tons or 22% lower than the reported production in 1989. Dimension stone output was estimated to rise to just over 30,000 short tons from 1989's reported 28,829 short tons. Principal uses of crushed stone were for concrete and bituminous aggregate and road base. Additional important uses were for riprap and jetty stone, filler stone, and cement manufacture.

Other Industrial Minerals.—Barite production resumed in the State after a year's hiatus, but only small amounts were reported by three companies for use in well drilling, paint, and rubber products. Magnesium compounds were obtained from seawater magnesia operations in Monterey and San Mateo Counties.

Expanded perlite for use in plaster and concrete aggregates, acoustic tile, low-temperature insulation, fillers, and roof insulation was produced from six plants in Los Angeles, San Diego, and San Bernardino Counties. Kerr-McGee produced muriate of potash (60% K_2O) and sulfate of potash (50% K_2O) from plants in San Bernardino County. California ranked seventh among 11 States reporting talc and pyrophyllite production with output from 3 mines in 3 counties.

Byproduct sulfur was recovered at 15 oil refineries in Contra Costa, Kern, Los Angeles, and Solano Counties.

Metals

Gold.—Lode gold production was reported throughout the State in Butte, Calaveras, Imperial, Inyo, Kern, Napa, Sierra, San Bernardino, and Tuolumne Counties. Total gold output of 29,607 kilograms (951,900 troy ounces) was about 6,000 ounces less than the 29,804 kilograms reported in 1989. Principal production was from 20 lode mines, but 2 placer operations in Nevada and Yuba Counties supplied about 3% of the total.

Napa County's McLaughlin Mine, owned by Homestake Mining Co. and Gold Fields Mining Corp.'s Mesquite Mine in Imperial County were the State's largest gold suppliers. Additional important producers included Meridian Mineral Co.'s Royal Mountain King Mine in Calaveras County, Coca Mines, Cactus Gold Mine in Kern County, Bond Gold Corp.'s Colosseum Mine in San Bernardino County, and Sonora Mining Corp.'s Jamestown Mine in Tuolumne County. In March, Homestake poured its one-millionth ounce of gold since it began production at the McLaughlin Mine in 1985. Gold Fields began development of the Rainbow pit at the Mesquite Mine.

U.S. Gold Corp. and AMAX Gold Inc. continued development of a conventional processing mill and cyanide heap-leach processing facility at their Hayden Hill gold project in Lassen County. Glamis Gold Ltd. purchased all of Echo Bay Mines Ltd.'s Randsburg gold properties, 5,600 acres, including the Baltic and Lamont deposits. Most of Glamis's production was attributed to the Picacho Mine in Imperial County, where news reports said 312,500 tons of ore was mined and placed on the leaching pads that yielded 22,128 troy ounces of gold during the year. The balance of the Glamis production came from the Yellow Aster Mine in Kern County, which was brought on-line during the summer.

Royal Gold Inc. reopened the Original Sixteen to One Mine, near Downieville, in July. Startup operations included mine repair and reconditioning of track, equipment,and the hoisting system.

Exploration for gold was conducted throughout the State. Eastmaque Gold Mines Ltd. reported exploration drilling on the Oro Cruz Joint Venture Project in Imperial County. Homestake Mining Co., Gold Fields Operating Co., and Bema Gold Corp. were also reported to be exploring in Imperial County. Canyon Resources Corp. announced a gold discovery at the Briggs deposit in the Panamint Range of Inyo County and continued with further evaluation drilling through the year. Glamis Gold Ltd. conducted further drilling at the Yellow Aster pit in Kern County. Pegasus Gold Corp. drilled the Virginia Mine site in Mariposa County. Sonoma Mining Corp. explored the Dutch App-Nyman area near Quartz Mountain in Tuolumne County.

Iron Ore.—Small shipments of iron ore were reported in the State by four operators. Direct iron ore shipments were made from Standard Industrial Minerals Inc.'s Tecopa (Beck) Mine and CalMat Co.'s Baxter Mine, both in San Bernardino County. P. W. Gillibrand Co. produced concentrates at its Soledad Canyon sand and gravel operation in Los Angeles County, and Yuba Natural Resources recovered concentrates from sand and gravel operations in Yuba County. The Kaiser Steel Eagle Mountain operation in Riverside County was permanently closed.

Silver.—Silver production was reported from 18 lode and 2 placer operations in the State principally as a byproduct of gold production. Total output of 21 metric tons (665,835 troy ounces) valued at more than $3 million was similar to that of the previous year, but about 10% lower in value because of declining silver prices. Coca Mines Inc.'s Cactus Mine in Kern County and Homestake's McLaughlin Mine in Napa County were the largest silver producers in California; both were from byproduct gold mining.

Tungsten.—California was the sole U.S. producer of tungsten concentrates in 1990. U.S. Tungsten Corp., Bishop, CA, continued to be the principal company in California tungsten concentrates production. The Pine Creek Mine and mill operated on an intermittent basis at levels below capacity to provide supplemental feedstock to the company's APT conversion facility. Imported concentrate was the primary source of raw material.

Curtis Tungsten Inc., Upland, CA, was the only other company producing tungsten concentrate. The first concentrate delivered from the Andrew Tungsten Mine in the San Gabriel

Mountains, north of Los Angeles, was announced in February 1990.

Other Metals.—California copper production resulted solely as a byproduct of tungsten refining at U.S. Tungsten Corp.'s Pine Creek Mine in Inyo County. Mercury production was practically nil, with less than 1/2 unit from Napa County, the only quantity reported sold during the year. All of the State's 1990 molybdenum production also was recovered as byproduct from U.S. Tungsten's Pine Creek operation. No lead or zinc production was reported in 1990.

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[1]State Mineral Officer, U.S. Bureau of Mines, Reno, NV. He has 25 years of mineral-related government experience and has covered the mineral activities in California for 9 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.

TABLE 1
NONFUEL MINERAL PRODUCTION IN CALIFORNIA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Boron minerals[2]	metric tons	577,877	$429,667	562,311	$429,806	1,093,919	$436,176
Cement:							
Masonry	thousand short tons	8	730	W	W	W	W
Portland	do.	10,423	601,152	10,911	642,020	10,032	604,080
Clays	metric tons	2,015,488	31,620	2,195,830	39,243	[3]2,163,515	[3]40,217
Gemstones		NA	3,365	NA	2,982	NA	1,501
Gold[4]	kilograms	22,442	316,246	29,804	366,595	29,607	368,300
Gypsum (crude)	thousand short tons	1,490	11,222	1,734	13,066	W	W
Lime	do.	458	20,242	395	24,503	345	19,425
Mercury	metric tons	W	W	W	W	([5])	([5])
Peat	thousand short tons	2	119	—	—	—	—
Pumice	metric tons	31,752	1,245	79,000	4,612	71,739	5,088
Sand and gravel:							
Construction	thousand short tons	141,946	622,074	e138,300	e670,800	132,214	626,000
Industrial	do.	2,444	42,078	2,426	43,863	2,452	48,055
Silver[4]	metric tons	15	3,148	21	3,650	21	3,209
Stone:							
Crushed	thousand short tons	e49,100	e275,000	54,887	238,034	e42,500	e200,600
Dimension	short tons	e42,048	e5,991	28,829	5,564	e30,077	e5,213
Combined value of asbestos, barite (1988, 1990), calcium chloride (natural), clay (fuller's earth, 1990), copper, diatomite, feldspar, iron ore (byproduct material, 1988-89, usable), magnesium compounds, molybdenum, perlite, potash, rare-earth metal concentrates, salt, soda ash, sodium sulfate (natural), talc and pyrophyllite, titanium concentrates (ilmenite, 1989-90), tungsten ore concentrates, and values indicated by symbol W		XX	334,755	XX	r369,664	XX	421,935
Total		XX	2,698,654	XX	2,854,402	XX	2,779,79

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]Begining with 1989 data reported in 1988 data converted.
[3]Excludes certain clays; kind and value included with "Combined value" data.
[4]Recoverable content of ores, etc.
[5]Less than 1/2 unit.

TABLE 2

CALIFORNIA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	47,198	$227,722	$4.82
Plaster and gunite sands	2,750	15,487	5.63
Concrete products (blocks, bricks, pipe, decorative, etc.)	587	3,781	6.44
Asphaltic concrete aggregates and other bituminous mixtures	15,325	87,017	5.68
Road base and coverings[1]	19,890	83,529	4.20
Fill	7,139	24,409	3.42
Snow and ice control	62	341	5.50
Railroad ballast	98	468	4.78
Other	1,428	7,888	5.52
Unspecified:[2]			
Actual	37,737	175,358	4.65
Total or average	132,214	626,000	4.73

[1]Includes road and other stabilization (cement and lime).
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 3

CALIFORNIA SAND & GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	457	2,086	962	3,552	853	3,504	6,451	33,353
Plaster and gunite sands	W	W	18	177	W	W	619	4,169
Concrete products (blocks, bricks, etc.)	W	W	—	—	W	W	W	W
Asphaltic concrete aggregates and other bituminous mixtures	281	4,362	498	5,043	115	418	2,821	19,550
Road base and coverings[1]	613	3,177	1,483	5,225	490	1,688	5,589	22,952
Fill	58	151	245	813	337	1,424	764	2,871
Snow and ice control	W	W	—	—	—	—	—	—
Railroad ballast	—	—	—				W	W
Other miscellaneous	22	140	13	46	322	1,245	287	1,428
Unspecified:[2]			—	—				
Actual	—	—	9	52	1,798	7,373	1,194	5,403
Total[3]	1,430	9,917	3,227	14,907	3,915	15,651	17,726	89,727

	District 5		District 6		District 7		District 8	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	1,041	5,576	1,728	8,615	848	4,732	6,305	26,065
Plaster and gunite sands	154	767	(4)	2	W	W	345	1,459
Concrete products (blocks, bricks, etc.)	—	—			—	—	22	86
Asphaltic concrete aggregates and other bituminous mixtures	W	W	1,001	5,432	W	W	1,964	8,995
Road base and coverings[1]	968	4,222	554	2,636	180	809	3,202	12,899
Fill	381	1,549	726	3,964	W	W	470	1,719
Snow and ice control	W	W	—	—	—	—	13	51
Railroad ballast	W	W	—	—	—	—	16	75
Other miscellaneous	280	1,772	—	—	554	2,750	201	1,105
Unspecified:[2]								
Actual	340	1,866	3,980	21,332	1,405	7,810	—	—
Total[3]	3,164	15,751	7,990	41,981	2,987	16,100	12,538	52,454

	District 9		District 10		District 11		District 12	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	10,263	45,647	138	513	13,861	72,704	4,293	21,374
Plaster and gunite sands	473	2,159	W	W	886	4,462	152	1,753
Concrete products (blocks, bricks, etc.)	W	W	—	—	W	W	127	1884
Asphaltic concrete aggregates and other bituminous mixtures	4,592	18,758	W	W	2,969	15,619	694	6,524
Road base and coverings[1]	3,284	10,999	231	778	2,530	14,779	765	3,366
Fill	1,140	3,229	359	617	1,258	3,458	1,150	3,927
Snow and ice control	—	—	—	—	—	—	—	—
Railroad ballast	—	—	—	—	—	—	—	—
Other miscellaneous	222	1,146	217	942	481	2,663	141	690
Unspecified:[2]								
Actual	10,209	44,214	682	2,375	14,729	66,075	3,390	18,858
Total[3]	30,183	126,152	1,627	5,225	36,714	179,760	10,713	58,377

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."

[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]Less than 1/2 unit.

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Asbestos:			
Calaveras Asbestos Corp.	Box 127 Copperopolis, CA 95228	Surface mine and plant	Calaveras.
KCAC Inc.	Box K King City, CA 93930	do.	San Benito
Boron minerals:			
Kerr-McGee Chemical Corp[1]	Kerr-McGee Center Oklahoma City, OK 73125	Evaporators and plant	San Bernardino.
United States Borax & Chemical	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. America	Box 604 Norwalk, CA 90650	do.	Do.
Cement:			
CalMat Co.[3]	3200 San Fernando Rd. Los Angeles, CA 90065	Plants	Various.
Kaiser Cement Corp. (Mitsubishi Mining & Cement Co.)	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.
Beazer/West Inc.	Box 832 Riverside, CA 92502	do.	Do.
Gifford-Hill & Co. Inc., 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	Surface mine and plant	Orange.
U.S. Silica Co.	3231 Oceanside Dr. Oceanside, CA 92054	Mine and plant	San Diego.
Gold:			
Gold Fields Mining Corp.[7]	HCR 75 Glamis 100 Brawley, CA 92227	Surface mine	Imperial.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Gold—Continued			
Homestake Mining Co.[7]	650 California St. San Francisco, CA 94108	Surface mine and plant	Napa.
Gypsum:			
U.S. Gypsum Co.	Plaster City, CA 92269	do.	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.
Sand and gravel (construction):			
CalMat Co.[9]	3200 San Francisco Rd. Los Angeles, CA 90065	Pits	Various.
Beazer/West Inc.	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/West Inc.	Box 19099 Dallas, TX 75219	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.

COLORADO

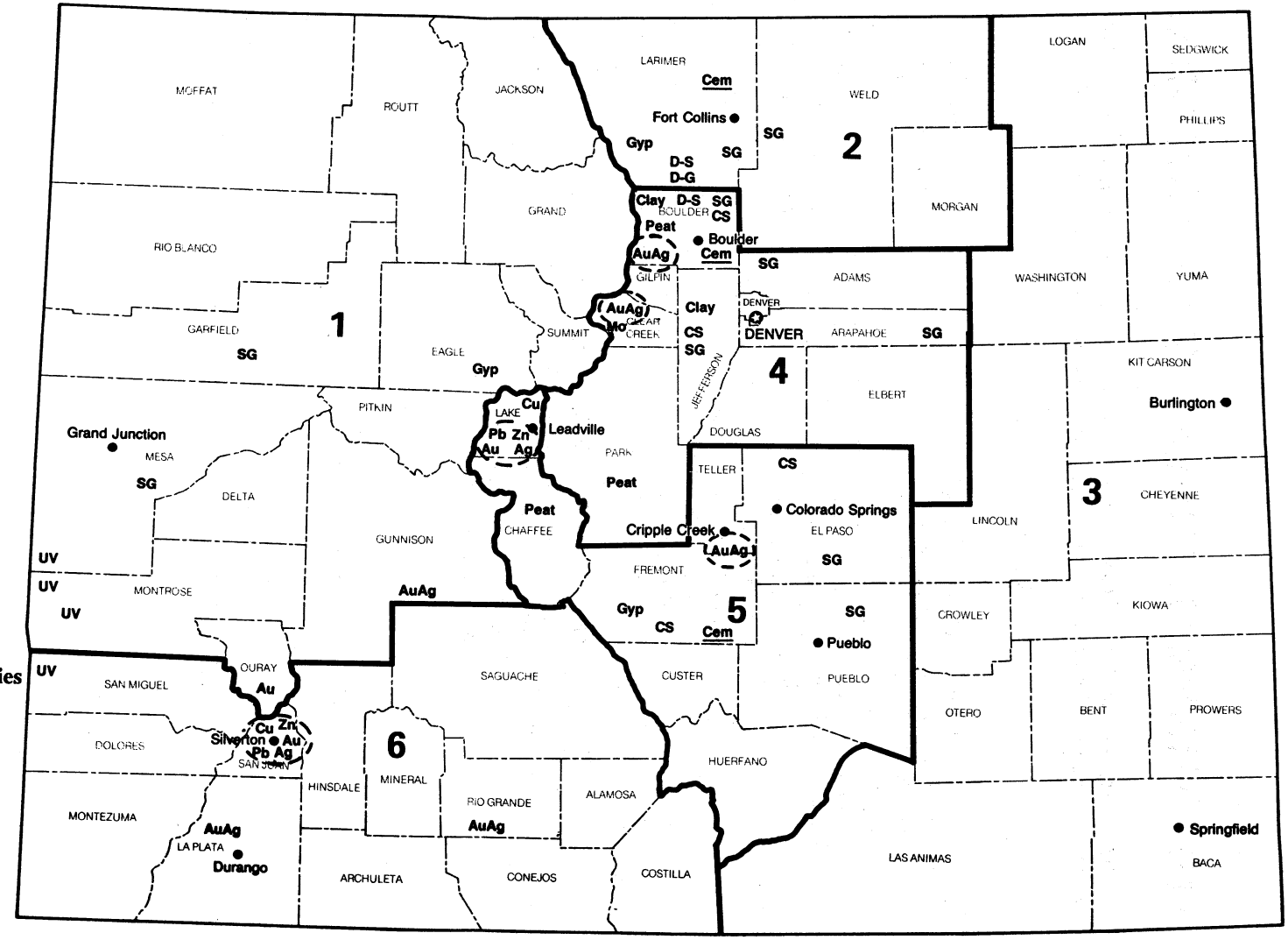
LEGEND

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

MINERAL SYMBOLS

AuAg	Gold-Silver
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
Cu	Copper
D-G	Dimension Granite
D-S	Dimension Sandstone
Gyp	Gypsum
Mo	Molybdenum
Pb	Lead
Peat	Peat
SG	Sand and Gravel
UV	Uranium-Vanadium
Zn	Zinc
	Concentration of mineral operations

Principal Mineral-Producing Localities



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 Doss H. White, Jr.

In 1990, Colorado's nonfuel mineral production was valued at $386 million, according to data reported to the U.S. Bureau of Mines. The effects of an economic slowdown on mineral value were evident—value fell $71.5 million from the figure reported by industry in 1989. Nationally, the State declined from 23d to 27th in total nonfuel mineral value, and output fell from 1.4% to 1.16% of the U.S. total.

The top three minerals produced in-State, in terms of value, were molybdenum, construction sand and gravel, and cement. These three accounted for more than 70% of the State's total mineral sales.

TRENDS AND DEVELOPMENTS

The 11-year period between 1980 and 1990 was one of extremes for Colorado's mineral producers. In 1980, the State's nonfuel mineral value was $1.3 billion, and molybdenum sales, $912 million, accounted for approximately 72% of the total. By 1990, mineral value had fallen $878 million, and molybdenum sales had fallen below 50% of the State's total.

During the 1980-90 period, mineral value declined drastically from the 1980 record of $1.3 billion to $338 million in 1983. Value rose to $436 million in 1984 as a result of the State's two molybdenum mines returning to full production. Value again fell in 1985 and 1986, but rose $3 million in 1987 to $373 million as a result of a dramatic increase in gold value. Gold value and total value fell in 1988. In 1989, value rose to $458 million, the result of an estimated increase in construction sand and gravel sales. An upturn in construction and work on the new Denver airport accounted for an increased demand for sand and gravel. The $386 million produced in 1990 was $141 million below the 11-year average of $527 million.

Developments during the year included the fall announcement of a new gypsum wallboard plant that began production at Gypsum. In September, the Yule Marble Quarry reopened and a slab was shipped to Tennessee for testing. In November, Climax Molybdenum Inc. announced

TABLE 1
NONFUEL MINERAL PRODUCTION IN COLORADO[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	247,471	$1,890	265,435	$2,064	262,292	[2]$1,864
Copper[3]	do.	898	2,386	W	W	W	W
Gemstones		NA	100	NA	240	NA	66
Gold[3]	kilograms	5,126	72,237	3,448	42,411	2,338	29,084
Peat	thousand short tons	W	W	W	412	W	W
Sand and gravel (construction)	do.	21,566	69,882	e25,300	e104,000	24,938	86,541
Silver[3]	metric tons	27	5,588	W	W	23	3,557
Stone:							
Crushed	thousand short tons	e10,600	e42,400	[4]7,261	[4]32,435	e [4]7,600	e [4]36,100
Dimension	short tons	e3,450	e143	5,310	398	e8,490	e1,394
Combined value of cement, clay (bentonite, 1990), gypsum (crude), helium (Grade-A, 1990), lead, lime, molybdenum, perlite, sand and gravel (industrial), stone (crushed traprock,1989-90), vanadium, zinc, and values indicated by symbol W		XX	169,379	XX	r275,765	XX	227,586
Total		XX	364,005	XX	457,725	XX	386,192

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" data.
[3]Recoverable content of ores, etc.
[4]Excludes certain stones; kind and value included with "Combined value" data.

plans to reopen the Climax Mine in 1992; the mine was closed in March 1987. Umetco Minerals Corp. closed several vanadium-uranium mines in November as a result of low uranium prices and demand. In February, NaTec Resources Inc. announced plans to develop a nahcolite mine in Rio Blanco County.

EMPLOYMENT

In 1990, Colorado's mining employment, which included oil and gas production, totaled 19,500.[1] The average annual pay for mining personnel in-State rose 0.5% from $42,371 in 1989 to $42,570 in 1990.[2] In the 1989-90 academic year, Colorado School of Mines graduates' average starting salaries were $33,197, up 8.7% from the $30,553 recorded in the 1988-89 school year.[3]

REGULATORY ISSUES

Seven of Colorado's 16 Superfund sites are old mining operations. Many of these have problems resulting from toxic metals leaching from spoil areas into nearby waterways. An attempt to clean up the Eagle Mine site near Vail has resulted in the creation of more problems than were solved. A system of pipes designed to divert clean water around waste piles was installed too close to the piles and pumped polluted water into nearby wetlands. Plans to pump polluted water back to the mine site for holding resulted in greater amounts of metals leached into the Eagle River. The efficiency of a water-treatment plant built to remove the metals from the seepage was reduced because of excessive sludge buildup. The Eagle Mine site cleanup is projected to cost about $30 million.[4]

A Federal court ruled that the U.S. Bureau of Reclamation was not exempt from fines that accompany environmental violations. Two environmental groups brought suit against the agency for allowing "toxic metal pollution from mines seep through an old tunnel known as the Leadville Drain and into the upper Arkansas River. Portions of the river are so polluted that aquatic life in (sic) limited."[5]

Citizens and local officials of several Colorado counties voiced concern over "mountainside scaring" resulting from mining operations. In many cases the scars were caused by aggregate operations. The close proximity of the operations to the communities voicing concern, a proximity that allowed low aggregate transportation costs, was the reason that new construction costs in the communities were kept at a minimum.

EXPLORATION ACTIVITIES

Exploration activity was reported as "brisk" by industry sources. One company completed a geophysical program on 26,000 acres in North Park. Earlier drilling in the Park's Black Cloud, Swede Group, and Wolverine Zirkel areas intersected significant gold, silver, lead, zinc, and copper mineralization, and the 1990 exploration was dedicated to further testing at each location.[6]

Tenneco Minerals finished its 1990 drilling program the 1st of July and removed the drills from a site north of Silver Cliff in Custer County. The firm announced plans to construct a $35 million mill at Silver Cliff. Nova Natural Resources Corp. drilled the Bassick Mine gold properties near the former town of Querida, approximately 7 miles east of Silver Cliff.

Summitville Consolidated Mining Co. Inc. continued its gold exploration program in Rio Grande County. The company's exploration program was funded at $300,000.

Idarado Mining Co., a subsidiary of Newmont Mining Corp., continued its exploratory drilling program in San Miguel and Ouray Counties. The company hoped to establish a reserve base large enough to warrant a mill on the Ouray side of the mountain near the closed Idarado Mine.

LEGISLATION AND GOVERNMENT PROGRAMS

The Colorado Legislature passed and the Governor signed into law four bills that directly impact the minerals industry. House bill 1115 established a new mined-land reclamation fee structure, increased existing fees, and created additional fees to cover permit amendments, technical revisions, operator changes, and notices of temporary cessation. House bill 1214 extended the tax credit for Colorado coal purchases until the year 2005. The credit will be granted when purchases exceed the amount purchased in base year 1988. Senate bill 34 defined legal rights when royalty interests in minerals were transferred, and Senate bill 177 required concurrent reclamation of all noncoal mine sites, where feasible.

During 1990, the Colorado Geological Survey (CGS) continued work on monitoring two large landslides and provided geotechnical support to the Colorado Department of Highways. Work was in its second year of a cooperative study on severe swelling soil conditions in the Pierre Shale. The study was in cooperation with the U.S. Geological Survey (USGS), Colorado Homebuilders Association, Jefferson County, and the Colorado School of Mines. CGS personnel continued the fee-funded Land Use Review Program for local governments. The Environmental Hydrology Program investigated several classes of contaminants.

The mineral fuels section of CGS continued work on an inventory of the State's mineral fuel resources and an evaluation of various development problems. Included were tight gas sands, coal-bed methane, and input to the USGS National Coal Resources Data System. Work was also ongoing on an analysis of State revenues from royalties and severance and ad valorem taxes.

The Colorado Mined Land Reclamation Division (MLRD) supervised the filling and capping of 40 underground coal mine shafts and subsidence craters in north Colorado Springs. The area has experienced 42 subsidence problems since 1979.[7] In April, the Mine Substance Protection Program waived its $100 inspection fee. The federally funded program, administered by the MLRD, was instituted in 1988 to offer low-cost insurance to 7,500 homeowners whose homes are built over mined-out areas.

U.S. Bureau of Mines personnel at the Information and Analysis field office in Denver, CO, continued work in accessing the mineral potential of Federal lands in Colorado. During the year, the first draft of the Crater Creek section of the San Juan National Forest report was submitted for technical review, and the Taylor Mesa section was nearing completion. The final report on the White River National Forest was completed.

The U.S. Mineral Management Service reported that the State received $45.3 million as its 1990 share of revenues associated with mineral leases on Federal public lands within Colorado.

The U.S. Department of Energy's budget for fiscal year 1991, October 1990 to September 1991, contained funding for a $19.6 million research facility for the Solar Energy Research Institute near Golden. The institute had been housed in leased space since its formation in 1976.[8]

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Colorado's 50-plus metal mines produced ores valued at more than 50% of the State's nonfuel mineral value. Metallic ores produced included copper, gold, lead, molybdenum, vanadium-uranium, and zinc.

Copper, Lead, Silver, and Zinc.—Production of these four metal commodities was reported by the Cross Mine in Boulder County, the Broken Handle and Franklin Mines in Clear Creek County, the ASARCO Incorporated Leadville Mine in Lake County, the Summitville Mine in Rio Grande County, the Sunnyside Mine in San Juan County, and mines in the Cripple Creek area of Teller County. The following 1990 metal production values were reported to the U.S. Bureau of Mines: copper--$2.2 million, and silver--$3.7 million. Values for lead and zinc are concealed to protect company proprietary data.

Gold.—Colorado mines produced 2,338 kilograms of gold valued at $29 million. This was a $13 million decrease from the $42 million reported in 1989.

Molybdenum.—Climax Molybdenum Co., a unit of Climax Metals Co., a subsidiary of AMAX, operated the Henderson Mine in Clear Creek County. Henderson ore was transported 15 miles by underground rail to the firm's mill in Grand County. When completed, development work at the 8,100-foot level and proposed development at the 7,700-foot level will provide the mine with a sustained production rate of 40 million pounds of molybdenum per year through the year 2007.

The company announced that it will resume production at the open pit of the Climax Mine near Leadville in 1992. Underground workings at Leadville are permanently closed. The surface mine, closed in 1987, has been undergoing "cleanup" mining and reclamation since 1989. In 1991, ore processing facilities at the Climax operation will be consolidated into one existing building and redesigned for a 24,000-ton-per-day capacity.[9]

A decline in output resulted from a production cut at the Henderson Mine beginning the first week in January.

Vanadium-Uranium.—Vanadium and uranium were recovered as coproducts from approximately 50 Colorado mines. All ore was shipped to White Mesa, south of Blanding, UT, for processing. Vanadium producers reported an 11% drop in production and a 10% decrease in value. The U.S. Bureau of Mines does not canvass uranium producers.

Other Metals.—Several metals were recovered as byproducts from smelting or were recovered or manufactured from other scrap metals. These are summarized below.

Asarco recovered cadmium as a byproduct of the extraction and refining of zinc metal from sulfide ore concentrates. The Asarco smelter was in Globeville in north Denver.

CF&I Steel Corp., Pueblo, was Colorado's only steel producer. The facility produced oil industry goods and was one of two manufacturers of steel rails in the United States. Company earnings were down at the end of the third quarter as a result of a drop in the rail market.

Catalyst Resources Inc., Denver, recovered palladium, platinum, and rhodium from scrap automobile and industrial plant catalytic converters.

Industrial Minerals

The State's industrial mineral sector manufactured (cement) or produced 18 different industrial minerals. The top three, which accounted for more than 40% of the total nonfuel mineral value, were (1) construction sand and gravel, (2) portland cement, and (3) crushed stone. The value of industrial mineral production was almost 47% of Colorado's total mineral production.

Cement.—Colorado's cement industry consisted of Holnam Inc., with plants in Fremont and Larimer Counties, and Southwestern Portland Cement Co., with a plant in Boulder County.

Holnam operated a dry-process plant at Laport, Larimer County, that produced portland cement and a wet-process plant at Portland, Freemont County, that produced both portland and masonry cement. Southwestern operated a dry-process plant at Lyons, Boulder County, that manufactured portland and masonry cement.

Portland cement output increased 4%, and value was up 12%. Masonry cement output was at the same level as that reported in 1989; value, however, increased almost 6%.

Clays.—The State's clay industry, 10 companies operating 27 pits, produced both common clay and bentonite. Output totaled 289,000 short tons valued at $1.9 million. Value decreased $200,000. Common clay was produced in seven counties; the three leaders, Douglas, Elbert, and Fremont on the Eastern Slope, accounted for approximately 46%

of the State's total tonnage. Eighty-five percent of the common clay was used in the manufacture of common brick. The remainder was used in the manufacture of firebrick, face brick, mortar, and chemicals.

Three hundred short tons of bentonite was produced in Fremont County. The bentonite was used for waterproof seals.

Gypsum.—Two companies in Eagle and Larimer Counties mined gypsum. Both production and value of crude gypsum fell sharply below the levels reported for 1989.

Eagle Gypsum Products began operation of its new gypsum wallboard plant at Gypsum in September. The $11 million plant was a Colorado limited partnership between Eagle Gypsum Ltd. and Eagle Investment Group Ltd. Partners, an Illinois limited partnership. The nearby mine also supplied gypsum to some of the State's cement plants. Wallboard from the Eagle plant was shipped as far west as California.

In September, Domtar closed its gypsum quarry and wallboard plant in Florence.

Lime.—Western Sugar Co. produced lime at plants in Morgan and Weld Counties, and Calco Inc. produced lime at a plant in Chaffee County. Production and value fell slightly below those reported by the two firms in 1989.

Peat.—During 1990, four companies, one each in Boulder and El Paso Counties and two in Park County, produced peat. Production fell slightly below the levels reported in 1989.

Perlite.—Presolite Products Inc. produced perlite from pits in Fremont County, and Grefco Inc. mined perlite from a pit in Conejos County. Sales were to the filter, plaster, concrete aggregate, low-temperature and cavity-fill insulation, horticulture aggregates, and filler industries. Output and value fell slightly below 1989 levels.

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 1988 and 1990 and estimates for 1989.

In 1990, Colorado's sand and gravel industry, 131 companies operating 396 pits, produced 24.9 million short tons valued at $86.5 million. This was 3.3 million tons above the output reported in 1988; value exceeded the 1988 level by $16.6 million. The three leading counties, Adams, Larimer, and Weld, accounted for 41% of the total tonnage. The three leading end uses, as reported by the producers, were road base and/or cover (28%), concrete aggregate (25%), and asphaltic concrete (12%). Other uses included snow-ice control, concrete products, fill, and railroad ballast.

Industrial.—Three firms produced industrial sand and/or gravel in Arapahoe, El Paso, and Larimer Counties. Production and value increased significantly.

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 estimates for 1988 and 1990 and actual data for 1989.

Crushed.—Stone production was estimated at 7.6 million short tons, a 300,000-short-ton increase over that reported in 1989. Value increased an estimated $3.7 million.

Dimension.—Four firms quarried granite, quartzite, sandstone, and marble. The estimated production exceeded the 1989 level by 3.2 million short tons. Value was up an estimated $1 million.

In September, the Yule Marble Quarry in Gunnison County reopened; the quarry closed in 1942. The underground quarry is scheduled to produce about 1,100 blocks per year. The blocks will be trucked to Glenwood for shipment to finishing plants. Quarrying equipment was imported from Carrara, Italy. The first block was shipped to a Knoxville, TN, firm for testing.

Plans to reopen a black marble quarry inside the Maroon Bells-Snowmass Wilderness were opposed by several environmental groups. The U.S. Forest Service offered to purchase the mineral claim covering the quarry site, but the offer was refused. The controversy was unresolved at yearend.

Sodium Compounds.—NaTec Resources Inc. announced plans in February to develop a nahcolite mine and process facility in Rio Blanco County. Nahcolite will be recovered by solution mining. The facility was scheduled to begin production in 1991 with initial production of 125,000 short tons of processed nahcolite per year.

Other Industrial Minerals.—Several industrial minerals mined in other States or countries were shipped into Colorado for processing into higher value products or used in the manufacture of other consumer products.

Ocher was shipped into the State for use as a coloring agent in brick manufacture. Colorado monument companies purchased dimension stone from out-of-State sources for finishing as grave markers. Crude vermiculite was shipped to W. R. Grace & Co.'s plant in Denver for exfoliating.

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[1]Rocky Mountain News. Colorado Labor Force. Sept. 4, 1990.

[2]U.S Department of Labor, Bureau of Labor Statistics. News. Sept. 6, 1991.

[3]Denver Post. Jobs and Salaries Picking up for Mines Grads. June 13, 1990.

[4]Rocky Mountain News. Mountain Mines Pose Toxic Plight. Sept. 20, 1990.

[5]———. Judge Rules U.S. Agencies Must Pay Pollution Fines. Jan. 23, 1990.

[6]Walden Jackson County Star. Caprock Reports. June 21, 1990.

[7]Denver Post. 40 Old Coal Mines Plugged in Springs. Mar. 28, 1990.

[8]Rocky Mountain Construction. Hotline--SERI Laboratory Funds Requested. Feb. 5, 1990, p. 4.

[9]Middle Park Times. Future Looks Stable for AMAX Mine Operations. Oct. 25, 1991.

TABLE 2

COLORADO: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	6,224	$22,730	$3.65
Plaster and gunite sands	235	1,192	5.07
Concrete products (blocks, bricks, pipe, decorative, etc.)	1,352	5,480	4.05
Asphaltic concrete aggregates and other bituminous mixtures	3,078	14,180	4.61
Road base and coverings	7,093	20,130	2.84
Fill	1,703	2,975	1.75
Snow and ice control	683	2,113	3.09
Railroad ballast	17	68	4.00
Other	221	1,078	4.88
Unspecified:[1]			
Actual	4,333	16,595	3.83
Total or average	[2]24,938	86,541	3.47

[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.

TABLE 3

COLORADO[1]: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	1,105	3,411	2,279	7,667	146	493
Plaster and gunite sands	W	W	194	980	W	W
Concrete products (blocks, bricks, etc.)	W	W	2	9	—	—
Asphaltic concrete aggregates and other bituminous mixtures	451	4,877	463	1,788	248	679
Road base and coverings	2,089	5,475	1,592	3,802	882	3,642
Fill	814	1,243	370	754	3	7
Snow and ice control	90	260	—	—	W	W
Railroad ballast	5	10	—	—	—	—
Other miscellaneous	77	315	—	—	2	6
Actual	574	2,092	690	2,744	37	169
Estimated	—	—	—	—	—	—
Total[4]	5,206	17,682	5,591	17,744	1,317	4,997

Use	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	2,148	8,865	278	774	267	1,520
Plaster and gunite sands	W	W	19	60	W	W
Concrete products (blocks, bricks, etc.)	W	W	—	—	—	—
Asphaltic concrete aggregates and other bituminous mixtures	1,549	5,356	303	1,148	W	W
Road base and coverings	1,244	3,973	425	884	861	2,354
Fill	442	837	66	108	8	25
Snow and ice control	513	1,648	35	65	W	W
Railroad ballast	(3)	3	W	W	W	W
Other miscellaneous	1,441	5,937	81	471	75	376
Unspecified:[2]						
Actual	1,589	6,969	1,340	4,077	—	—
Estimated	—	—	—	—	—	—
Total[4]	8,926	33,588	2,547	7,587	1,212	4,276

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Excludes 139,067 short tons valued at $668,291 not reported by county.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Less than 1/2 unit.
[4]Data may not add to totals shown because of independent rounding.

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Holnam Inc.[1]	Box 8789 750 17th St. Denver, CO 80201	Plants	Fremont and Larimer.
Southwestern Portland Cement Co.[1]	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 Incorporated[2]	Box 936 Leadville, CO 80461	Mine and mill	Lake.
Pikes Peak 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.
Sunnyside Gold Corp., a subsidiary of Echo Bay Mines Ltd.[2]	Box 177 Silverton, CO 81433	Mine and mill	San Juan.
Gypsum:			
Domtar Gypsum	1173 State Highway 120 Florence, CO 81226	Mine and plant	Fremont.
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:			
AMAX Inc.	1707 Cole Blvd. Golden, CO 80401	Mines and mills	Clear Creek, Grant, Lake.
Peat:			
Hyponex Corp.	Box 586 Fountain, CO 80817	Bog	El Paso.
Universal Peat Sand & Gravel Inc.	1557 South Ingalls St. Lakewood, CO. 80226	do.	Park.
Perlite:			
Grefco Inc, Building Products Div.	Box 308 Antonito, CO 81120	Plant	Conejos.
Persolite Products Inc.	Box 105 Florence, CO 81226	Mine and plant	Custer and Fremont.
Sand and gravel:			
Cooley Gravel Co. (J. L. Shiely Co.)[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.	Pitkin, Moffat, Routt, Mesa.

See footnotes at end of table.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Albert Frei & Sons Associates	11521 Brighton Rd. Henderson, CO 80640	do.	Adams, Clear Creek, Garfield, Weld.
Western-Mobile Inc.[1]	Box 5183TA Denver, CO 80217	do.	Boulder, El Paso, Larimer, Pueblo, Weld, and others.
Stone:			
Asphalt Paving Co.	14802 West 44th Ave. Golden, CO 80401	Quarries	Jefferson.
Associated Aggregates	33501 Highway 6 Idaho Springs, CO 80452	do.	Various.

[1]Also stone.
[2]Also copper, lead, silver, and zinc.
[3]Also silver.

CONNECTICUT

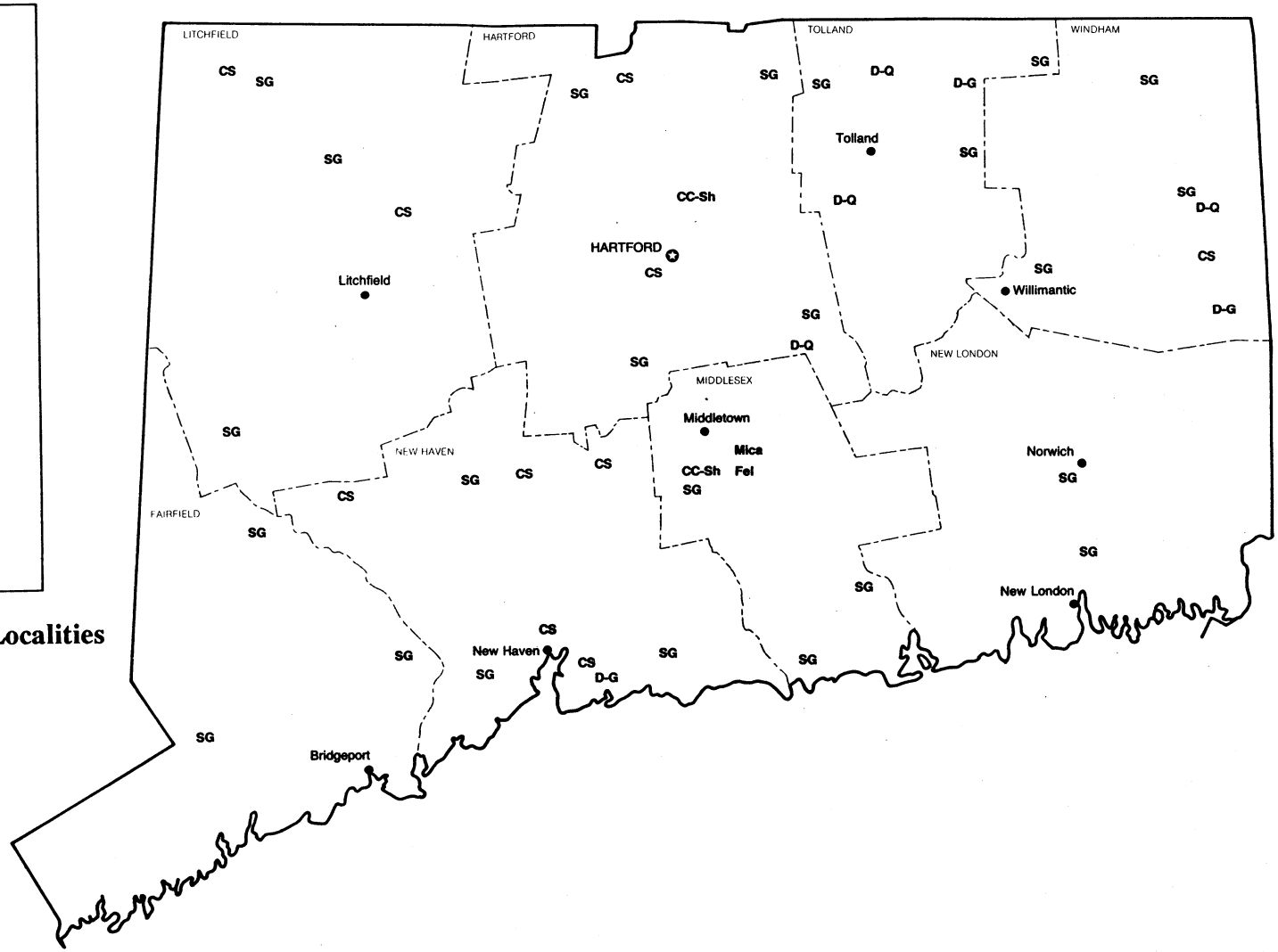
LEGEND

- State boundary
- County boundary
- Capital
- City

MINERAL SYMBOLS

CC-Sh	Common Clay & Shale
CS	Crushed Stone
D-G	Dimension Granite
D-Q	Dimension Quartzite
Fel	Feldspar
Mica	Mica
SG	Sand and Gravel

Principal Mineral-Producing Localities



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 1990 was $117.9 million, a $4.7 million increase from that of 1989. Crushed stone and construction sand and gravel were the two leading mineral commodities produced. Other commodities produced included common clay, dimension stone, feldspar, industrial sand, and mica.

TRENDS AND DEVELOPMENTS

In 1990, the value of total construction contracts, which relied heavily on mineral aggregates, was down 22% from that of 1989. Declines were reported in all categories. The hardest hit sector was in residential construction, which fell 36%, from $243 million in 1989 to $155 million in 1990. The value of nonbuilding construction contracts declined by 23%, from $289 million to $222 million, and nonresidential building contracts were down 7%, from $233 million in 1989 to $216 million in 1990. As a result of these construction declines, demand for crushed stone and construction sand and gravel continued to be soft in 1990. In 1990, the estimated output of crushed stone, the State's leading mineral commodity in terms of value, fell 15% from that of 1989. Output of construction sand and gravel rose from the 1989 estimated output, but was about equal to the 1988 canvassed output. One program that has helped some aggregate producers was the continuing $7.1 billion, 10-year Transportation Infrastructure Renewal Program established in 1984. During 1990, $451 million was approved by the Connecticut General Assembly for this Connecticut Department of Transportation (ConnDOT) program. ConnDOT's 1990 budget also included: $32.5 million for highway and bridge renewal; $30 million for town aid road grants; and $7.5 million for local bridges.[3]

EMPLOYMENT

In 1990, the average number of workers[4] employed in the minerals extractive industries in Connecticut was 927. This included 375 workers in the stone industry, 313 in the sand and gravel business, and 16 in nonmetal mining operations. In addition, 223 workers were employed at mineral-related mills and preparation plants in the State.

REGULATORY ISSUES

The Connecticut Hazardous Waste Management Service (CHWMS) started a program to evaluate innovative uses of technology that minimize hazardous waste and prevent pollution. The service had received a $300,000 grant from the Environmental Protection Agency (EPA) for Waste Reduction Innovative Technology Evaluation (WRITE) pilot projects. Connecticut was one of six States invited by the EPA to apply for the

TABLE 1
NONFUEL MINERAL PRODUCTION IN CONNECTICUT[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$2	NA	$2	NA	$2
Sand and gravel (construction)	thousand short tons	8,275	32,102	e5,800	e24,700	8,542	37,943
Stone:							
Crushed	do.	e11,400	e76,900	2 11,480	2 78,734	2 e10,200	2 e70,600
Dimension	short tons	e19,718	e1,914	W	W	W	W
Combined value of clays (common), feldspar, mica (scrap, 1988, 1990), sand and gravel (industrial), stone (crushed granite, 1989-90), and values indicated by symbol W		XX	7,198	XX	9,780	XX	9,348
Total		XX	118,116	XX	113,216	XX	117,893

eEstimated. 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 stones; kind and value included with "Combined value" data.

grant. The CHWMS will provide up to $100,000 in matching funds.[5]

Facing a goal of 25% waste reduction set by the State and effective January 1, 1991, the State Department of Public Works was advised in April by the Connecticut Recycling Coalition as to how some towns were dealing with recycling. To meet the 25% goal, the State Department of Environmental Protection (DEP) will prohibit nine items from being placed in landfills or incinerators. This will, in turn, force towns to find other places to dump these materials or take them to regional recycling centers. The nine items included in the ban were glass, cans, newspapers, corrugated cardboard, scrap metal, office paper, leaves, waste motor oil, and vehicle batteries.[6]

LEGISLATION AND GOVERNMENT PROGRAMS

A number of bills concerning environmental issues were signed into law in 1990. Topics addressed included the illegal dumping of asbestos, solid waste management, recycling, resource recovery facilities, low-level radioactive waste disposal, and radon and lead abatement in public schools.

A Milford Superior Court judge ruled in January that the Beacon Falls Planning and Zoning Commission amendments to the town's zoning laws, which banned three mining companies from processing imported gravel, were illegal. The judge upheld appeals filed by O&G Industries Inc., D&J Quarry Products Inc., and Hamden Sand & Gravel Co., thus nullifying the amendments passed by the Planning and Zoning Commission in 1988. The amendments would have barred the companies from bringing crushed stone and sand and gravel to Beacon Falls from other towns as of January 1, 1990. The amendments also would have prohibited the companies from processing existing stockpiles of those materials as of January 1991. The judge ruled that because the companies were already operating locally before the amendments were adopted, the town cannot prevent them from processing the material there.

The Connecticut Geological and Natural History Survey continued programs on the collection, interpretation, and dissemination of information on the State's natural resources. Major efforts for the year included acquisition of 1990 Statewide aerial photography; topographic, bedrock, and surficial geological mapping; soils mapping; a continued study of the geology of Long Island Sound; and a continuing radon investigation. A Connecticut mining exhibit opened at the National Mining Museum and Hall of Fame in Leadville, CO.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Clays.—Two companies mined common clay and shale for use in manufacturing common and face brick. K-F Brick Co. mined Pleistocene glacial lake clay near South Windsor and also quarried Jurassic age shale near Suffield, both in Hartford County. The Michael Kane Brick Co., the State's other producer, operated an open pit mine in glacial lake deposits in Middlesex County.

Feldspar.—Connecticut continued to rank second nationally of the seven States that produced feldspar in 1990. The Feldspar Corp. operated three open pit quarries and a froth flotation plant in the old Middletown Pegmatite District in Portland and Middletown, Middlesex County. Processed feldspar was shipped by truck to markets elsewhere in New England, New York, and New Jersey and was used principally as a flux by the glass and ceramics industry. Feldspar production in Connecticut decreased in 1990 because the depressed housing market in the northeast resulted in decreased feldspar usage for plumbing fixtures and tile.

Gemstones.—Individual collectors and mineral clubs recovered gem stones in quarries and abandoned mine sites, primarily from pegmatites. The Middletown Pegmatite District in the central part of the State was one of the most popular gem collecting sites.

Iodine.—Crude iodine was shipped to Connecticut by Uniroyal Chemical Co. Inc. at a plant near Middlebury, New Haven County. The crude iodine was used primarily to manufacture rubber, antioxidants, and organic chemical compounds.

Mica.—The Feldspar Corp. recovered mica as a byproduct of feldspar mining operations in Middletown and Portland, Middlesex County. The mica was marketed as a filler and as an additive to well drilling mud.

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 1988 and 1990 and estimates for 1989.

Construction sand and gravel was the State's second leading mineral commodity in terms of value and accounted for almost one-third of the State's value of mineral production. In 1990, 63 companies mined construction sand and gravel from 67 operations. Leading counties, in order of output, were Hartford, Litchfield, and New Haven. Major uses were for construction and roadbuilding.

In December, 14 sand and gravel operators in the Township of Plainfield filed a written protest against the Plainfield Planning and Zoning Commission's efforts to impose new regulations in the township concerning mining activities. The sand and gravel operators, most of whom are grandfathered, objected to the proposal of having to file permit applications for preexisting gravel operations. Other conditions in these new regulations included restricting operating hours, regulating topsoil restoration and

stockpiled materials, and limiting the annual amount of sand and gravel that may be mined in 1 year to 25,000 cubic yards. The new regulations are expected to be challenged in court.

In July, the Manchester Sand & Gravel Co. and its affiliated companies filed for reorganization under chapter 11 of the U.S. Bankruptcy Code. The company cited the declining construction and real estate industries in the region as the primary reason.

Near yearend, the Utility Contractors Association of Connecticut (UCAC) voted to merge with the Connecticut Construction Industries Association (CCIA). The CCIA represents many sand and gravel and crushed stone operators in Connecticut. Under the merger, which becomes effective January 1, 1991, the UCAC will become a full division within the CCIA.

Industrial.—Two companies produced industrial sand in the State. U.S. Silica of Connecticut operated a quarry near North Stonington, New London County, and The Feldspar Corp. processed industrial sand as a byproduct of feldspar refining in Middletown, Middlesex County. Principal uses were for blasting, filtration, and glass products.

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 1988 and 1990 and actual data for 1989.

Crushed.—Crushed stone was the State's leading mineral commodity produced and accounted for 60% of the State's total mineral value. Estimated crushed stone production (predominantly Jurassic aged basalt that is commonly called traprock) declined 11% from that of 1989. Major uses were for roadbuilding and concrete aggregate.

After more than a 6-year dispute, the Bolton Zoning Commission unanimously agreed in March to grant a quarry permit to American Heritage Stone Inc. With the Zoning Commission approval, the company will be allowed to mine 3 acres of the quarry--2 acres in an industrial zone and 1 acre in a residential area. The issuing of the permit ended a longstanding battle between the company and the commission over how much of the company's 10 acres could be mined. The permit must be renewed each year.

In November, the East Granby Planning and Zoning Commission denied Roncari Industries' proposal to expand its crushed stone quarry operations by 116 acres. The company, which quarries about 70 acres, applied to change the zoning for the additional acres it owns from agriculture to quarry usage. Commission members voted 6 to 0 not to change the zoning and cited the inability to predict Roncari's future as their reason. Roncari officials said it would take about 55 years to quarry the whole parcel. Some members of the Commission agreed that they would like to see the quarry expansion occur in smaller steps, rather than one zone change for the whole parcel. The commission was also uncertain about how considerate new owners might be if Roncari sold the operation. The commission chairman indicated the issue would be clarified in a revised town plan.

Dimension.—Dimension granite was quarried in New Haven and Litchfield Counties, and dimension granite and quartzite were quarried in Tolland and Windham Counties. The stone was sold as irregular-shaped stone, rough blocks, and cut stone.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related experience and has covered the mineral activities in Connecticut for the past 6 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Geologist, State Geological and National History Survey of Connecticut, Department of Environmental Protection, Hartford, CT.

[4]Connecticut Construction Industries Association Inc. 1990 Annual Report, p. 4.

[5]"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 in 1990.

[5]ConnStruction. Connecticut's New Hazardous Waste Program. V. 6, No. 4, June/July 1990, p. 16.

[6]———. New Recycling Laws Discussed. V. 6, No. 4, June/July 1990, p. 19.

TABLE 2

CONNECTICUT: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	1,480	$9,363	$6.33
Plaster and gunite sands	8	137	17.13
Concrete products (blocks, bricks, pipe, decorative, etc.)	W	W	5.27
Asphaltic concrete aggregates and other bituminous mixtures-	272	1,272	4.68
Road base and coverings	506	2,570	5.08
Fill	788	2,601	3.30
Snow and ice control	364	1,782	4.90
Other	218	1,405	6.45
Unspecified:[1]			
Actual	1,146	4,489	3.92
Estimated	3,761	14,325	3.81
Total[2] or average	8,542	37,943	4.44

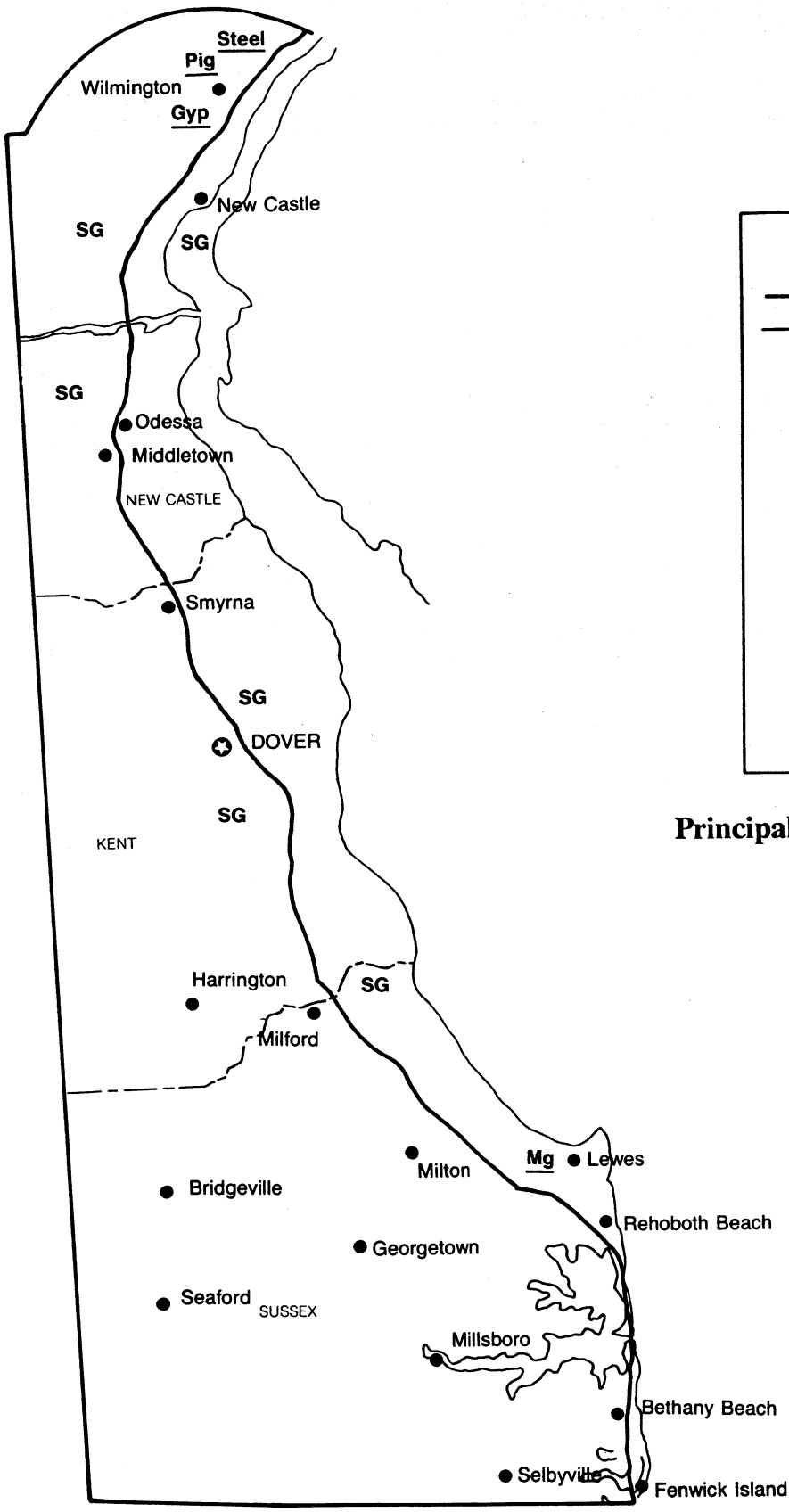
W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[2]Data may not add to totals shown because of independent rounding.

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	Mine and plant	Hartford.
Feldspar:			
The Feldspar Corp.[1]	Box 99 Spruce Pine, NC 28777	Mines and plant	Middlesex.
Sand and gravel:			
Construction:			
Bakerville Lumber and Construction Co.	321 Maple Hollow Rd. New Hartford, CT 06057	Pit	Litchfield.
The Balf Co.	301 Hartford Ave. Newington, CT 06111	Pit	Hartford.
Connecticut Sand and Stone Corp.	7 West Main St. Plainville, CT 06062	Pit and plants	Hartford and Litchfield.
O&G Industries Inc.[2]	23 Casson Ave. Box 907 Torrington, CT 06790	Pit	Do.
R. A. Rawson Sand and Gravel Inc.	R.F.D. 1 Putnam, CT 06260	Pits and plant	Windham.
Industrial:			
U.S. Silica Co. of Connecticut	Box 187 Berkeley Springs, WV 25411	Pit and plant	New London.
Stone (1989):			
Crushed:			
Allyndale Corp.	Box 265 East Canaan, CT 06018	Quarry	Litchfield.
Edward Balf Co.	Box 11190 Newington, CT 06111	do.	Hartford.
O&G Industries Inc.	23 Casson Ave. Box 907 Torrington, CT 06790	Quarries	Litchfield and New Haven.
Roncari Industries Inc.	1776 South Main St. East Granby, CT 06026	Quarry	Hartford.
Tilcon Tomasso 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	do.	New Haven.
Dimension:			
Castellucci & Sons Inc.	West River St. Providence, RI 02904	do.	Do.
R. B. Marriott & Sons Co.	Box 67 Oneco, CT 06373	do.	Windham.
Wayne C. Williams General Construction Inc.	R.F.D. 1, Conklin Rd. Stafford Springs, CT 06076	do.	Tolland.

[1]Also crude mica and industrial sand.
[2]Also crushed stone.

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

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]

The value of construction sand and gravel in Delaware in 1990 was approximately $7.0 million. Magnesium compounds were also produced in the State, but data for that commodity was excluded from the State total to avoid disclosure of company proprietary information.

TRENDS AND DEVELOPMENTS

Mineral-related manufacturing continued to contribute to the State's economic development in 1990. Commodities used in manufacturing included those imported at the Port of Wilmington. Shipments received at the port in 1990 increased for the following: gypsum rock by 10% to 364,000 short tons; salt by 34% to 268,000 tons; magnesite ore by 56% to 75,000 tons; and ilmenite by 36% to 53,000 tons. Steel imports declined from 200,000 tons in 1989 to 126,000 tons in 1990. Total cargo, including fuels, received at the port increased to 4.5 million tons from 3.7 million tons in 1989.

LEGISLATION AND GOVERNMENT PROGRAMS

In 1990, the Delaware General Assembly enacted House bill 391 requiring immediate notification of the discharge of a pollutant. Under the legislation, the Delaware Department of Natural Resources and Environmental Control (DNREC) adopted regulations listing substances to be reported, which included petroleum substances discharged into surface waters, ground water, or on land. The regulations were the most stringent to date, surpassing those contained in the Comprehensive Environmental Response Compensation and Liability Act, the Clean Air Act, or previous DNREC regulations.

The DNREC, Division of Water Resources, was authorized under House bill 368 to develop regulations for extractive use operations or borrow pits. The State's sand and gravel industry was expected to be regulated under this legislation. Public hearings and meetings to formulate the regulations were conducted during 1991, and final regulations were expected in 1992.

House bill 520, which would have removed an exemption that permitted a steel manufacturing plant to remain operating in the coastal zone, was vetoed by the Governor. The legislation, if enacted, would have closed Delaware's only operating steel plant. The legislation was proposed because of a dispute about the reemployment of steelworkers who worked at the plant before it changed ownership in 1988.

The Delaware Geological Survey (DGS) conducted geologic and mineral-related investigations used primarily in land use planning and environmental policies developed by State and local governments. During the year, sand and gravel resources were studied in southern Delaware to determine environments of deposition and possible sources of sand for beach nourishment.[2]

The DGS received $23,500 from the Minerals Management Service of the U.S. Department of the Interior in a cooperative study with the American Association of State Geologists. This study began in 1990 and was aimed at examining the potential for offshore nonfuel mineral resources.

TABLE 1
NONFUEL MINERAL PRODUCTION IN DELAWARE[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$1	NA	$1	NA	$1
Marl (greensand)	short tons	750	10	—	—	—	—
Sand and gravel (construction)	thousand short tons	1,933	5,988	e1,900	e6,200	2,184	6,967
Total[2]		XX	5,999	XX	6,201	XX	6,968

eEstimated. 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 DNREC received a $258,000 grant from the U.S. Environmental Protection Agency to develop a Statewide program to assist business and industry in minimizing wastes.

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 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 1988 and 1990 and estimates for 1989.

In 1990, eight companies operating eight pits reported production of 2.2 million short tons of sand and gravel; in 1988, sand and gravel production was about 1.9 million tons.

Stone.—Delaware is without a crushed stone industry and, therefore, received shipments of stone from other States for use in construction. Crushed stone was trucked into Delaware for construction of a major roadway bypass around Dover and Smyrna. In 1989, BTO Ltd. Partnership proposed building stone depots along rail lines in Camden, Felton, and other sites to supply stone for the bypass construction. However, local government denied rezoning for the depots and the proposal was dropped in 1990.

Metals

Steel.—CitiSteel USA Inc. completed its first full year of operations at the former Phoenix Steel Corp. plant in Claymont. CitiSteel, owned by the China International Trust & Investment Corp., assumed $20.7 million in debts and paid $13.5 million for the mill in 1988.[3]

The mill, which at one time had a 400,000-ton-per-year capacity, produced about 200,000 tons of carbon plant steel in 1990.

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. In 1990, more than 200,000 short tons of municipal solid waste was processed at the facility. Recovered materials included 7,800 tons of ferrous metals, 820 tons of nonferrous metals (primarily aluminum), and 1,250 tons of glass.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related and government experience and has covered the mineral activities in Delaware for 6 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistance.

[2]Groot, J. J., K. W. Ramsey, and J. F. Wehmiller. Ages of the Bethany Beaverdam, and Omar Foundations of Southern Delaware. Delaware Geol. Survey Report of Investigations 47, Newark, DE 19716, 1990, 19 pp.

[3]American Metal Market. CitiSteel USA Showing Profits. V. 98, No. 156, Aug. 10, 1990, p. 3.

TABLE 2
DELAWARE: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	577	$2,267	$3.93
Plaster and gunite sands	W	W	5.11
Concrete products (blocks, bricks, pipe, decorative, etc.)	106	435	4.10
Asphaltic concrete aggregates and other bituminous mixtures	W	W	4.17
Fill	597	1,273	2.13
Snow and ice control	4	17	4.25
Other	363	1,593	4.39
Unspecified:[1]			
Actual	W	W	2.90
Estimated	537	1,383	2.58
Total or average	2,184	[2]6,967	3.19

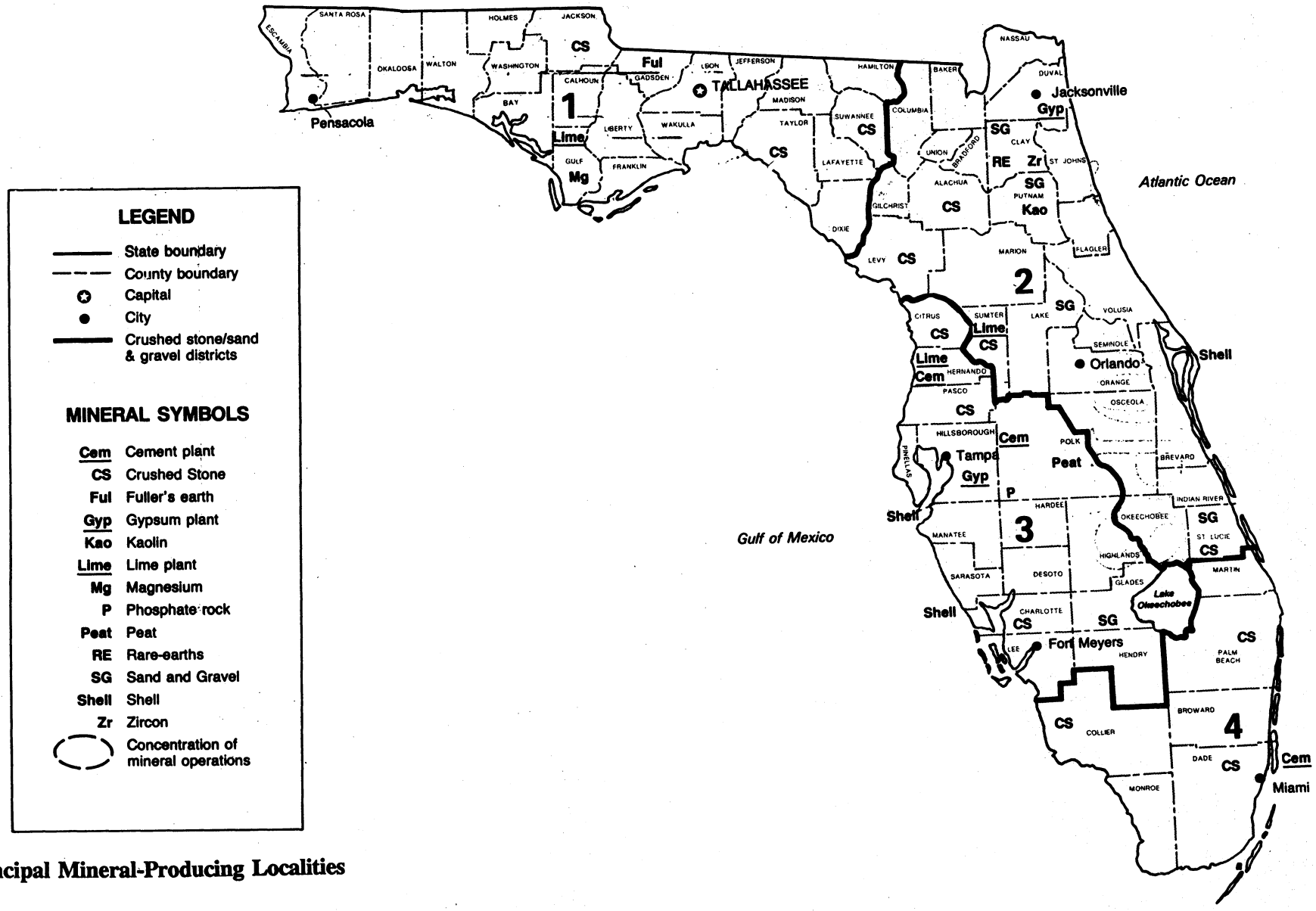
W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[2]Data do not add to total shown because of independent rounding.

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 19805	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.
George & Lynch Inc.	113 West 6th St. New Castle, DE 19720	Dredge	Kent.
Parkway Gravel Inc.	4048 New Castle Ave. New Castle, DE 19720	Pit	New Castle.
Steel:			
CitiSteel USA Inc.	4001 Philadelphia Pike Claymont, DE 19703	Mill (plate)	Do.
Sulfur (recovered):			
Texaco Inc.	Wrangle Hill Rd. Delaware City, DE 19706	Refinery (petroleum)	Do.
Titanium dioxide:			
E. I. du Pont de Nemours & Co. Inc.	1007 Market St. Wilmington, DE 19898	Corporate headquarters	Do.
Do.	Edgemoor, DE 19809	Plant (chemical)	Do.

[1]Also sand and gravel.

FLORIDA



Principal Mineral-Producing Localities

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 James R. Boyle[1] and Walter Schmidt[2]

The 1990 value of nonfuel mineral production in Florida was almost $1.56 billion, a decrease of $44 million below that of 1989. The decline in mineral demand and sales reflected the effects of the recession on most sectors of the State's economy and a downturn in construction activity during much of 1990. A reduction in the output of cement, both portland and masonry, and crushed stone, two major construction mineral commodities, approximately $50 million, was a major reason for the decline in Florida's mineral value.

Despite the reduction in mineral output and value, the State continued as the Nation's leading phosphate rock producer and ranked among the top three States in crushed stone, masonry cement, and peat output. Florida ranked fourth nationally in total mineral value, contributing 4.69% to the $33.3 billion of nonfuel mineral commodities produced in the United States in 1990.

TRENDS AND DEVELOPMENTS

Florida has a multimodal mineral industry, unlike many of the Sun Belt States whose mineral output is used primarily by the construction industry. Approximately 50% of the State's mineral value is derived from the production of phosphate rock, and about 33% comes from the sale of construction mineral commodities, cement, sand and gravel, and stone. This multifaceted production helps to insulate the State's mineral industry from the economic slumps experienced in States where mineral sales are to a limited industrial base.

The year was good for the phosphate industry, but poor for producers of construction mineral commodities. Following the Iraq invasion of Kuwait on August 2, fertilizer prices rose 25% to 40%. Fertilizer exports from the two Middle East countries fell, and China purchased 2.8 million metric tons of fertilizer from the U.S. phosphate industry.[3] Florida, historically, has supplied more than 80% of the U.S. phosphate rock-fertilizer output, and the State's phosphate industry was able to meet the increased demand.

TABLE 1
NONFUEL MINERAL PRODUCTION IN FLORIDA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	411	$25,892	477	$31,231	442	$27,777
Portland	do.	3,682	168,719	4,357	207,857	3,954	186,404
Clays	metric tons	536,922	44,423	[2]563,687	[2]46,941	[2]391,334	[2]39,625
Peat	thousand short tons	266	5,091	235	4,515	252	4,381
Sand and gravel:							
Construction	do.	18,654	53,083	e17,900	e55,500	18,472	59,123
Industrial	do.	636	6,928	681	7,768	520	7,024
Stone (crushed)	do.	e [3]83,200	e [3]374,400	83,995	341,397	e74,000	e317,400
Combined value of clays (common, 1989-90), gem stones, magnesium compounds, phosphate rock, rare-earth metal concentrates, staurolite, stone (crushed marl 1988), titanium concentrates (ilmenite and rutile), and zircon concentrates		XX	713,345	XX	913,054	XX	922,470
Total		XX	1,391,881	XX	1,608,263	XX	1,564,204

eEstimated. 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.

The problems of the construction industry and the producers of construction mineral commodities were twofold. Rampant overbuilding in the early and mid-1980's stimulated by a booming economy produced one of the softest real estate markets in Florida's history. The poor market conditions, coupled with the effects of the recession and changing loan policies resulting from the savings and loan industry scandals, had a negative impact on construction. Construction employment suffered an over-the-year decline of 42,700 jobs or 12.5%. The Florida Department of Labor and Employment Security noted that this was the "largest setback in an overall descent which began in October 1988, and the ninth month posting a negative growth rate in 1990."

Both trends noted are short term and are reversible. However, one long-term, irreversible trend facing the largest sector of Florida's mineral industry is the depletion of high-grade phosphate reserves in the central part of the State and the shift in mining to counties with lower grade reserves south of current mining operations. Historically, Polk County has produced the bulk of the Nation's and a major share of the world's phosphate requirements. By the year 2000, most of the Polk County reserves will have been depleted. The associated chemical plants that process the phosphate rock cannot be relocated because of the enormous investment in each facility and the difficulty in obtaining the necessary permits for a new plant.[4]

Most developments during 1990 were phosphate industry-related. Consolidated Minerals Inc. announced plans to seek the required permits to construct a chemical and associated cement and powerplant complex and phosphate mine in De Soto County. Gardinier Inc. began work on a $5 million project to cover its Hillsborough County gypsum stack and restore former marshlands. Permits for a new gypsum stack in Polk County were obtained by IMC Fertilizer Inc. Royster Phosphate Inc. was granted the permits to begin construction of a new sulfuric acid plant in Manatee County. Nu-West Industries Inc. sold its Manatee County subsidiary, Nu-Gulf Industries, including the Wingate phosphate mine, to Gulf Atlantic Corp.

The Port of Tampa continued as Florida's leading port in terms of tonnage, both foreign and domestic, and ranked ninth nationwide. The five leading commodities shipped through the port in 1990 were minerals or mineral-related products. These included phosphate rock (21.9 million short tons), petroleum (12.3 million short tons), coal (5.8 million short tons), sulfur (4.5 million short tons), and ammonia (1.9 million short tons).

Port Manatee suffered one of the largest declines in income in its 20-year history. Shipments of dry bulk cargo--cement, lumber, phosphate, sand, and steel--were 460,000 short tons below the 1989 level.[5]

EMPLOYMENT

Mining employment averaged 9,600 during the first 6 months of 1990, but decreased to an average of 9,200 during the last half of the year. This was an over-the-year decline of 4.2%.[7]

REGULATORY ISSUES

Wetlands, gypsum stacks, and water "limits" topped the list of regulatory issues directly impacting the State's mineral producers. State law prohibits wetlands destruction unless the company disturbing the acreage can offset environmental damage by building man-made wetlands or protecting swamps elsewhere. However, the Department of Environmental Regulation (DER) permitted almost 2,000 acres of wetland destruction in 1990 and required only 12% to be replaced.

In central Florida, DER turned most of its wetlands protection duties over to the water management district.[8] One water management district postponed votes on wetlands mining regulations because of indecision on which operations would be exempt from the regulations. Proposed regulations would protect wetlands "not being mined or prepared for mining."[9]

In 1989, the DER reported that water seeping through gypsum stacks, a byproduct of phosphate rock processing, was contaminating the aquifer that provides water for 90% of the State's population. The waste contained sulfuric and phosphoric acid, radioactive radium, arsenic, and other toxic substances. The gypsum stacks typically covered 1,000 to 2,000 acres each, and one in Hillsborough County was taller than a 13-story building. In 1988, runoff from this stack killed thousands of fish.[10] Of the 60 phosphogypsum stacks in the United States, approximately one-half are in Florida. New stacks were sited in areas underlain with clay, and a plastic liner was installed at the base of each stack to prevent ground water contamination.[11]

Early in the year, a ruling by the U.S. Environment Protection Agency (EPA) that the phosphate industry did not have to reduce radon emissions from the gypsum stacks took effect. EPA ruled in November 1989 that the emissions were within the acceptable risk of one cancer death per year for every 10,000 people. The ruling was criticized by the environmental community.[12]

Two years of below-normal rainfall and a growing population had State officials considering year-round water restrictions. During the year, restrictions on water usage were either ongoing or put into effect in many of Florida's water management districts. Mineral processing companies using large amounts of process water faced the prospect of curtailed operations.[13]

LEGISLATION AND GOVERNMENT PROGRAMS

Although the Florida Legislature passed no bills that directly impacted the Florida mineral industry, Manatee County officials were involved in a series of legal actions that would directly impact one fertilizer manufacturer. The County Board of Zoning Appeals ruled that Royster Phosphates Inc. did not need a special permit from the County Commissioners to build an acid plant at

the company's fertilizer manufacturing complex at Piney Point. The County Board of Commissioners voted to sue the Board of Zoning Appeals and Royster to block construction. The Commissioners then voted to hire a lawyer to defend the Zoning Board. The Manatee County taxpayers were to pay for both suits.[14]

The Florida Geological Survey (FGS) is charged with the investigation and dissemination of data on the State's geology and mineral resources. During 1990, the Survey continued work, begun in late 1989 under contract to DER, on the aquifer distribution, conditions, and potentiometric surface of the DER Water Management Districts. The first volume was completed, and work on the second was underway.

Staff of the FGS and the Division of State Lands were directed by the Governor and cabinet to review the policies of oil and gas exploration on or over sovereignty submerged lands and in the State's water conservation areas. Several working meetings, workshops, and a public hearing were conducted to gather input. Recommendations were presented to the Governor and cabinet during the year.[15]

The Summer Inservice Institute, a consortium of Florida A&M University, the Florida Geological Survey, the U.S. Geological Survey, the U.S. Bureau of Land Management, and the Florida Department of Education, conducted a geology program for science teachers. The program, "Studies of Geologic and Hydrologic Foundations of Florida's Environment," included 60 hours of instruction.

The Florida Institute of Phosphate Research is a State agency charged with conducting or funding applied research to mitigate the environmental impacts of mining and processing phosphate rock. During the year, the institute sponsored, with the University of Florida, a symposium on natural radioactivity in agricultural products. The institute continued to monitor two county roads constructed by the institute using phosphogypsum. The institute funded a study by the University of Florida on forage crop uptake of radionuclides after gypsum is applied as a soil additive, and in December, an international symposium on uses and recycling of phosphogypsum was sponsored.

FUELS

Petroleum and Natural Gas.—The State dropped to 20th nationally in crude oil and gas output. In 1990, Florida's petroleum and natural gas industry produced 5,674,382 barrels of oil and 7,484,621 thousand cubic feet of casinghead gas. The Jay Field continued as the leading producer with 64% of the oil and 83% of the gas. Six seismic exploration permits were issued to geophysical exploration companies for 83 line miles; 59 were completed at yearend. The work was carried out in Santa Rosa and Okaloosa Counties in northwest Florida. Two gravity survey permits were issued and one was conducted in south Florida by yearend.[6]

Uranium.—"Yellow cake," uranium dioxide, was produced by one company at a plant in Polk County. The oxide was extracted from phosphoric acid and shipped to Oklahoma for the manufacture of fuel rods for the electric generation industry. Production and value are not reflected in table 1.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Florida's mineral producers mined or manufactured 13 industrial minerals, and their sales accounted for more than 95% of the State's total mineral value. Industrial mineral sales topped $1 billion for the 13th consecutive year. Phosphate rock, crushed stone, and portland cement accounted for approximately 84% of the State's total mineral value.

Cement.—Sales of portland and masonry cement accounted for 14% of the mineral value in Florida and combined, ranked third among the 13 mineral commodities produced in-State. Together the two totaled $214 million. Florida again ranked first among the masonry cement-producing States and sixth in the production of portland cement. The State's six cement firms produced 442,000 short tons of masonry cement valued at $28 million and almost 4.0 million short tons of portland cement with a $186 million value. Demand for the two cement types was $25 million lower than in 1989 because the recession had a negative impact on the construction industry and the demand for cement.

Six companies operated plants in Bradenton, Brooksville (two), Fort Pierce, Hialeah, Miami, and Tampa. Three plants produced masonry cement, and all six manufactured portland. The six firms operated eight kilns; five used the dry process and three used the wet.

Imported clinker, primarily from France, Mexico, and Spain, was ground at the Bradenton and Tampa plants. The other plants manufactured clinker from locally mined clay and limestone, and one firm used waste limestone fines from its aggregate operation. Fly ash, bag house dust, and millscale supplied the alumina and iron oxide requirements. Spanish gypsum was used in the final grinding process.

Holnam Inc.'s quarry at Crystal River, FL, completed its first full year of operation in June. Limestone from the quarry was barged to Holnam's cement plant in Mobile, AL. The Crystal River quarry, which cost about $8 million, supplied all of the Mobile cement plant's stone requirements.

Clays.—The State maintained its second place ranking among the 44 States reporting clay output. Clay sales were sixth in ranking among the minerals produced by the State's mineral industry. Clay production, 391,000 metric tons, was 173,000 metric tons below the tonnage reported for 1989. Value paralleled output; $40 million of raw clay was mined in 1990 compared with $47 million in 1989. The industry produced common clay, fuller's earth, and kaolin.

The production of common clay, a clay or clay-like material sufficiently plastic to allow easy molding and vitrification

below 1,100° C, was reported by two firms operating mines in Clay and Lake Counties. Principal sales were to the cement, brick, and lightweight aggregate industries. Common clay output rose 12% and value increased 18%.

Fuller's earth, an absorbent clay, was mined from an area extending from the north Florida Panhandle into southwestern Georgia. Florida's fuller's earth industry, Engelhard Co., Floridin Co., Mid-Florida Mining Co., and Milwhite Co, mined clay from four mines in Brevard, Gadsden, and Marion Counties. Beneficiation included drying and grinding, kiln firing, and screening. Primary sales were to the pet waste, oil and grease absorbent, fertilizer, pesticide carrier, and salt water drilling mud industries. Production was down almost 52,000 metric tons while value decreased $7.1 million below the 1989 level. Although production decreased, the State ranked second nationally in output.

Kaolin, a white clay with many industrial applications because of a platy structure, was produced in Putnam County by the Feldspar Corp. The company mined the deposit with a dredge, producing a sand-clay slurry. Sand was recovered and separated into both industrial and construction fractions. The kaolin was solidified, extruded, and dried. Principal customers were the whiteware, wall tile, and electric porcelain industries. Output, 38,444 metric tons, fell 4,200 metric tons below the 1989 level. Value declined about 5% below that reported in 1989.

Peat.—Florida continued as the second ranked peat producer; the State lost its first place ranking to Michigan in 1989. Florida's peat producers reported a 252,000-ton harvest valued at $4.4 million. The 1990 harvest exceeded the 1989 level by 17,000 short tons; value, however, was $134,000 below that reported by the industry for 1989.

Ten companies produced both reed-sedge and humus peat in a six-county area. Lake County accounted for almost 53% of the tonnage harvested. The majority of the sales was to horticultural establishments.

In midyear, EcoPeat Co., a joint venture between a Maryland company and a Massachusetts company, was formed. EcoPeat then acquired the assets of General Peat Resources LP of St. Petersburg. The St. Petersburg company had obtained contracts with Florida Power Co. (FPC) and Florida Power & Light (FP&L) to supply sufficient peat to produce 312 megawatts of power.

EcoPeat planned to build and operate two 80-megawatt electric generating units near Lake Placid, FL, under contract with FPC. A 40-megawatt oil-burning power unit at Avon Park, FL, was to be retrofitted for peat firing under a 30-year contract with FP&L and was planned to be operational by mid-1995. Two 80-megawatt peat-fueled powerplants were also planned in Palm Beach County, FL, under contract with FP&L.

Assuming that the projects materialize as planned, about 2.5 million annual tons of bone-dry peat would be required to fuel the plants. This would conceptually quadruple current U.S. peat production by the mid-to-late 1990's. The company reported that the peat-fueled powerplants would be economically competitive and environmentally attractive when compared with conventional coal-fired plants.

Phosphate Rock.—Florida ranked first in the Nation in output of phosphate rock, and the industry continued as the principal mineral industry in the State. The State supplied approximately 30% of the world's phosphate rock requirements, and phosphate sales accounted for more than 50% of the State's mineral value. Production of marketable phosphate rock in 1990 decreased almost 9%. Value increased less than 1% over that of 1989, indicating an increase in unit value.

The Florida Phosphate Institute reported phosphate rock output of 35.4 million metric tons produced in 1990. Marketing data, i.e., phosphate rock value, are not collected by the Institute. The U.S. Bureau of Mines combines phosphate rock production and value data for Florida and North Carolina to protect the confidentiality of the data supplied by the single North Carolina producer. Therefore, data reflecting the value of Florida production are not published.

Approximately 90% of the phosphate rock was used for fertilizer manufacture. In 1989, the latest year with available data, fertilizer production consisted of 8.81 million short tons of diammonium phosphate, 1.62 million short tons of triple superphosphate, 1.27 million short tons of phosphoric acid, and almost 1 million short tons of monoammonium phosphate.

Five percent of the phosphate rock was processed into livestock feed supplements in several southeastern plants while the balance was used in the manufacture of a variety of items, including bone china, cleaning products, film, light bulbs, soft drinks, vitamins, and other consumer goods.

Historically, Polk County has accounted for the majority, approximately 80%, of Florida's phosphate rock output, and the fortunes of the phosphate industry in Polk County mirrored the industry as a whole. The decade of the 1980's was the toughest ever experienced by the Polk County phosphate producers. In 1980 and 1981, production totaled 43 million metric tons and 42.8 million metric tons, respectively. Production plummeted to 30.2 metric tons in 1982, recovered to some extent during the following three years, then fell to 29.7 million metric tons in 1986. This triggered massive layoffs, and companies closed mines for months at a time and reduced chemical plant operations to less than the normal 24-hour shift.

The 1980 output of 43 million metric tons was accomplished with 14,620 workers. In 1989, the industry mined 38.2 million metric tons with 9,783 workers, approximately 89% of the tonnage with 67% of the 1980 work force. Enhanced technology and economic necessity trimmed the work force to a minimum.[16]

During 1990, 9 companies operated 16 mines in a 5-county area. Nine mines were in Polk County, three in Hillsborough County, two in Hamilton County, and one each in Hardee and Manatee Counties.

Consolidated Minerals Inc. announced plans for a mine-cement factory-powerplant complex in De Soto County that would produce 4 million short tons of phosphate rock, 2.5 million tons of cement, and 1 million tons of fertilizer annually. The 17,000-acre complex would house a 600-megawatt electrical generating plant and would cost an estimated $1 billion to construct. Local residents and environmental groups opposed the complex.

In August, Gardinier began covering its gypsum stack on the eastern shore of Hillsborough Bay. The 60-year-old stack extended over almost 400 acres and was 200 feet high. The gypsum was covered with high-density polyethylene, plastic overlain with a felt liner, and capped with 165,000 cubic yards of dirt.[17]

Gardinier announced plans to recreate a marsh on a 500-acre site used by the company as a dredge spoil disposal site. The $500,000 project will create "a wide, shallow channel that will meander for nearly a mile through the property, bringing water to areas formerly diked and drained. The channel will restore the original mouth of the Alafia River, closed and rerouted in the 1920's to accommodate shipping." A series of shallow ponds and marshes will be created.[18]

In June, following a lengthy public hearing, the Polk County Commissioners approved IMC Fertilizer's gypsum stack development plan. The new stack, in the western part of Polk County, is expected to reach a height of 200 feet by 1992 and will replace the existing 132-foot stack. The stack will be constructed on 500 acres of once-mined land.

Nu-West Industries Inc. sold its Manatee County subsidiary, Nu-Gulf Industries, which operated the Wingate Creek phosphate mine, to the Gulf Atlantic Corp. The selling price was $17 million, $1 million less than Nu-West paid for the property in 1988. Nu-Gulf's principal assets were the 4,500-acre mine, plant, and a long-term lease for dock facilities at Port Manatee. The mine closed in the summer of 1989 because of low phosphate rock prices.[19]

Nu-Gulf reopened the mine after the sale, but closed it in November in a cost-saving effort to avoid bankruptcy. In December, however, Nu-Gulf and Royster Phosphates Inc. signed a joint-venture agreement that allowed Nu-Gulf to reopen the mine. Under terms of the agreement, Royster agreed to purchase Nu-Gulf and obtained an option to purchase all Nu-Gulf stock.[20]

In August, Estech Inc. completed the shutdown of the Silver City phosphate rock mine in Polk County. The Silver City mine was the second Estech mining operation to close in the past 2 years as phosphate rock reserves were depleted. The company's Watson Mine, also in Polk County, closed in 1989.[21]

Sand and Gravel.—The State ranked 16th of the 50 sand and gravel-producing States, and sand and gravel sales accounted for approximately 4% of Florida's mineral value. Production was reported by 26 companies operating 43 mines in a 20-county area.

Construction.—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 1988 and 1990 and estimates for 1989.

Florida construction sand and gravel statistics are compiled by geographical districts, as depicted in the State map. Table 3 presents end-use data for this commodity in the four Florida districts.

Construction sand and gravel production increased slightly; 17.9 million short tons was estimated to have been produced in 1989, 600,000 short tons below the 18.5 million short tons reported for 1990. Value increased by $3.6 million. The five leading sand and gravel-producing counties were Hendry, Lake, Marion, Polk, and Putnam. The five accounted for approximately 77% of Florida's sand and gravel output. Most of the sand and gravel was shipped by truck (48%), 6% was not transported, and the remainder was unspecified.

Industrial.—Florida ranked 20th among the 38 States with industrial sand production. The State's industrial sand industry produced 520,000 short tons valued at $7 million. This was a decrease of 161,000 short tons and $744,000, respectively.

Production was reported by five companies operating eight mines in Escambia, Glades, Lake, Marion, Polk, and Putnam Counties. Putnam was the leading county in terms of tonnage mined. One operation produced industrial sand as a byproduct of kaolin mining.

The Chemicals Group of PPG Industries of Pittsburgh and Essilor International of France agreed to form a joint venture to manufacture and market Transitions optical plastic photochromic lenses for which industrial sand is the major raw material. The new company, to be headquartered in St. Petersburg, is another example of the increasing use of plastics in ophthalmic applications at the expense of glass. This shift to plastics impacted a major industrial sand market.[22]

Staurolite.—A staurolite concentrate was recovered by E. I. du Pont de Nemours & Co. Inc. as a byproduct of mineral sands processing in Clay County. The primary markets were the foundry, sand blasting, and cement industries. Production and value declined 8% and 11%, respectively.

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 1988 and 1990 and actual data for 1989.

The estimated stone production, 74 million tons valued at $317 million, was 9.9 million short tons and $24 million below the level reported by the State's 84 stone producers in 1989. Despite the decline, Florida remained in second place behind Pennsylvania among the 48 States with stone production. Florida's estimated stone value ranked second

behind phosphate rock in total mineral value and accounted for 20% of the State's total.

In 1989, the last year with a complete industry survey, production was reported from 130 mines in a 29-county area. The five leading counties, Dade, Broward, Hernando, Lee, and Sumter, accounted for more than 70% of the crushed stone output. The stone production consisted of limestone (87%), oyster shell (5%), dolomite (2%), marl (less than 1%), and stone of unspecified type (less than 6%). Three of the 10 largest quarries in the United States were in south Florida. They were CSR Corp.'s FEC quarry, Tarmac America's Pennsuco quarry, and Vecellio & Grogan Inc.'s White Rock quarry.

Limestone output in 1989 was reported by 68 companies operating 102 quarries in 25 counties. The five leading counties, tonnage-wise, were the Broward-Collier-Dade-Lee contiguous-counties area in southern Florida and Hernando County in the east-central part of the State.

In 1989, the major end uses, tonnage-wise, for both limestone and dolomite were for graded road base (26%), concrete aggregate (25%), fine screening (10%), concrete stone sand (9%), and crusher run fill (6%). End uses for 10% were unreported.

During 1989, shell was produced by nine companies operating nine quarries. Production totaled 3.5 million short tons valued at $9.9 million. Unit value was $2.82 per ton. Most of the output was from ancient shell zones in the Hillsborough- Manatee-Sarasota contiguous-counties area in west-central Florida. Shell mining was also reported from Indian River and Palm Beach Counties on the Atlantic Coast and from Orange County near Orlando. Principal sales were for graded road base (37%), crusher run fill (production withheld), and unpaved road surface (6%). Approximately 30% of the end uses was unspecified.

Dolomite, a high-magnesium limestone, was mined by five companies from nine quarries in Jackson, Suwannee, and Taylor Counties in north-west Florida and in Citrus County on the central Florida Gulf Coast. In 1989, production was 1.6 million short tons valued at $8.1 million; unit value was $5.19 per ton. End uses were reported with limestone.

Marl output in 1989 was reported by three companies from three quarries in Collier and Lee Counties in southwestern Florida and from Indian River County on the south-central Atlantic coast. Production, 266,000 short tons valued at $800,000, was used for graded road base.

Approximately 5.6 million short tons of stone valued at $16.6 was not identified by stone type in the 1989 canvass. Major uses for the unidentified stone were graded road base, bituminous, and concrete aggregate.

Sulfur.—Exxon Corp.'s natural gas desulfurization plant in Santa Rosa County was Florida's only sulfur recovery plant. The facility produced and shipped 55,000 metric tons, a decrease from the 67,000 metric tons shipped in 1989.

Other Industrial Minerals.—In addition to the mineral commodities listed in table 1, several minerals were recovered from process streams or shipped into the State for processing into higher value products.

Fluosilicic acid, a byproduct of wet-process phosphoric acid manufacture, was produced by six companies. The acid was sold for several industrial applications, including water purification.

Gypsum, both byproduct and imported, were recovered and/or used by several firms during the year. Imported gypsum was calcined at three plants in Duval and Hillsborough Counties and used in the manufacture of wallboard. Work continued on a wall board plant in Miami. The South Florida Gypsum Co. plant, which will use crude gypsum imported from Spain, was scheduled for completion in 1991.

Nitrogen, recovered by Air Products and Chemicals Inc. at a Pace Junction plant, was used in the production of anhydrous ammonia. Anhydrous ammonia was also produced by Jones Chemical Inc. at a facility in Fort Lauderdale and nitric acid was produced by Nitram Inc. at a Tampa plant.

Perlite was expanded by four firms at plants in Broward, Duval, Escambia, and Indian River Counties. Crude perlite ore was purchased from mines in the Western United States. Sales were to the horticultural, insulation, plaster aggregate, tile, oil-water absorbent, concrete aggregate, and filter aid industries. Output, 23,487 short tons, slightly exceeded the 23,084 short tons reported in 1989. The unit value was $209.05 per ton.

Vermiculite was exfoliated at W. R. Grace plants in Broward, Duval, and Hillsborough Counties and at Schmelzer Sales Co.'s Hillsborough County plant. Crude vermiculite was purchased from mines in Montana, South Carolina, and Virginia. Principal sales were to the concrete aggregate, horticulture, and insulation industries.

Metals

Florida continued as one of the leading metal-producing States in the Southeast. In 1990, the State ranked in the top 25 in metal production.

Iron and Steel.—Florida Steel Corp., one of the top 15 steelmakers nationally, operated minimills at Jacksonville and Tampa. The company had 5 mills and 15 reinforcing steel fabricating plants in the South and was one of the Nation's largest minimill operators.

The company's two Florida minimills, which housed three electric furnaces and one 4-stand and two 2-stand continuous casters, had an aggregate capacity of 603,000 net tons per year. Florida Steel continued work with Carnegie Mellon's Center for Materials Production in Pittsburgh, PA, to determine the cost effectiveness of the CONSTEEL steelmaking process.

Dade County's resource recovery plant, using an updated front-end separation system installed in 1989, recovered almost 8,000 gross tons of postconsumer steel products in the first quarter. Projected recovery was 18,000 tons of recyclable material per week. Much of

the recovered steel products will be sold to the Nation's minimills as head feed for steelmaking.[23]

Mineral Sands.—Dredges were used to recover mineral sands by Associated Minerals (USA) Inc. at Green Cove Springs and E. I. du Pont de Nemours & Co. Inc. at Trail Ridge. Wet mills at the dredge sites upgraded crude ore to approximately 80% mineral content concentrate. When dredged, the ore averaged from 2% to 4% mineral content. The concentrate was trucked to dry mills where electrostatic and magnetic separation were used for the final mineral concentrations. Concentrates recovered included monazite, titanium, and zirconium.

Rare Earths.—A monazite concentrate was recovered at the Associated Minerals' Green Cove Springs plant. The concentrate was shipped to Rhone-Poulence in La Rochelle, France, for processing. A fraction of the processed concentrate was shipped to a company plant in Texas for further processing by the solvent extraction process to recover the light element rare-earth fraction.

Titanium Concentrates.—Concentrates of the titanium minerals, rutile, ilmenite, and leucoxene, were recovered by Associated Minerals and Du Pont. Associated Minerals' dry mill recovered the three titanium minerals as separate concentrates. A rutile concentrate was sold to a Savannah, GA, titanium dioxide plant operated by Kemira OY. Du Pont purchased the ilmenite concentrate for its titanium dioxide pigment plants in Delaware and Tennessee. Kerr McGee purchased the leucoxene concentrate for feed for its synthetic rutile plant in Mobile, AL.

The Du Pont mill produced a concentrate with the three titanium minerals for use in its Delaware and Tennessee plants. Du Pont continued work on its new mine about 10 miles north of the Trail Ridge operation. The new mine will have a production capacity comparable to that of the current mines, about 100,000 metric tons per year of ilmenite-leucoxene concentrate containing about 65% titanium dioxide.

Uranium.—IMC Fertilizer Inc. operated a plant to extract uranium from phosphoric acid. The company's New Wales plant near Mulberry in Polk County produced about one-fourth of the Nation's supply of uranium oxide, termed "yellow cake." The uranium oxide contained about 0.7% U-235, the uranium isotope. Approximately one truckload of yellow cake was sent to a nuclear fuel manufacturing plant in Oklahoma each week.[24]

Zirconia Concentrates.—The two mineral sands companies, Associated Minerals and Du Pont, recovered and marketed a zircon concentrate. Associated Minerals sold its concentrate to grinding plants in New York and South Carolina. After grinding, these facilities sold the milled zircon to the ceramic, refractory, and foundry industries. Du Pont recovered four grades of zirconium concentrate that were sold to the ceramic and foundry industries.

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[1]Former State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. 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]Chemicalweek. Forecast 1991. V. 148, No. 1, Jan. 2, 1991.

[4]Winter Haven News-Chief. Phosphate Mining Heading for a Close by Year 2000. Mar. 31, 1991.

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[22]Industrial Minerals. PPG/Essilor Opthalmics Venture. No. 274, July 1990, pp. 17-18.

[23]American Metal Market. Plant Recovers 590 Tons of Steel Products Weekly. Apr. 13, 1990.

[24]The Tampa Tribune. Bay Area Fuels Nuclear Industry. July 22, 1991.

TABLE 2

FLORIDA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	8,377	$30,906	$3.69
Plaster and gunite sands	249	867	3.48
Concrete products (blocks, bricks, pipe, decorative, etc.)	427	1,489	3.49
Asphaltic concrete aggregates and other bituminous mixtures	125	1,084	8.67
Road base and coverings[1]	W	W	3.17
Fill	635	1,329	2.09
Other	225	708	3.15
Unspecified:[2]			
Actual	2,420	7,781	3.22
Estimated	6,014	14,959	2.49
Total or average	18,472	59,123	3.20

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes road and other stabilization (lime).
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 3

FLORIDA: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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]	681	2,523	6,728	25,452	1,530	4,975	114	312
Asphaltic concrete aggregates and other bituminous mixtures	125	1,084	—	—	—	—	—	—
Road base and coverings[2]	—	—	W	W	—	—	80	160
Fill	55	69	532	1,137	W	W	W	W
Other miscellaneous[3]	—	—	75	343	38	114	78	214
Actual	—	—	1,635	5,329	786	2,452	—	—
Estimated	618	1711	1,646	4,039	3,730	9,143	21	65
Total[4]	1,479	5,387	10,615	36,299	6,084	16,685	293	751

W Witheld to avoid disclosing company propietary data; included with "Other constuction aggregates.
[1]Includes plaster and gunite sands.
[2]Includes road and other stabilization (lime).
[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.

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:			
Engelhard Corp. Specialty Chemicals Div.	Menlo Park Edison, NJ 08817	Mines and plant	Brevard.
The Feldspar Corp., EPK Div.[1]	Box 8 Edgar, FL 32049	do.	Putnam.
Florida Solite Corp.	Box 297 Green Cove Springs, FL 32043	do.	Clay.
Floridin Co.	5380 Capitol Cr. NW Tallahassee, FL 32303	do.	Gadsden.
Mid-Florida Mining Co.	3300 Southwest 34th Ave., Suite 152 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.
Stricklin Peat Inc.			Clay.
TU-CO Peat	9601 Bear Rd. Sebring, FL 33870	do.	Highlands.
Perlite (expanded):			
Airlite Processing Corp. of Florida	Route 2, Box 740 Vero Beach, FL 32960	Plant	Indian River.
Armstrong Cork Co.	Box 1991 Pensacola, FL 35289	do.	Escambia.
Chemrock Corp.	End of Osage St. Nashville, TN 37208	do.	Duval.
W. R. Grace & Co.[3]	62 Whittemore Ave. Cambridge, MA 02140	do.	Broward.
Phosphate rock:			
Agrico Mining Co.	Box 1110 Mulberry, FL 33860	Mine(s) and plant complex	Polk.
CF Industries Inc.	Box 1549 Wauchula, FL 33873	do.	Hardee.

See footnotes at end of table.

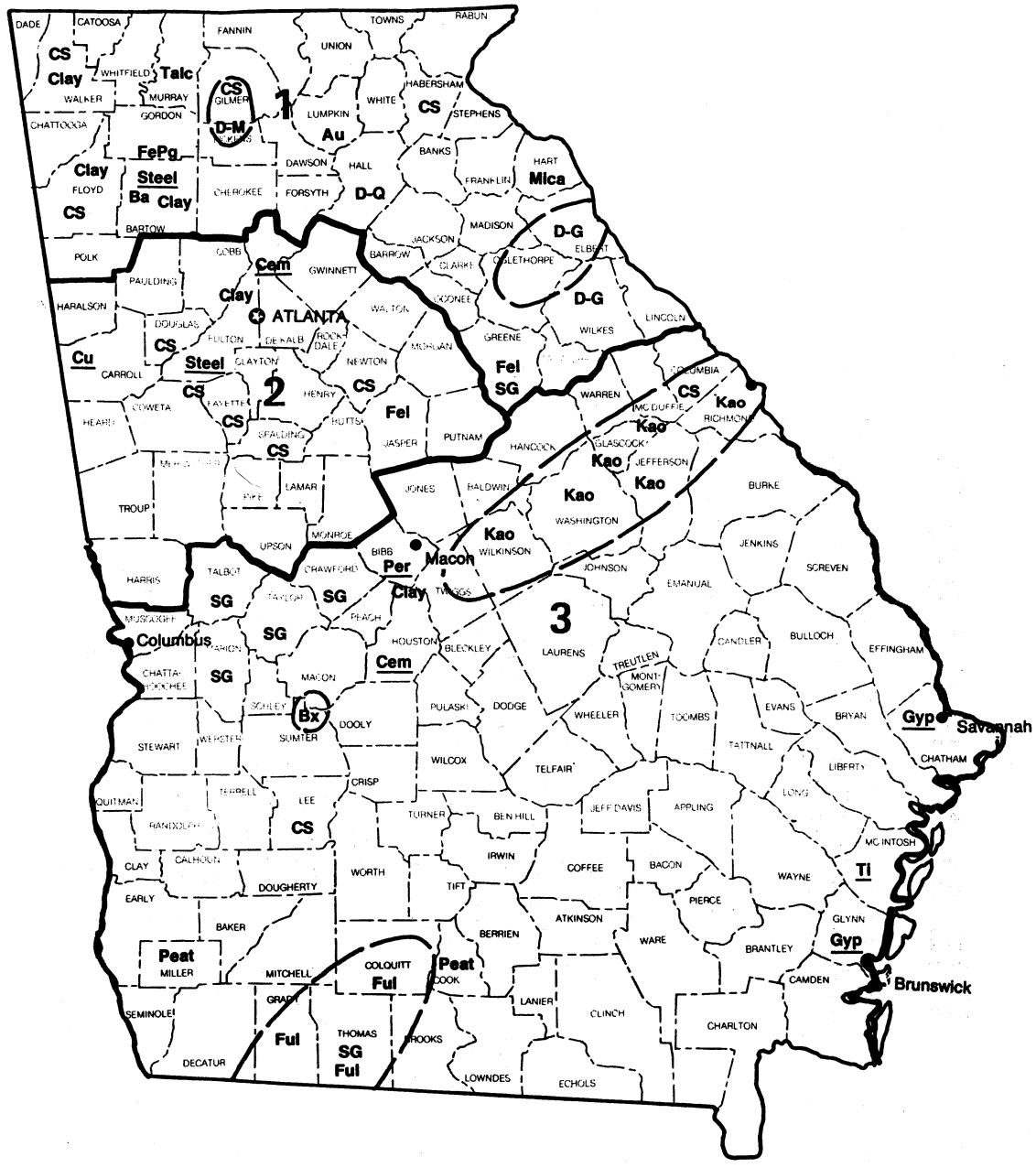
TABLE 4-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Phosphate rock—Continued			
Estech Inc.	Box 208 Bartow, FL 33830	do.	Polk.
Gardinier Inc.	8813 Highway 415 Riverview, FL 33524	do.	Do.
IMC Fertilizer Inc.	Box 867 Bartow, FL 33830	do.	Do.
Mobil Mining and Minerals Co.	Box 311 Nichols, FL 33863	do.	Do.
Occidental Chemical Agricultural Products Inc.	White Springs, FL 32096	do.	Hamilton.
Seminole Fertilizer Corp.	Box 471 Bartow, FL 33830	do.	Polk.
USS Agri-Chemicals Inc.	Box 867 Fort Meade, FL 33841	do.	Do.
Sand and gravel:			
Construction:			
Florida Rock Industries Inc., Shands & Baker.	Box 4667 Jacksonville, FL 32201	Pits and plant	Clay, Glades, Lake, Marion, Polk, Putnam.
General Development Corp.	1111 South Bayshore Dr. Miami, FL 33131	do.	Hendry, St. Lucie, Sarasota.
E. R. Jahna Industries Inc., Ortona Sand Co. Div.	102 East Tillman Ave. Lake Wales, FL 33853	do.	Glades, Lake, Polk.
Silver Sand Co. of Clermont Inc.	Route 1, Box US 1 Clermont, FL 32711	Pit and plant	Lake.
Industrial:			
The Feldspar Corp.	Box 8 Edgar, FL 32049	do.	Putnam.
E. R. Jahna Industries Inc., Ortona	102 East Tillman Ave. Sand Co. Div. Lake Wales, FL 33853	do.	Glades and Lake.
Standard Sand & Silica Co.	Box 35 Davenport, FL 33832	Pit and plant	Polk and Marion.
Staurolite:			
Associated Minerals (USA) Ltd. Inc.[4]	Green Cove Springs, FL 32043	Mine and plant	Clay.
E. I. du Pont de Nemours & Co. Inc.[4]	Du Pont Bldg. D-10084 Wilmington, DE 19898	Mines and plants	Do.
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.	Box 15065 West Palm Beach, FL 33416	do.	Dade.
Vulcan Materials Co.	Box 7497 Birmingham, AL 35253	Quarries and plant	Broward and Dade.

[1]Also construction and industrial sand and gravel.
[2]Also crushed stone.
[3]Also exfoliated vermiculite.
[4]Also titanium concentrates.

GEORGIA



LEGEND

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

MINERAL SYMBOLS

Au	Gold
Ba	Barite
Bx	Bauxite
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
Cu	Copper smelter
D-G	Dimension Granite
D-M	Dimension Marble
D-Q	Dimension Quartzite
Fel	Feldspar
FePg	Iron Oxide pigments
Ful	Fuller's earth
Gyp	Gypsum plant
Kao	Kaolin
Mica	Mica
Peat	Peat
Per	Perlite plant
SG	Sand and Gravel
Steel	Iron and Steel plant
Talc	Talc
Tl	Titanium plant
	Concentration of mineral operations

Principal Mineral-Producing Localities

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]

The value of nonfuel mineral commodities produced in Georgia in 1990 increased to a record high for the eighth consecutive year. The State's mineral industry produced $1.5 billion of industrial mineral commodities, an increase of $108 million over the production reported to the U.S. Bureau of Mines in 1989. Once again, clay was the most valuable commodity produced, with a value of $1.1 billion or 71% of Georgia's total value. Kaolin and fuller's earth, the two leading clay commodities, topped $1 billion in combined value for the first time in 1990. Georgia led the Nation in the value of barite, total clay, fuller's earth, kaolin, natural iron oxide pigments, and synthetic mullite produced. The State ranked second nationally in the value of industrial minerals produced and fourth in the value of total mineral production. No metal production was reported in Georgia for 1991.

TRENDS AND DEVELOPMENTS

The 7.8% increase in the value of mineral production reflected Georgia's strong economic base, which allowed it to maintain a strong position despite the recession that impacted the Nation in 1990. Crushed stone, the second most valuable mineral commodity produced in Georgia, was responsible for a large part of the State's increase in total value. The estimated value of crushed stone rose 20.7% over that of 1989 to a record high $317.3 million. The increase was largely attributable to an increase in the unit price of the stone since the quantity produced increased by only 5.1%. Other contributors to the increase were clay and several of the mineral commodities for which data were withheld to protect proprietary company data.

On June 28, Alabama filed suit in U.S. District Court in Birmingham to prevent the U.S. Army Corps of Engineers from guaranteeing water for future growth of the Atlanta area without fully considering Alabama's needs. In July, Florida joined Alabama's lawsuit, and the Alabama Wildlife Association also filed an intervention plea in hopes of strengthening Alabama's position. The suit stems from Georgia's request for allocation of water from Lake Lanier, Carters Lake, and Lake Allatoona, whose

TABLE 1
NONFUEL MINERAL PRODUCTION IN GEORGIA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	10,274,358	$908,771	9,768,312	$1,004,954	9,855,248	$1,060,539
Gemstones		NA	20	NA	21	NA	20
Sand and gravel:							
Construction	thousand short tons	9,526	30,185	e6,100	e18,900	5,158	16,644
Industrial	do.	W	W	537	7,013	W	W
Stone:							
Crushed	do.	e57,400	e317,200	50,417	262,805	e53,000	e317,300
Dimension	short tons	e190,472	e27,768	[2]145,545	[2]12,087	[2] e147,068	[2] e12,483
Talc and pyrophyllite	do.	23,587	260	W	W	W	W
Combined value of barite, bauxite (1988-89), cement, feldspar, iron oxide pigments (crude), mica (scrap), peat, stone (dimension marble, 1989-90), and values indicated by symbol W		XX	89,621	XX	81,515	XX	88,138
Total		XX	1,373,825	XX	1,387,295	XX	1,495,124

eEstimated. 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 stones; kind and value included with "Combined value" data.

waters flow through or adjacent to Alabama and Florida en route to the Gulf of Mexico. By yearend, there had been little progress in negotiations that began between the States after the suit was filed.

In 1990, Atlanta became the second largest intermodal hub in the United States. Industrial minerals produced throughout the southeastern United States made up a significant part of the cargo passing through Atlanta. Atlanta also served as the hub for much of the intermodal cargo exported and imported through the Port of Savannah. Atlanta's two major railroads, CSX and Norfolk Southern Corp., operated overnight container service to Savannah 5 days per week. However, exports through the west coast ports at Los Angeles and Oakland, CA, achieved significant volume after American President Lines and Norfolk Southern Railroad initiated double-stack train service between the west coast and Atlanta in 1985. The service, originally focused on the transportation of Pacific Rim consumer goods to the southeastern United States, achieved a westbound balance in 1990. Kaolin and aluminum products made up a significant part of the westbound cargo.

The Atlanta Regional Commission was considering six potential sites for the location of a second airport to supplement Hartsfield International Airport, the Nation's second busiest airport. The six sites were within a 50-mile radius of Atlanta, with four of them north of Interstate 20. Announcement of the proposed airport led to increased leasing activity in the vicinities of the proposed sites by aggregate producers.

Corporate changes continued to have a significant impact on Georgia's mineral industry. ECC Group, the British owner of Georgia's third largest kaolin producer, purchased approximately two-thirds of the assets of the State's second largest producer, Georgia Kaolin Corp. (GK), a subsidiary of Switzerland's Asea, Brown, Boveri Ltd. (ABB). ECC initially attempted to purchase all of GK, but a U.S. Justice Department ruling issued on December 30, 1990, restricted the sale. (Additional details are given in the Kaolin subsection.) ABB also sold another of its Georgia-based subsidiaries, Mullite Corp. of America (Mulcoa), to a foreign conglomerate, France's Imetal. Australia's CSR Ltd., the Nation's third largest construction sand and gravel producer in 1990, acquired Cox Sand of Georgia. Reversing the trend of foreign companies acquiring American mineral interests, a Cartersville company, Chemical Products Co., announced that it would construct a strontium carbonate plant in Mexico.

EMPLOYMENT

U.S. Department of Labor (DOL) statistics[3] showed an average of 8,700 persons employed in the mining industry in 1990. This represented a slight decrease from the 8,800 workers listed for 1989. Total nonfarm employment in Georgia increased from 2,941,100 to 2,995,500 during the same period.

U.S. Mine Safety and Health Administration (MSHA) statistics[4] indicated that, at yearend, 9,004 workers were employed at 243 mining and mineral processing sites. The mining industry's largest employer in Georgia was Engelhard Corp., with 2,052 employees at 12 locations. The discrepancy between DOL and MSHA data possibly resulted from DOL including some workers employed at mineral processing plants in its manufacturing category, while MSHA considered them mining workers.

REGULATORY ISSUES

The Federal Government's stated policy of no net loss of wetlands was a matter of concern to several segments of Georgia's mining industry, especially clay, peat, and sand and gravel producers. Many producers felt the broad definition of wetlands being used and the lack of a definitive policy on the reclamation or restoration of wetlands disturbed by mining operations would prevent them from mining undeveloped reserves.

Opposition by local residents and environmentalists to mining operations, especially crushed stone quarries, continued to be a major regulatory issue in Georgia. Existing and proposed mining operations of at least 13 stone producers encountered protests in 9 counties. The Georgia Environmental Protection Division (EPD) settled differences with the U.S. Environmental Protection Agency (EPA) on standards for computer modeling of air emissions. The dispute arose in 1989 when EPA officials claimed the EPD's guidelines for preparation of the model were less stringent than the EPA's. As a result of the settlement, EPD issued air-quality, water-quality, and mining permits for a proposed crushed stone quarry in White County and began requiring computer modeling for all future air discharge permit applications.

Another controversy between the EPA and Georgia occurred when the State set less stringent dioxin limits than those recommended by the Federal agency. Athough the paper industry had reduced dioxin pollution by about 90% as a result of new technology, it still could not comply with the more stringent levels recommended by EPA. At yearend, the EPA had not issued a ruling as to whether or not they would accept the State's standards.

In November, Joe D. Tanner was appointed by newly elected Governor Zell Miller to head the Department of Natural Resources (DNR). Former DNR Commissioner J. Leonard Ledbetter, under pressure from environmental groups, resigned the position in July. Tanner served as DNR's first commissioner from 1972 until 1984, when he was replaced by Ledbetter.

There were 11 hazardous waste sites in Georgia on EPA's National Priority List (NPL). The EPA also maintained a list of sites containing hazardous waste that may require remedial action that are referred to as Wastelan Preremedial Sites. At yearend, EPA's list of Wastelan sites contained 797 locations in 118 of Georgia's 159 counties. Fulton County had 96 potential hazardous waste sites. Superfund (NPL) sites were not included in the Wastelan lists.

Georgia Conservancy reacted to the proposed drilling of five additional

offshore phosphate test wells by threatening lawsuits. The lawsuits would attempt to force a complete Environmental Impact Study (EIS) to determine the effects of offshore mining on the marine environment before allowing the test drilling. The project's supporters contended that such an EIS could delay the proposed drilling by at least 1 year, would cost millions of dollars, and was premature unless and until a mining company applies for an offshore lease. Conservancy members also contended that offshore exploration and mining could deleteriously affect the endangered Northern Right Whale by forcing them to move to less-favorable reproductive habitats.

EXPLORATION ACTIVITIES

The Minerals Management Service (MMS), in cooperation with the Georgia Geologic Survey, successfully completed a test hole off Tybee Island in June, despite opposition from the Georgia Conservancy and other environmental groups. The hole was drilled to help evaluate the potential for offshore mining of potential phosphate deposits off the Georgia coast. Results of the testing were sufficiently encouraging to lead task force members to propose that an additional five holes be drilled in 1991.

Although a permit to mine gold issued to Atlantic Gold Fields Inc., a Halifax, Nova Scotia, firm, was revoked by the EPD in 1990, exploration drilling continued at the company's idle Royal Vindicator Mine. The deposit, 1.5 miles south of Tallapoosa, Haralson County, was acquired by Atlantic and its joint-venture partner, Jascan Resources Inc., Toronto, from U.S. Borax and Chemical Co. in 1987.

LEGISLATION AND GOVERNMENT PROGRAMS

Three laws affecting mineral activity were enacted by Georgia in 1990. Act 1279 amended the Georgia Hazardous Waste Management Act to provide for the preparation of hazardous waste reduction plans and for biennial progress reports by hazardous waste generators. Act 1344 expanded Federal regulations by requiring hazardous waste reduction plans, progress reports, and criteria for evaluation by local governments. Act 1273 prohibited the sale of cleaning agents containing more than 0.5% phosphorus. Georgia became the first State to limit phosphates in detergents, although limits had previously been set by some local governments.

Two lawsuits affecting mineral lease agreements were decided in 1990. In reference to suits filed by a property owner against two crushed stone producers, the Georgia Supreme Court overturned a lower court decision that a mining company had the implied duty to mine rock under the terms of its lease. The second case involved Georgia's mineral lapse statute, which sets the conditions allowing the owner of a property's surface-only rights to claim title to the mineral rights if the minerals are not being mined. The court ruling clarified the conditions that must be met in order for the mineral-rights owner to satisfy terms of the statute by paying taxes on the mineral rights.

The Georgia Geologic Survey completed fieldwork on two Accelerated Economic Mineral Program projects. Geologic mapping and sampling were finished on east-central Georgia gold deposits, and several areas were investigated and mapped to identify potential deposits of heavy-mineral sand. EPD regulated more than 490 surface mining operations, including 78 crushed stone quarries, 64 in-stream sand dredging operations, and 151 kaolin pits during 1990. The DNR collected more than $205,000 in fines from 20 facilities for violations of environmental laws. Reclamation of an abandoned open pit coal mine on Lookout Mountain in extreme northwestern Georgia was completed in May using forfeited bond monies. The land had been partially reclaimed before the mining company ceased to exist. This was the last coal mine reclamation for which Georgia had an obligation under the Surface Mining Act. The Federal Government assumed responsibility for reclamation of all remaining coal mines under the Surface Mine Reclamation Act.

The Interstate Mining Compact Commission (IMCC) established an Interstate Coalition on Mine Waste to give EPA information of mine waste programs pursuant to subtitle D of RCRA. Georgia was one of nine States declining to join the coalition.

EPD received a $300,000 grant from EPA to improve pollution prevention efforts started in 1989. In conjunction with Georgia Institute of Technology, EPD will assist private companies research waste-reduction technologies. Work with 10 high-priority companies began in 1990.

The University of Georgia received $134,387 for marine minerals technology research from the Minerals Research Institute (MRI). MRI is funded by the U.S. Bureau of Mines and contributed more than $4.8 million to 18 universities in 1990.

Projects at the Tuscaloosa Research Center of the U.S. Bureau of Mines included a study of the dewatering of fine-particle mineral slurries based, in part, on Georgia kaolin slurries. The Resource Evaluation Branch of the Bureau's Denver Field Operations Center reviewed Draft Environmental Impact Statements for several projects in Georgia. Bureau personnel note the types and locations of potential mineral deposits that might be impacted by the projects. Projects reviewed in 1990 included proposed highway construction projects in Bartow, Catoosa, Cherokee, Forsyth, Gwinnett, Newton, Rockdale, Walton, and Walker Counties and a pumped-storage facility at the Richard B. Russell Dam and Lake on the Georgia-South Carolina border. The Bureau's Salt Lake City Research Center continued to evaluate phosphate and heavy-minerals samples from offshore Georgia and South Carolina and to develop methods for recovering the minerals.

U.S. Geological Survey projects affecting Georgia included an overview of industrial minerals of the U.S. Atlantic and Gulf of Mexico Coastal Plains and a

study of heavy-mineral placers at the Fall Zone.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

All of the nonfuel mineral commodities produced in Georgia were industrial minerals. Fourteen industrial mineral commodities were mined in 1990, and eight others were produced from raw materials mined within the State or shipped in. Georgia ranked third nationally both in the value of industrial mineral production and in the variety of industrial mineral commodities mined.

Barite.—Georgia ranked first nationally in the value and second in the quantity of barite produced. Barite was produced by two companies, Cyprus Industrial Minerals Corp. and New Riverside Ochre Co., near Cartersville. The Cartersville Mining District is the oldest continuously active mining district in the United States. Mining of gold began about 1835, and barite has been mined in the district since 1887. All of the barite mined in 1990 was used by the chemical and the industrial filler and pigments industries.

Bauxite.—Bauxite production was not reported to the Bureau in 1990. Bauxitic material, a natural mixture of bauxitic kaolin and bauxite with a very low iron oxide and alkali content, was mined by two companies, American Cyanamid Co. and Mulcoa. The deposits occur within the Lower Paleocene Nanafalia Formation in the Coastal Plains Province of southwestern Georgia. American Cyanamid's production of bauxitic kaolin was used in the manufacture of alum, and Mulcoa used the material in the production of synthetic mullite.

Cement.—Both masonry and portland cement were produced by two companies, Blue Circle Inc. in Atlanta and Medusa Corp. in Clinchfield, Houston County. Georgia ranked 11th in quantity and 10th in value of masonry cement, which was produced in 33 States, and 20th in quantity and 21st in value of portland cement, which was produced in 38 States. Both companies produced Types I and II portland cement for general use and Type III high-early- strength cement. Blue Circle also produced Type IV cement for applications requiring low heat of hydration.

Clays.—Georgia once again led the Nation in both the volume and the value of clays produced. Clay was mined in 19 of Georgia's 159 counties with three types of clay, common clay, fuller's earth, and kaolin, produced.

Common Clay and/or Shale.—Common clay was mined at 14 locations by 10 companies in 9 counties. Although the quantity of common clay produced declined by 3.7% from that produced in 1989, its value increased by 2.5% as a result of higher unit prices. The leading producers were Boral Bricks Inc. in Richmond County, Atlantic Cement Div. of Blue Circle Industries in Douglas and Fulton Counties, Bickerstaff Clay Products Co. in Columbus and Floyd Counties, and General Shale Products Corp. in Floyd and Fulton Counties. Major uses of common clay were in the manufacture of common brick, portland cement, face brick, ceramic floor tile, and wall tile. Other end uses included quarry tile, flue linings, glazes, glass, and enamels.

Fuller's Earth.—In 1990, Georgia once again led the Nation in both the quantity and value of fuller's earth mined. Georgia accounted for more than 28.1% of the tonnage and 32.5% of the value of fuller's earth produced nationally in 1990. Two types of fuller's earth were produced, attapulgite (palygorskite) in Decatur and Thomas Counties and montmorillonite in Houston, Jefferson, and Thomas Counties.

The attapulgite occurs in a belt extending from Meigs, GA, to Quincy, FL. Almost 85% of the Western World's production of attapulgite in 1990 was mined from this belt.[6] The fuller's earth is found as discontinuous beds and lenses of montmorillonite, attapulgite, and sepiolite, with lesser amounts of silica in the form of diatoms, opaline nodules, and sand. The fuller's earth forms part of the marine sediments constituting the Miocene Torreya Formation, a member of the Hawthorne Group. Attapulgite was mined in the northern part of the belt by Floridin Co., a subsidiary of U.S. Silica Co. that is owned by England's Rio Tinto-Zinc Corp. PCL, and by Oil-Dri Corp. of Georgia. Floridin produced principally absorbents with lesser amounts of gellants, while Oil-Dri produced a wide variety of products in granular or powder form. Attapulgite was mined in the southern part of the belt by Engelhard Corp. and by Milwhite Co. Inc. Both companies produced a variety of absorbent and gellant products.

Montmorillonite was mined in the northern part of the belt by Waverly Mineral Products Co., a subsidiary of England's Laporte Industries, for use in the absorbents market. Montmorillonite was also mined in Houston and Jefferson Counties by Medusa Aggregates Co. and by Georgia-Tennessee Mining and Chemical Co., a subsidiary of Hartz Mountain Corp. Another major pet absorbent manufacturer, Excel International Inc., Santa Barbara, CA, announced plans to mine fuller's earth to produce animal waste absorbents at a plant to be built near Wrens. The fuller's earth in this area occurs in the Eocene Twiggs Clay Member of the Dry Branch Formation as montmorillonite with crystallized silica and lesser amounts of kaolinite and illite.

Kaolin.—Georgia continued to rank as the principal producer of high-grade kaolin products in the world. In 1990, the State accounted for more than 30% of the world's estimated production. More than 2.8 million metric tons of kaolin valued at almost $428 million was exported to over 30 foreign countries. Georgia kaolin exports accounted for 1.6 million tons (57%) of the total. The quantity of kaolin produced increased 2.2% over that produced in 1989 to 7.7 million metric tons, and its value

increased by 3.8% to $981,000. Kaolin was mined by 19 companies at 71 pits in 9 counties. Table 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 Bureau's 1990 Clays Annual Report, which also contains a breakdown of kaolin exports. Kinds of kaolin sold or used by producers with their quantities produced in million metric tons and values were: water washed, 4.1 million metric tons, $464.7 million; calcined, 1.1 million metric tons, $306.1 million; delaminated, 1.3 million metric tons, $160.5 million; air-float, 0.9 million metric tons, $40.3 million; and unprocessed, 0.2 million metric tons, $9.1 million. Both low-temperature filler and high-temperature refractory grades are included in the calcined kaolin.

Engelhard Corp. remained Georgia's leading kaolin producer in 1990. However, ECC America Inc. took a major step toward challenging Engelhard for the lead in kaolin production when it acquired a majority of Georgia Kaolin Co.'s (GK) assets. ECC endeavored to purchase all of GK for a reported[7] $520 million, but the U.S. Justice Department ruled that part of the transaction violated fair trade laws and allowed ECC only part of the purchase. Included in the sale to ECC were GK's pits and two plants near Sandersville in Washington County, its pits in Jefferson and Warren Counties, and its high-solids plant near Wrens. GK's corporate offices in Macon and its Carbonates Div. with precipitated calcium carbonate operations in Washington, Oregon, South Carolina, and Saskatchewan, Canada, also became part of ECC. Excluded from the sale were GK's operations at Dry Branch, which were retained by GK's parent company ABB and reorganized as the Dry Branch Kaolin Co.

Feldspar.—Georgia ranked fourth nationally in both the tonnage and the value of feldspar produced. The value of feldspar produced was virtually unchanged from that of 1989, although the quantity produced was slightly less. 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.

Iron Oxide Pigments.—Georgia once again in 1990 led the Nation in the value, which increased slightly over that of 1989, of iron oxide pigments mined. New Riverside Ochre Co., the State's only producer of natural iron oxide pigments, 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% manganese 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.—Georgia ranked second nationally in the value of mica produced and tied with South Carolina for second place in the tonnage mined. Production, both quantity and value, was essentially unchanged from that of 1989. Franklin Mineral Products Div., Mearl Corp., was one of eight integrated suppliers of mica products in the United States in 1990. The company operated a mine and wet-grinding facility near Hartwell in Hart County to supply mica for the high-end markets, such as performance coatings, rubber, and pearlescent pigments. Concentrate from the plant was also shipped to the company's plant at Franklin, NC, for final processing.

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 1988 and 1990 and estimates for 1989.

Georgia construction sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 6 presents end-use statistics for Georgia's three districts.

Construction sand and gravel was a minor factor in Georgia's mineral industry, accounting for only 1% of the value of mineral commodities produced in 1990. Consequently, the State ranked 43d nationally in both the volume and the value of construction sand and gravel produced. Forty-two companies operated 45 plants and 51 pits in 33 counties during the year. The leading companies, ranked by annual production, were Atlanta Sand and Supply Co., The Morie Co. Inc., Brown Brothers Sand Co., Florida Crushed Stone Co., and Atlas Sand & Gravel Co. These five companies produced 39% of the quantity and 38% of the value of construction sand and gravel in 1990. Ninety percent of the total production was attributable to only one-half of the companies. Major uses of construction sand and gravel are summarized in table 5.

Industrial.—The value of industrial sand and gravel produced in Georgia was almost unchanged from that of 1989, although the quantity produced dropped by almost 5%. Nationally, the State ranked 20th in value and 21st in quantity when compared with the 38 States producing industrial sand and gravel. Three companies, Atlanta Sand and Supply, The Morie Co., and Florida Crushed Stone, accounted for all of the State's production. Major uses of industrial sand and gravel in 1990 were glass containers, blasting sand, ground fillers, and filtration sand. The 4 products accounted for the end use of more than 95% of the sand produced. 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.

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 1988 and 1990 and actual data for 1989.

Crushed.—Crushed stone continued to be Georgia's second most valuable mineral commodity, accounting for an estimated 21.2% of the total value produced. Georgia led the Nation in the quantity and value of granite quarried for crushed stone, while it ranked fourth in value and eighth in the quantity of all varieties of crushed stone produced. The aggregate industry's hopes for increased crushed stone production in future years were diminished because the legislature failed to enact a proposed gasoline tax increase to fund an accelerated highway and bridge construction program. Preliminary work on authorized projects such at the outer belt around Atlanta continued in 1990, although construction was not expected to begin before 1992.

The major producers of crushed stone were Beazer USA with two Georgia subsidiaries, Davidson Mineral Properties and The Stoneman Inc.; Blue Circle Aggregates Inc.; Florida Rock Industries Inc.; Martin-Marietta Aggregates Inc.; and RCM Holdings USA Ltd.

Newfoundland Resources and Mining Ltd. (NRM) established a 100,000- to 150,000-ton stockpile at the Port of Savannah as part of its new venture to sell crushed limestone to markets along the Eastern United States seaboard. The company also maintained a similar stockpile and its own docking and loading facilities at the Port of Philadelphia. NRM, a subsidiary of United Kingdom-based Explaura Holdings PLC, supplied material meeting American Society for Testing and Materials 57, 67, 87 aggregate specifications and minus 3-inch base material at a price competitive to local markets. NRM also investigated the feasibility of supplying a high calcium (99.9%-purity) to the chemical and flue gas desulfurization markets.

Ground calcium carbonate (GCC) for the paint, plastics, and paper markets was produced by Georgia Marble Co. from its underground marble mine at Tate, Pickens County. The company also produced a dolomitic marble from underground mines near Whitestone on the Pickens-Gilmer Counties line. This material was used as decorative chips for architectural applications and in carpet backing. GCC was also produced by ECC America at a plant in Cartersville, Bartow County, which was permanently closed in December. The plant used crushed marble shipped in by rail from ECC's quarry at Gantts Quarry, AL. The Specialty Products Div. of Franklin Limestone Co. produced GCC from limestone shipped from Franklin's quarry at Anderson, TN. The limestone was ground at the company's plant near Dalton, Whitfield County, and used in the manufacture of carpet backing, PVC flooring, caulking and sealing compounds, and polymer cement. Dolomitic marble from the Whitestone area was also ground at the plant for use in the manufacture of carpet backing by Filler Products Inc. at Chatsworth, Murray County.

Dimension.—Georgia ranked second in the quantity and third in the value of dimension stone produced in 1990, but led the Nation in both the quantity and value of dimension marble quarried. Estimated production decreased slightly in 1990, largely as a result of the recession impacting the Nation.

In 1990, 101 firms, 30 of which operated quarries, were members of the Elberton Granite association. Several new and modified systems were being used in Elberton granite quarries to free large blocks from the area's extensive granite deposits. Jet burners, which burn a pressurized mixture of fuel oil and air, have long been the preferred mechanism for cutting the massive blocks. The air burner produces an 1,800° F flame that differentially expands crystals in the granite causing it to break apart. However, revised MSHA regulations will restrict the use of handheld air burners because of excessive noise.

Two new systems developed to meet the new MHSA requirements are an automatic burner and an oxygen burner. The automatic burner is a self-contained track mounted system operated by computerized controls. The operator can leave the area, thus meeting the new MSHA regulations, once the system is activated. Fail-safe controls stop the operation if the unit malfunctions or has problems. The oxygen burner was used extensively in the mid-1950's but was discontinued because of high operating costs, especially the cost of oxygen. New modifications to meet the new noise requirements and a significant decline in the cost of oxygen have made the oxygen burner viable again.

Other systems that meet the noise regulations are high-speed drills that have been in limited use in the area since 1982. Improved tungsten carbide-tipped drill bits have reduced drilling costs and increased penetration rates to 3 to 4 feet per minute. The drilling system includes a pneumatically powered vertical slot drill used to free the back side of the quarry blocks and a hydraulically powered liner drill for preparing holes horizontally along the front of the blocks. Also included is an improved dust collection system. Diamond wiresaws are also being used in conjunction with burners. Burners are used to channel the back of the block if it is between walls. The wiresaw consists of a diamond impregnated loop of cable on a system of pulleys and wheels that simultaneously cuts the granite on the top, bottom, and back of the loop. Production rates of 35 to 40 square feet per hour have been reported using the wiresaw system.

Talc.—Georgia's talc production decreased significantly in 1990. Nationally, the State ranked 8th in volume and 10th in value of 11 States reporting talc production. Southern Talc Co., a subsidiary of United Catalysts Inc., suspended mining operations at the company's underground mines near Chatsworth in December. At yearend, Southern's dry-grinding and froth-flotation plant was still operating using stockpiled local talc blended with ore shipped in from Montana.

Other Industrial Minerals.—The only other industrial mineral commodities mined in Georgia in 1990 were gem stones and peat. The State remained a minor gem stone producer, ranking 32d nationally in the value of gem stones produced. Amethyst was the principal variety produced, with most of the production coming from a mine operated by Dan Quillan Co. in Greene County. Peat was produced by one company, the Hyponex Corp. in Cook County. Both the quantity of peat produced and its value remained nearly unchanged in 1990, allowing Georgia to maintain its ranking of 13th and 14th in the respective categories.

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. Included in this group are aragonite, brucite, celestite, gypsum, expanded perlite, rutile, slag, and exfoliated vermiculite.

Kemira Inc. used aragonite imported from the Bahamas for acid neutralization at its titanium dioxide pigment plant in Savannah. The company also used rutile from Florida and foreign sources and titanium-rich slag from Canada to manufacture the TiO_2 pigments and produce byproduct gypsum. 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 Building Products 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. The Specialty Products Div. of Franklin Limestone Co. ground calcined gypsum for use in flame and smoke suppressants at its Dalton plant. Limestone and alumina trihydrates (ATH) were also ground and blended at the plant for use in fire retardant materials. ATH was also used in the manufacture of reinforced plastics. Brucite and ATH were ground for use in fire retardants by Filler Products Co. at Chatsworth, Murray County.

Celestite, imported from Mexico by Chemical Products Corp. (CPC), Cartersville, was processed to manufacture strontium chemicals for the glass industry. CPC began construction of a plant to manufacture strontium carbonate in Reynosa, Tamaulipas, Mexico. The plant was expected to be similar in size and design to CPC's Cartersville plant, which reportedly[6] has a capacity of about 22,000 metric tons of $SrCO_3$ per year. The Cartersville plant also has a production capacity of about 9,000 tons per year of strontium nitrate.

Georgia has two plants that require salt in their production of chlorine. Brunswick Pulp and Paper Co., Brunswick, Glynn County, required 63,000 short tons of imported salt for its plant, which has a production capacity of 36,000 short tons of chlorine. Olin Corp., Augusta, Richmond County, required 201,000 short tons of purchased salts for its 115,000-short-ton capacity plant. The plant produced chlorine and caustic soda. Iodine chemicals were produced by three companies, Ajay Chemicals Inc. at Powder Springs, Cobb County; Diversey Wyanndotte at Tucker, De Kalb County; and Yes (formerly Natrochem) at Savannah.

Georgia ranked fifth of 33 States in the production of expanded perlite. Both the quantity and value of expanded perlite were unchanged from that produced in 1989. Armstrong World Industries Inc. was Georgia's lone producer of expanded perlite, which was imported from Greece and used in the manufacture of acoustic tile at its plant in Macon, Bibb County. Exfoliated vermiculite was also produced by only one company, Anitox Corp., from a plant at Buford, Gwinnett County. The vermiculite was used as a horticultural medium and fertilizer carrier. Georgia continued to rank in the lower two-thirds of 20 States producing expanded vermiculite, although production increased significantly in 1990.

Metals

Metal production from Georgia was not reported to the Bureau in 1990, although it was possible that a minor amount of gold may have been produced as a byproduct of some of the sand and gravel operations in the Piedmont Province. Seven companies were permitted by the Georgia Department of Natural Resources to mine gold in 1990. All were small producers of construction sand and gravel that recovered small amounts of gold using water separation methods. Gold in Georgia occurs in two belts. The Dahlonega belt runs along the Appalachian foothills from the Cleveland area in White County toward Bremen in Haralson County and into Alabama. The Slate belt, which is being mined in South Carolina, is further south in the Piedmont Province and covers an area bounded by Lexington, Oglethorpe County; Thomson, McDuffie County; and Union Point, Green County.

Numerous metals such as copper, corundum, gold, iron ore (limonite and hematite), lead, manganese, pyrite, and silver have been mined in Georgia but are not economically viable under present economic conditions. However, metal products are commonly manufactured in the State from metallic ore or concentrates shipped into the State or from recycled metals.

Southwire Corp., one of the Nation's leading producers of aluminum and copper cable, made two major acquisitions during the year. Its headquarters and primary production facilities are at Carrollton, Carroll County. Early in 1990, Southwire purchased National Intergroup Inc.'s 54% interest of their jointly owned aluminum smelter in Hawesville, KY, ending the joint venture that was formed in 1968. In June, Southwire announced that it, together with an international array of metal interests, had acquired AT&T-Nassau Metals Corp. of Gaston, SC. Southwire will control 55% of the operation, with the rest divided between American subsidiaries of Tokyo's Mitsubishi Metals Corp., Sweden's Trelleborg AB, and the Bank of

Montreal. The acquisition will bring Southwire's annual copper rod production to about 750 million pounds, making it the country's largest copper scrap consumer and rodmaker.[9]

Another major metal producer in Georgia, Atlantic Steel Co., began dismantling casting equipment in Atlanta as part of an effort to consolidate its wire, rod, and bar manufacturing in Cartersville. Rolling operations were expected to continue in Atlanta until the site is sold or redeveloped under a joint-venture arrangement. The company plans to convert two three-strand Concast casters in Atlanta into a single six-strand unit in Cartersville. In October, Atlantic unveiled a new scrap management system developed by International Mill Services Inc. (IMS) of Philadelphia at its Cartersville plant. The IMS system utilizes specially designed mobile equipment, portal cranes, and computerized scales to determine amounts of specific types of scrap needed by the melt shop. In another transaction involving steel, an Atlanta company, Central Metals Co., bought J.T. Knight, also in Atlanta, to become the largest scrap processor in Georgia.

Other metal producers in Georgia included Bliss and Loughlin Steel Co., which operated a cold-finish carbon steel bar mill in Cartersville. Southern Zinc operated a smelter and refinery producing zinc dust, zinc oxide, and zinc slabs in Atlanta.

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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 Georgia since 1989. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

[2]Principal geologist, Georgia Geologic Survey, Environmental Protection Div., Georgia Department of Natural Resources.

[3]U.S. Department of Labor, Bureau of Labor Statistics. Employment and Earnings. V. 38, No. 5, May 1991.

[4]U.S. Department of Labor, Mine Safety and Health Administration. Metal/Nonmetal Mine Safety and Health. Jan. 2, 1991.

[5]Post Herald (Birmingham). EPA Can't Force State To Comply On Dioxin, Reilly Says. July 13, 1990.

[6]Industrial Minerals (London). Industrial Minerals 1990--Clay. No. 285, June 1991, p. 596.

[7]Mining Journal (London). ECC Returns to Core. V. 314, No. 8076, June 22, 1990, p. 506.

[8]Mining Engineering. Industrial Minerals 1990--Strontium. V. 43, No. 6, June 1991, p. 613.

[9]American Metals Market. Buy May Give Southwire Stronghold in Copper Wire Rod, Scrap Recycling. V. 98, No. 115, June 13, 1990.

TABLE 2
GEORGIA: FULLER'S EARTH SOLD OR USED BY PRODUCERS, BY KIND

(Thousand metric tons and thousand dollars)

Kind	1987		1988		1989		1990	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Attapulgite	337	22,770	393	26,931	894	85,052	745	95,171
Montmorillonite	199	12,433	191	12,472	988	80,643	1,563	128,475
Total	536	35,213	584	39,403	1,882	165,695	2,308	223,646

TABLE 3
GEORGIA: KAOLIN SOLD OR USED BY PRODUCERS, BY COUNTY

County	1989			1990		
	No. of mines	Quantity (thousand metric tons)	Value (thousands)	No. of mines	Quantity (thousand metric tons)	Value (thousands)
Richmond[1]	3	407	$23,071	3	405	$14,281
Twiggs	6	1,865	263,104	6	2,146	272,418
Washington	5	2,494	292,285	5	2,764	289,179
Wilkinson	5	965	176,656	4	1,059	147,419
Other[2]	6	1,263	115,634	9	1,287	257,498
Total[3]	26	6,994	870,750	27	7,661	980,795

W Withheld to avoid disclosing company proprietary data; included in "Other"
[1]Includes Jefferson County.
[2]Includes Columbia, Houston, Macon, Sumter, and Warren Counties.
[3]Data may not add to totals shown because of independent rounding

TABLE 4
GEORGIA: KAOLIN SOLD OR USED BY PRODUCERS, BY USE

(Metric tons)

Use	1989	1990
Domestic:		
Adhesives	26,359	41,735
Chemicals	W	W
Fiberglass and mineral wool	293,023	243,754
Firebrick,blocks and shapes	31,803	6,728
Floor, wall tile, and ceramics	W	W
Paint	218,406	225,879
Paper coating	2,568,846	2,753,171
Paper filling	1,542,402	1,452,615
Plastics	40,547	54,906
Rubber	97,186	58,903
Sanitary ware	33,018	39,042
Whiteware		
Other	1,098,945	1,193,636
Exports	1,543,987	1,590,566
Total	7,494,522	7,660,935

W Witheld to avoid disclosing company proprietary data; included in "Other."

TABLE 5

GEORGIA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	2,357	$7,266	$3.08
Plaster and gunite sands	177	457	2.58
Concrete products (blocks, bricks, pipe, decorative, etc.)	W	W	3.61
Asphaltic concrete aggregates and other bituminous mixtures	48	75	1.56
Fill	35	94	2.69
Railroad ballast	2	10	5.00
Other[2]	54	391	7.24
Unspecified:[3]			
Actual	1,961	6,118	3.12
Estimated	523	2,234	4.27
Total or average	5,158	16,644	3.23

TABLE 6

GEORGIA:[1] SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	W	W	W	W	2,027	5,825
Plaster and gunite sands	—	—	—	—	177	457
Concrete products (blocks, bricks, etc.)	—		—	—	W	W
Asphaltic concrete aggregates and other bituminous mixtures	—	—	—	—	48	75
Fill	—	—	—	—	35	94
Railroad ballast	—	—	—	—	2	10
Other miscellaneous	50	200	280	1,240	55	390
Unspecified:[2]						
Actual	239	753	23	77	1,527	4,744
Estimated	244	1,217	—	—	279	1,018
Total[3]	533	2,170	303	1,317	4,151	12,612

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Excludes 171,091 short tons valued at $544,069 not reported by county.
[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.

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:			
Cherokee Brick & Tile Co.	Box 4567 Macon, GA 31213	Open pit mines and plants	Bibb.
Boral Bricks Inc.	Box 1957 Augusta, GA 30903	Open pit mines	Bibb and Richmond.
Bickerstaff Clay Products Co.	Box 1178 Columbus, GA 31993	Open pit mines and plants	Floyd, Fulton, Muscogee.
Fuller's earth:			
Oil Dri Corp. of America	Box 200A Ochlocknee, GA 31773	do.	Thomas.
Waverly Mineral Products Co.	Box 106 Meigs, GA 31765	do.	Do.
Georgia Tennessee Mining & Chemical Co.	Box 307 Wrens, GA 30833	do.	Jefferson.
Kaolin:			
Engelhard Corp.	Box 37 Gordon, GA 31031	do.	Decatur, Washington Wilkinson.
Georgia Kaolin Co., a subsidiary of CE Minerals	Box 1504 Milledgeville, GA 31061	do.	Various.
Anglo American Clays subsidiary, ECC America Inc.	Box 471 Sandersville, GA 31082	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.	Box 1397 Brunswick, GA 31520	do.	Glynn.
National Gypsum Co.	4500 Lincoln Plaza Dallas, TX 75201	do.	Chatham.
Domtar Gypsum, division of Domtar Inc.	1221 Broadway, Suite 700 Oakland, CA 94612	do.	Do.
Mica:			
Franklin Mineral Products Co. Inc., division of The Mearl Corp.	Drawer 390 Hartwell, GA 30643	do.	Hart.

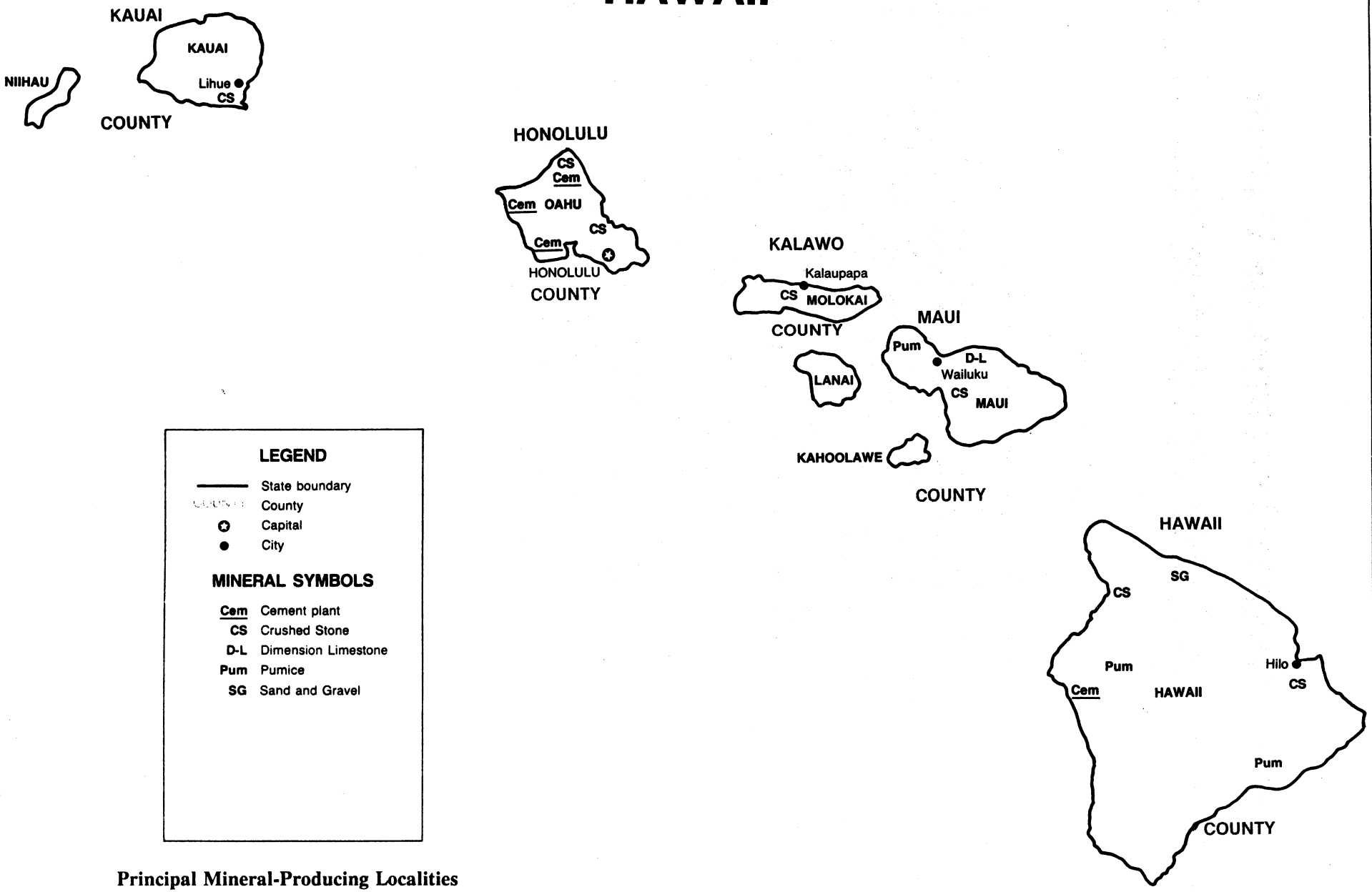
See footnotes at the end of table.

TABLE 7-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Construction:			
Howard Sand Co.	Box 118 Butler, GA 31006	Open pit mines	Talbot and Taylor.
Florida Crushed Stone Co.	Box 230 Ochlocknee, GA 31773	do.	Brantley and Thomas.
Butler Sand Co.	Box 1954 Butler, GA 31006	Open pit mine	Taylor.
Industrial:			
Montgomery Sand Co., a subsidiary of Florida Crushed Stone Co.	Box 255 Mount Vernon, GA 39445	Open pit mine and plant	Montgomery.
The Morie Co. Inc., Georgia Silica Div.	1201 North High St. Millville, NJ 08332	do.	Marion.
Atlanta Sand & Supply Co.	Route 1 Roberta, GA 31078	do.	Crawford.
Stone:			
Crushed:			
Vulcan Materials Co.	Box 80730 Atlanta, GA 30366	Quarries and plants	Various.
Davidson Minerals Properties Inc. and The Stoneman Inc., subsidiaries of Beazer USA	Box 486 Lithonia, GA 30058	do.	Do.
Georgia Marble Co., Aggregate Group	Box 409 Lithonia, GA 30058	do.	Do.
Dimension:			
Granite:			
T & C Quarries Inc.	Box 119 Elberton, GA 30635	Quarries and finishing plant.	Elbert and Oglethorpe.
Bennie & Harvey Inc.	Box 958 Elberton, GA 30635	Quarries and finishing plant.	Oglethorpe.
Star Granite Co.	Box 159 Elberton, GA 30635	do.	Oglethorpe and Wilkes.
Marble:			
Georgia Marble Co.	1201 Roberts Blvd., Bldg. 100 Kennesaw, GA 30144	do.	Pickens.
Talc:			
Southern Talc Co., a subsidiary of United Catalysts	Drawer F, Holly St. Chatsworth, GA 30705	Underground mine and plant	Murray.

[1]Also produced crude iron oxide pigments.
[2]Also produced common clay and limestone.

HAWAII



Principal Mineral-Producing Localities

THE MINERAL INDUSTRY OF HAWAII

This chapter has been prepared under a Memorandum of Understanding between the 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]

Hawaii's nonfuel mineral production value in 1990 was more than $106 million. The 16% increase in production from that of 1989 reflected Hawaii's continuing rise in construction spending and rising prices of the materials used in construction, as growth continued strong through 1990. According to the Bank of Hawaii, gross State product (GSP) for Hawaii has increased over 60% since 1983, with the most rapid real growth occurring in the last 3 years. Hawaii ranked 43rd nationally in the value of 1990 nonfuel mineral production.

TRENDS AND DEVELOPMENTS

Industrial minerals accounted for the total mineral value. Portland cement, construction sand and gravel, and crushed stone were the principal commodities produced, accounting for approximately 99% of the total.

Mineral production in Hawaii was used principally for local construction. The Bank of Hawaii reported 1990 construction completed (construction put in place) was up 29% from that of 1989 to $4.1 billion.

LEGISLATION AND GOVERNMENT PROGRAMS

On November 15, 1990, the U.S. Department of the Interior and the University of Hawaii's LOOK Laboratory released the final Environmental Impact Statement (EIS) on mining manganese nodules from the ocean floor near Hawaii, culminating a 6-year effort by a State-Federal task force. The EIS addressed 10 potential seamount mining sites pointing to the possibility of a new source of cobalt, manganese, nickel, and platinum ore for U.S. industry. Researchers at the University of Hawaii continued to seek methods of breaking down the manganese crusts into their various components and disposing of the waste.

The Marine University of Hawaii received, under the Mining and Minerals Research Institute program, an allotment grant of $546,536 in fiscal 1990 for their Marine Minerals Technology program .

REVIEW OF NONFUEL MINERAL COMMODITIES

Industrial Minerals

Cement.—Hawaiian finished portland cement production and value increased to 532,000 short tons and was valued at more than $46,000,000 during 1990, up

TABLE 1
NONFUEL MINERAL PRODUCTION IN HAWAII[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	10	$1,531	10	$1,566	12	$1,870
Portland	do.	354	28,880	493	40,495	532	46,311
Gemstones		NA	W	NA	44	NA	55
Sand and gravel (construction)	do.	652	3,173	e600	e3,200	438	2,459
Stone (crushed)	do.	e5,700	e41,000	6,205	46,746	e7,000	e55,400
Combined value of other industrial minerals and values indicated by symbol W		XX	348	XX	(2)	XX	(2)
Total		XX	74,932	XX	3 92,051	XX	3 106,095

eEstimated. 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]Value excluded to avoid disclosing company proprietary data.
[3]Partial total, excludes values that must be concealed to avoid disclosing company proprietary data.

20% and 15%, respectively, from that of 1989. Masonry cement production also increased 20% to 11,690 short tons.

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 limestone, sand, gypsum, and volcanic ash.

Pumice and Pumicite.—Pumice production in Hawaii declined 67% from that of 1989. Principal uses were in road construction and landscaping.

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 1988 and 1990 and estimates for 1989. Construction uses of sand and gravel were partially supplemented by crushed stone, decreasing about 33% (from reported 1988 production) to 438,000 short tons. However, higher prices limited the decrease in value of the sand and gravel to 24%, resulting in a total value of $2,459,000.

Grove Farm Rock Co. 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 1988 and 1990 and actual data for 1989.

The estimated crushed stone production of 7 million short tons in 1990 was about 13% higher than that reported in 1989.

[1]State Mineral Officer, Bureau of Mines, Reno, NV. He has 25 years of mineral-related government experience and has covered the mineral activities in Hawaii for 9 years. Assistance in the preparation of the chapter was given by Marguerite Roberto, program assistant.

TABLE 2
HAWAII: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

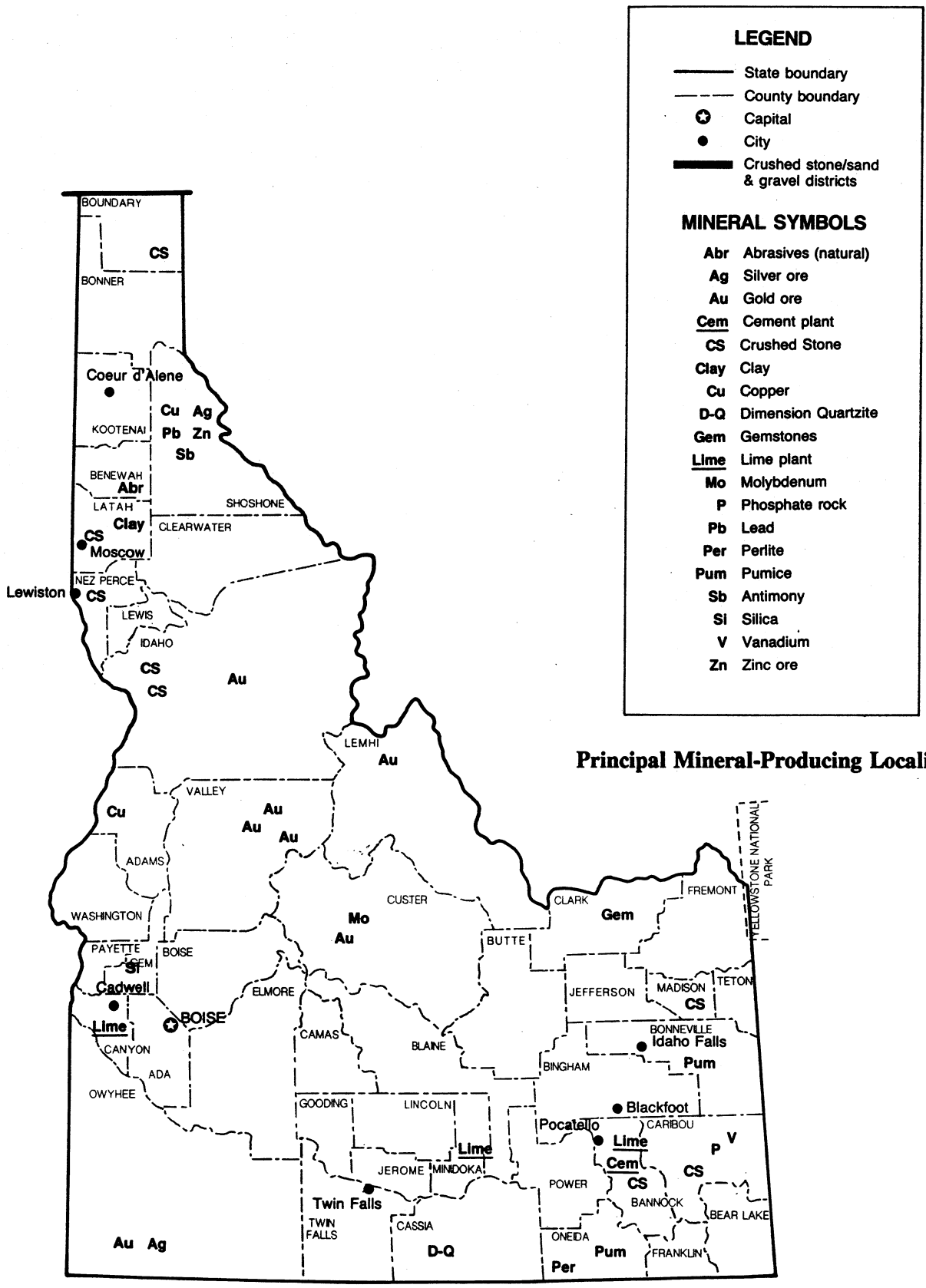
Use	Quantity thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	W	W	$6.19
Road base and coverings	50	$227	4.54
Railroad ballast	W	W	1.75
Other	262	1,533	5.85
Unspecified:[1]			
Estimated	125	699	5.59
Total or average	[2]438	2,459	5.62

W Withheld to avoid disclosing company proprietary data; included with "Other."
[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.

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Hawaii Cement	Barbers Point Plant 91-044 Kaomi Loop Ewa Beach, HI 96706	Cement plant	Oahu.
Pumice:			
Maui Pineapple Co. Ltd.	Box 445-C Lahaina, HI 96761	Surface mine	Do.
Puna Sugar Co. Ltd.	Box 120 Keaau, HI 96749	do.	Hawaii.
Volcanite Ltd.	Box 3000 Kailua Kona, HI 96740	do.	Do.
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.

IDAHO


LEGEND
State boundary
County boundary
Capital
City
Crushed stone/sand & gravel districts
MINERAL SYMBOLS
Abr Abrasives (natural)
Ag Silver ore
Au Gold ore
Cem Cement plant
CS Crushed Stone
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
Sl Silica
V Vanadium
Zn Zinc ore
Principal Mineral-Producing Localities
BOUNDARY
BONNER
KOOTENAI
BENEWAH
LATAH
CLEARWATER
NEZ PERCE
LEWIS
IDAHO
LEMHI
VALLEY
ADAMS
WASHINGTON
PAYETTE
BOISE
GEM
CANYON
ADA
OWYHEE
ELMORE
CAMAS
BLAINE
GOODING
LINCOLN
JEROME
MINIDOKA
TWIN FALLS
CASSIA
ONEIDA
POWER
BANNOCK
BEAR LAKE
FRANKLIN
CARIBOU
BINGHAM
BONNEVILLE
JEFFERSON
MADISON
TETON
FREMONT
CLARK
CUSTER
BUTTE
YELLOWSTONE NATIONAL PARK
Coeur d'Alene
Moscow
Lewiston
Cadwell
BOISE
Twin Falls
Idaho Falls
Blackfoot
Pocatello
Cu Ag
Pb Zn
Sb
Abr
Clay
CS
Au
Cu
Au
Au
Au
Mo
Au
Gem
CS
Lime
Sl
Lime
Lime
Cem
CS
P
V
CS
Au Ag
D-Q
Pum
Per
Pum

THE MINERAL INDUSTRY OF IDAHO

This chapter has been prepared under a Memorandum of Understanding between the 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 1990 was valued at $399.8 million, an increase of almost 10% from that reported for 1989, according to the U.S. Bureau of Mines. A drop in the value of molybdenum and silver production was more than offset by gains in the value of lead, phosphate, construction sand and gravel, and zinc.

Phosphate rock continued to be the leading mineral commodity in terms of value, followed by silver, molybdenum, zinc, and gold. The metallic minerals—antimony, copper, gold, lead, molybdenum, silver, vanadium, and zinc accounted for almost 58% of the State's nonfuel mineral production value, a slight drop from the 62% in 1989.

Idaho ranked 26th nationally for total mineral production value compared with 28th in 1989. The State was first in the Nation in antimony and garnet production; second in silver and vanadium production; and third in output of lead, molybdenum, and marketable phosphate rock.

TRENDS AND DEVELOPMENTS

During the first half of 1990, the outlook for base and precious-metal mining in Idaho looked promising. Silver production remained relatively steady; the State ranked second in the Nation in output, accounting for one-fifth of total U.S. silver produced. Idaho's base metal production--copper, lead, and zinc--showed strong increases of more than 52% in quantity and 59% in value from that of 1989. By the end of the year though, there was a disappointing slump in prices. In December, the price of silver tumbled to its lowest point in 17 years. Lead and zinc prices, which had risen to their highest levels in years, also began to decline. Companies began hedging their plans, especially in the Coeur d'Alene mining district, where historically, the bulk of Idaho's silver and base metals has been produced. Owing to a combination of legal and cash-flow problems, a few companies closed or

TABLE 1
NONFUEL MINERAL PRODUCTION IN IDAHO[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2]	metric tons	8,519	W	W	W	W	W
Copper[3]	do.	2,269	$6,028	2,950	$8,516	W	W
Feldspar	do.	—	—	11,612	720	W	W
Gemstones		NA	500	NA	500	NA	$320
Gold[3]	kilograms	3,218	45,349	3,057	37,602	W	W
Phosphate rock	thousand metric tons	4,706	81,011	W	W	4,380	101,610
Pumice	metric tons	W	W	W	W	31,333	220
Sand and gravel:							
Construction	thousand short tons	6,914	19,897	e5,800	e18,900	9,222	25,590
Industrial	do.	483	5,089	459	5,037	552	6,234
Silver[3]	metric tons	340	71,512	439	77,651	436	67,565
Stone (crushed)	thousand short tons	e3,400	e13,100	3,298	12,609	e4,300	e12,900
Combined value of antimony, cement, lime, molybdenum (1989-90), perlite, stone (dimension, 1988-89), vanadium, zinc, and values indicated by symbol W		XX	48,130	XX	r203,075	XX	185,322
Total		XX	290,616	XX	364,610	XX	399,761

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]Recoverable content of ores, etc.

announced closures. A number of miners were furloughed, and anxiety over the possibility of additional layoffs grew.

On the plus side, gold exploration continued strong, and at least six new gold mines were under active development. Industrial minerals continued to be a valuable, although often overlooked part of the State's mineral sector. Total industrial mineral production value increased by more than 22% from that of 1989. Phosphate was the highest valued mineral commodity produced in Idaho, and although production remained essentially the same as in 1989, it had the largest absolute value increase in 1990. Expansion and renovation continued throughout the year at many phosphate mines and plants.

EMPLOYMENT

For the third consecutive year, employment in Idaho's mining sector increased. According to the Research and Analysis Bureau of the Idaho Department of Employment, overall mining employment averaged about 3,900 employees, an increase of 3% over that of 1989. The number of metal mining employees grew by 7% to about 2,780.

Although the average hourly wage was unchanged from that of 1989 at $13.37, the average weekly earnings for mineral production workers dropped owing to a decline in the average length of the workweek. Average weekly earnings were $534 in 1990, a drop of $27 from that of the previous year; average length of the workweek declined from 41.9 hours to 40 hours.

REGULATORY ISSUES

Early in the year, Gulf Resources and Chemical Corp. paid the Environmental Protection Agency (EPA) $1.4 million for reimbursement of costs incurred in the 1986 Fast Track cleanup at the Bunker Hill Superfund site. The 1986 cleanup involved the removal and replacement of soils with high-lead content in public parks and along road shoulders.

During the summer, six mining companies, a railroad owner, and a chemical manufacturer agreed to prepay $3.18 million to clean up heavy metals in the Kellogg area. The goal of the program was to remove toxic metals, primarily lead and cadmium, from 100 residential properties. Those contributing to the cleanup were ASARCO Incorporated, Callahan Mining Corp., Coeur d'Alene Mines Corp., Gulf Resources, Hecla Mining Co., Stauffer Chemical Co., Sunshine Precious Metals Inc., and the Union Pacific Railroad Co.

Other work completed at the Superfund site included fencing of the smelter complex to restrict public access, covering a copper dross pile containing a significant concentration of arsenic, draining and neutralizing an unstable acid tank, and removing asbestos on the outside of buildings.

The EPA extended until the end of 1991 the period of time FMC Corp. has to comply with the stringent new radioactive emission standards at its Pocatello elemental phosphorus plant. In December 1989, the EPA reduced the Federally allowed level of radioactive emissions from 21 curies to 2 curies per year. FMC's plant discharges an estimated 10 curies per year, and the company originally was given until March to comply or face large fines or curtailment of operations. FMC agreed to invest more than $20 million over the next 3 years to make improvements in air quality controls; its goal is to reduce emission by 70% to 80%.

J.R. Simplot Co. shut down three phosphate ore calciners at its Pocatello fertilizer plant, significantly reducing particulate emissions. The company continued work on an estimated $30 million slurry pipeline that will allow direct pumping between its Smokey Canyon phosphate mine and its Pocatello plant. The pipeline eliminates the need for stockpiles and is expected to further reduce dust emissions.

EXPLORATION ACTIVITIES

The number of exploration projects in Idaho increased from 82 in 1989 to 99 in 1990. Gold and other precious metals continued to be the most sought after commodities, but several companies actively pursued base metals and a number of firms explored for industrial minerals.

In northern Idaho, Cominco Ltd. continued its efforts to identify polymetallic mineralization at the Buckhorn Mine on Scout Mountain on the Idaho-Montana border, Newmont Exploration Ltd. continued exploration in the Fall Creek and Legett Creek areas near Golden, and Gold Fields Mining Corp. completed a drilling program at Florence.

Golden Chest Inc. announced that drill results on the Golden Chest Mine 1 mile east of Murray indicate it can be mined by open pit methods. The property was drilled by Newmont Mining Corp. and returned to Golden Chest in 1990. Also, after finding a bedded gold vein on the property, Newmont returned to International Basic Resources Inc. the historic Mother Lode Mine on Ophir Mountain across Prichard Creek from the Golden Chest Mine.

Elsewhere in northern Idaho, Shoshone Silver Co. worked on a drift at the Keep Cool Mine in the Lakeview mining district and Kennecott Exploration Corp. explored near the old King David Mine on Ruby Creek, east of Bovill. NJB Mines Inc. applied for a permit to mine a small open pit on the Ko-Dan claims north of the Red River Ranger Station and Canyon Resources Corp. dropped its interest in the Robinson Dyke Mine.

In Lehmi County, FMC Gold Corp. and American Gold Resources Corp. (AGR) continued an exploration program on AGR's Arnett Creek property, a prospect on 17,000 acres adjacent to and west of FMC's Beartrack property. The joint venture drilled near the Haidee and Little Chief Mines. AGR was also a partner with Placer Dome Ltd. in exploring targets around Leesburg and Shoup and with Asarco on a 25,000-acre claim block south of Arnett Creek.

Formation Capital Corp. acquired the King Solomon, Wallace Creek, and Silverton Mines 4.5 miles east of Beartrack and joint ventured three other land packages. Teck Exploration Ltd. explored the Morning Glory property

adjacent to Beartrack; Gold Fields drilled the Bobcat-Redrock property; and Hecla assessed claims near Williams Pass.

Also in Lehmi County, Golden Chest obtained 23 unpatented claims on the Freeman Creek property approximately 10 miles north of Salmon; FMC continued to explore the Ditch Creek area near North Fork; Placer Dome Inc. drilled at Kinney Creek; ECM Inc. leased the Pine Creek property to Gwalia (USA) Ltd., an Australian firm; and West Fork Gold Co. drilled on the West Fork of Indian Creek.

In south-central Idaho, Atlanta Gold Corp. continued development of its metallurgically complex Atlanta gold property northeast of Boise in Elmore County. Ore would be mined from two open pits, concentrated by flotation, and treated by biooxidation and cyanidation. In December, Atlanta Gold granted an exploration option to Newmont. Newmont's drilling program will test a deep higher grade gold target beneath the low-grade open pit reserves.

Kennecott drilled and constructed roads at the old Moscow Mine in the Moore Creek drainage near Big Creek; Placer Dome continued evaluation of its Red Mountain prospect near Yellow Pine and Independence Mining Co. drilled on Logan Creek near the old Independence Mine and at Smith Creek east of Big Creek. West of Stanley, Sunshine Mining Co. drilled at Valley Creek and Washington Basin.

Westmont Mining Inc. continued evaluating a base metal prospect in the Boulder Mountains near the headwaters of the North Fork of the Lost River and Plexus Resources Corp. explored near Coyote Creek and on the Navarre property in the Mackay area. In the Rocky Bar area, the joint venture of Newmont and GEXA Gold Corp. drilled, mapped, and built roads, while Cactus West Exploration Ltd. examined the Bonaparte Mine near Cayuse Creek. In the Boise Basin area, Pegasus Gold Inc. entered into a joint venture with Cactus West on the Century claims by the Gold Hill Mine near Quartzburg, Independence Mining Co. mapped and drilled in the Alder Creek drainage above Placerville, and Rhino Resources Co. drilled at the Giant Mine on Shaw Mountain.

In southwest Idaho, an agreement was reached between Noranda Exploration Inc. and Gold Canyon Resources Inc. in which Noranda would manage the exploration program at Gold Canyon's Blue Dog property near Weiser, Washington County. Gold Canyon had previously reached an agreement with its former partner, Bradner Resources, in which it acquired 100% ownership of the property. The Chandler property, adjacent to the Blue Dog, was being explored by the joint venture of Gold Canyon, Bradner, Silver Standard Resources, and Carlin Resources.

Also in the southwest, Amax Inc. drilled south of the Jordan Valley on the north edge of South Mountain; Nerco Exploration Co. explored on Tennessee Mountain, War Eagle Mountain, Twin Peaks, and the Milestone deposit in Owyhee County; and Ican Minerals Ltd. drilled at the Idaho Almaden Project, northeast of Weiser.

In southeast Idaho, Placer Dome drilled northwest of Kilgore near Dubois; Gold Fields explored in South Heglar Canyon northeast of Sublett and acquired the Cherry Creek property near Malad; Atlas Corp. sampled in the Magpie Basin and Rock Creek areas south of Twin Falls; and Cordex Exploration Co. drilled in Valve House Draw and Box Canyon south of Pocatello.

LEGISLATION AND GOVERNMENT PROGRAMS

Mineral-related legislation enacted in the Idaho legislative session included bills that clarified different aspects of mineral exploration, such as when and where exploration certificates need to be filed, definition of certain exploration terms, rental fees, the use of motorized equipment, and when exploration and reclamation plans are needed.

The State of Idaho initiated a new and unique method of helping silver producers in the Coeur d'Alene mining district. The State Lottery Commission inaugurated a new "scratch" game in which top prize winners received cash along with silver and gold bullion minted by Sunshine Mining at its Hayden Lake refinery. Sunshine Mining is the only U.S. mining company to mine, refine, and mint gold and silver bullion.

The Mining and Mineral Resources Institute of the University of Idaho, at Moscow, received an allotment of $339,000 from the U.S. Bureau of Mines in 1990. The school had received a total of $3.5 million since inception of the Mineral Institute Program in 1978.

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Antimony.—Idaho was the only State in the Nation reporting antimony production in 1990. Production increased by more than 17% in quantity, but dropped by 13% in value from that of 1989. Sunshine Mining recovered antimony as a byproduct from the electrolytic treatment of tetrahedrite, a complex silver-copper-antimony sulfide that is the principle ore mined at the Sunshine Mine near Kellogg, Shoshone County.

Copper.—Idaho's copper production decreased in quantity and value from that of 1989. The major copper-producing region in the State continued to be the Coeur d'Alene District where copper was recovered as a byproduct at the following mines, by order of quantity produced: the Coeur, Galena, Sunshine, and Lucky Friday Mines.

Alta Gold Co. ceased operations in midsummer at its Copper Cliff Mine near the Hells Canyon gorge, about 40 miles northwest of Council in Adams County. The copper-silver mine and mill was reactivated in 1989 after being closed for 8 years owing to low prices. Ore was stockpiled for later processing.

Gallium.—N. A. Degerstrom Co. continued construction of a processing plant in Soda Springs, Caribou County, to extract gallium and silver from "treater dust," a waste product at Monsanto

Industrial Chemical Co.'s nearby elemental phosphorus plant. Gallium will be won by solvent extraction and silver in a cyanide-leach circuit. The gallium will be sold to the electronics industry where it is used to make gallium arsenide computer chips.

Gold.—Gold production dropped slightly both in quantity and value from that of 1989. The State ranked 10th nationally in gold production in 1990, unchanged from that of 1989.

After a 1-year suspension of operations, Hecla reopened the Yellow Pine heap-leach gold mine about 45 air-miles east of McCall in 1989. The mine was Idaho's largest gold producer in 1990. Because of its remote location, the Yellow Pine is operated on a seasonal basis, ideally May through November. Ore was mined from the Homestake open pit, an oxidized gold deposit, and processed at the newly constructed heap-leach pad and gold recovery plant at the site. A large sulfide deposit was identified but a feasibility study on putting it into production had not begun.

Nerco Minerals Co.'s DeLamar gold-silver mine, 20 miles east of Jordan Valley, OR, in Owyhee County, was the State's second ranked gold producer. The property includes an open pit, a countercurrent decant mill, a vat-leach plant, and heap-leach facility. The mill was in the process of being expanded. The company announced an increase in ore reserves, with production coming mainly from the Glen Silver area and the new mining area referred to as the South Wahl pit. Nerco continued the permitting process to bring its Stone Cabin Project into production. Stone Cabin is sited on nearby Florida Mountain and would become a satellite operation of the DeLamar Mine. The proposed gold and silver operation would include three open pits, with ore processing via heap leaching and conventional milling at Delamar. Work included feasibility studies, facilities engineering and permitting activities, and the preparation of an environmental impact statement. An engineering and procurement contract, including geology review, mine design, crushing, and leaching, was awarded.

The Champagne Mine, operated by Idaho Gold Corp., had better-than-anticipated gold and silver production and was the State's third ranked gold producer in 1990. The open pit, heap-leach mine on Idaho Gold's Lava Creek property, 20 miles west of Arco, Butte County, began production in September 1989. The on-site plant uses a Merrill-Crowe process, designed with a zero discharge, closed system for environmental considerations. Idaho Gold is 85% owned by BEMA Gold Inc. and 15% owned by Glamis Gold Ltd. The company intensively explored the St. Louis and Poison Gulch zones, also on the Lava Creek Property, less than 1 mile from the Champagne Pit, and found anomalous gold and silver values at the surface.

The Stibnite Mine, owned and operated by a joint venture of Pioneer Metals Corp. and MinVen Gold Corp., was Idaho's fourth ranked gold producer in 1990. The seasonal open pit, heap-leach operation is 15 miles southeast of Yellow Pine, Valley County. A legal dispute between Pioneer Metals and Pegasus Gold involved the Stibnite gold mine. According to published reports, Pegasus claimed that Pioneer defaulted on a loan and, therefore, forfeited its share of the gold property, which was offered as collateral for the loan, to Pegasus. Pioneer filed counterclaims against Pegasus. A Canadian court awarded Pegasus a settlement, but Pioneer responded by saying its assets were fully encumbered to its bank. A preliminary agreement reached between Pegasus and Pioneer would eliminate all of Pioneers debts to Pegasus with the transfer of Pioneer's interest in the Stibnite property to Pegasus.

In the fall, Coeur d'Alene Mines ceased all operations at its Coeur Thunder Mountain gold mine, east of McCall in Valley County. Before closure, it produced enough to rank fifth in Idaho gold production. Sited in the Frank Church-River of No Return Wilderness Area, the company had moved production from the Sunnyside deposit, which was exhausted in 1989, to its nearby Lightning Peak deposit. Because of severe winter conditions, the 8,500-foot-above-sea-level deposit was only able to operate during the 6 warm months. Coeur d'Alene Mines leased the property from Thunder Mountain Gold Inc. and received a number of awards from the Idaho Department of Lands for its reclamation efforts.

U.S. Antimony Corp. (USAC) mined at its Speciman gold property near Lowman, Boise County. Output was trucked 85 miles for treatment at USAC's Preacher Cove mill in the Yankee Fork area. USAC started construction on a 250-ton-per-day surface mine and mill at its Yellowjacket property 15 miles southwest of Cobalt, Lehmi County. Sited on almost 12 acres of Forest Service land and more than 12 acres of private land, it was projected to take 6 to 10 years to mine the estimated 312,000 tons of reserves. Concentrates will be shipped to the Preacher Cove mill for further processing.

The Princess Blue Ribbon Mine, 14 miles northeast of Fairfield, Camas County, was closed owing to the collapse of a tailings pond dam at its gold extraction site. The dam failure sent a wave of water and sediment into Big Beaver and Willow Creeks. The Idaho Department of Environmental Quality refused to issue a permit necessary to reopen the dam. Precious Metals Technology Inc. was the owner of the mine and the largest employer in Camas County.

Other gold producers included Hecla's Lucky Friday Mine and Asarco's Coeur and Galena Mines, all in the Coeur d'Alene mining district. A number of gold placer mines were active in the State. A and T Mining, the largest gold placer in the State, continued to operate near Lucille, Idaho County and G and G Mining installed a large trommel at a placer claim near Moose Basin in Clearwater County. Golden Chest conducted bulk testing at the Butte Creek Placer Project, also known as The Nugget Factory, near Murray, Shoshone County, and many recreational suction dredges were operating throughout Idaho.

FMC Gold acquired Meridian Gold Co. for stock from the Meridian Minerals Co., a unit of Burlington Resources Inc. The purchase included a 71% interest in Meridian Gold's Beartrack gold property, reportedly the largest gold discovery in Idaho's history; the remainder is owned by Canyon Resources (15%) and Mirex Partners (14%). The Lemhi County gold deposits are 10 miles west of Salmon, north of the historic placer mining town of Leesburg, in the Mackinaw mining district. Two large stockwork disseminated gold deposits have been identified. The deposits, Gold Ridge and North, are situated on the Panther Creek Fault Zone within the Trans-Challis belt. Total land position for the Beartrack and adjoining properties covered about 70 square miles. The proposed 705-acre mine would include two open pits, a cyanide heap-leach pad, waste rock dumps, and other facilities. Activity in 1990 included preproduction work on the oxide deposit, metallurgical testing of the sulfide ores, and completion of required permitting. The Salmon National Forest released a draft environmental statement for public comment.

CoCa Mines Inc. continued development of its Grouse Creek gold and silver project in Custer County, 27 miles southwest of Challis. CoCa acquired the property, at Jordan Creek in the historic Yankee Fork mining district, when it purchased Geodome Resources Ltd., the parent of Sunbeam Mining Co., in 1989. As a result of extensive drilling, two mineral deposits have been identified, the Sunbeam and Grouse Creek. Pending completion of a supplemental environmental impact statement and the receipt of all necessary permits, mine construction was expected to begin in 1992 and production in late 1993. The original Sunbeam Mine environmental impact statement, completed in 1984, was used as a basis for the supplement. The project has been hampered by environmental concerns involving the Pinyon Basin wetland, which would be used for part of the mining operation.

Idaho Gold continued development of its Buffalo Gulch and Ericson Reef deposits near Elk City in Idaho County. Plans are for the proposed open pit, heap-leach gold mines to be operated as one unit. Final Bureau of Land Management (BLM) and State permits were received for the Buffalo Gulch deposit, sited about 3 miles northwest of Elk City; Idaho Gold expected to begin production in late 1991. Final permitting was underway for the Ericson Reef deposit, approximately 8 miles north-northwest of Elk City. Depending on the permitting process, the company planned to bring the property into production in 1992. Plans are to initially mine an oxide cap that overlies a sulfide ore body still under evaluation.

Pegasus purchased the Black Pine gold property from Noranda. Noranda had completed the permitting of its proposed heap-leach gold mine in Cassia County but sold the property because of slumping gold prices. The agreement allows for Noranda to buy back a 49% interest after 500,000 troy ounces have been recovered by Pegasus. Pegasus began preliminary work on the $12 million construction project and said it expected the open pit, heap-leach mine to be in production by mid-1991. The 10,500-acre site is centered around the Tolman Mine in the Black Pine Mountains of the Sawtooth National Forest, southeast of Burley.

Lead.—Lead production in Idaho ranked third nationally, a drop from its second place ranking in 1989. The value of lead production continued an upward climb, with reported value reflecting an increase of more than six times that of 1987. The quantity of lead produced in 1990 rose by better than 15%, and the value increased 35% compared with that of 1989. Lead production was concentrated in the Coeur d'Alene mining district in Shoshone County.

Hecla's Lucky Friday Mine was the State's leading lead producer. The company's 1990 annual report showed the mine produced 17,300 short tons of lead, 1.9 million troy ounces of silver, 3,300 short tons of zinc, 900 troy ounces of gold, and 49 short tons of copper. During the year, Hecla's new Lucky Friday Underhand Longwall mining method was fully implemented. The system was designed to enhance safety and improve efficiency by employing more mechanized equipment, including rubber-tired vehicles, a ramp system, and cement sandfill. Hecla laid off 10 workers in late November. The action was based on Hecla's decision to close one production stope and one development drift. The stope accessed a vein of silver with no attendant lead or zinc. Hecla continued exploration of the Snowstorm property east of Mullen near the Lucky Friday.

Other mines reporting production included Bunker Hill Mining Co.'s Bunker Hill Mine and Asarco's Galena Mine.

Molybdenum.—The quantity of molybdenum produced in Idaho increased by 3%, but the value dropped by more than 14% from that of 1989. Molybdenum was produced by Cyprus Minerals Inc. at its Thompson Creek open pit mine near Challis, Custer County. The mill operated all year, processing in excess of 26,000 tons per day. Work continued on stripping the high wall in preparation for future mining. This was also the first full year of operation of the company's new high-purity, lubricant-grade molydisulfide plant.

Silver.—Silver production in Idaho remained virtually the same as that in 1989, but value dropped 13% as a result of declining prices. The State ranked second after Nevada in silver production. Nerco's DeLamar Mine in Owyhee County was the fifth ranked producer in the State. The remaining top six silver-producing mines were in the Coeur d'Alene mining district of Shoshone County.

Sunshine Mining was the State's largest silver producer and the Nation's only large vertically integrated mining company. The company operated the Sunshine silver mine and refinery on Big Creek and a mint near Coeur d'Alene, both in Shoshone County. According to Sunshine Mining's 1990 annual report, the mine produced 5.5 million troy ounces of silver and 2.0 million pounds

of copper. The mint produced silver and gold coins and bars, and the company had a contract with the U.S. Government to produce coin blanks. Sunshine Mining continued to discover high-grade silver ore in the Rambo and Silver Syndicate areas of the mine.

Asarco operated the Coeur and Galena silver mines in Shoshone County. The Galena Mine, the State's second largest silver producer, is owned by Callahan, Asarco, and Hecla. The mine utilized horizontal cut-and-fill mining and track haulage with battery-powered locomotives. During the early part of the year, repairs were made to the main shaft, including the installation of new timbers, because of ground control problems. Despite the interruption, the mine produced 3.1 million troy ounces of silver, 1 thousand short tons of copper, 700 short tons of lead, and some gold, according to Asarco's 1990 annual report. With a new circuit for processing silver-lead, Galena now produces both silver-copper and silver-lead concentrates.

The Coeur Mine was the State's third ranked silver producer. After acquiring Hecla's 5% interest, Coeur d'Alene Mines receives 45% of the mine output, with Asarco and Callahan controlling the balance. According to the Coeur d'Alene Mines 1990 annual report, the Coeur Mine produced 2.1 million troy ounces of silver and 480 troy ounces gold in 1990. Asarco continued evaluation of the American Silver property, concentrating on the Wire Silver Vein area adjacent to and accessed from the 3400 level of the Coeur Mine.

Hecla's Lucky Friday Mine was the State's fourth largest silver producer. Other mines reporting silver production included Bunker Hill Mining's Bunker Hill Mine and Star Phoenix Mining Co.'s Star Morning Mine, both in Shoshone County, and Hecla's Yellow Pine Mine and Coeur d'Alene Mines' Thunder Mountain Mine, both in Valley County.

Vanadium.—Idaho ranked second in the Nation in vanadium production value. In 1990, output declined by almost 14% in quantity and 10% in value from that of 1989. 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.—The quantity of zinc production in the State was almost 2 1/2 times that achieved in 1989, and the value was more than two times greater. The State ranked fifth nationally in zinc production, up from its seventh ranking in 1989.

The State's largest zinc-producing mine in 1990 was Bunker Hill Mining's Bunker Hill Mine at Kellogg, Shoshone County. Under a management agreement signed in January, the mine was operated by Faucett Mine Services of Osburn. The company increased production to more than 2,000 tons of ore per day and concentrated it efforts in the high-grade-zinc Quill ore body, including the identification and development of additional reserves on its downward extension. Zinc concentrates were sent to Cominco's smelter in Trail, British Columbia, and to smelters in Japan. The mine also produced lead and silver; shipments of lead-silver concentrate were sent by rail to Asarco's smelter in East Helena, MT. During the year, the company replaced track in the Kellogg Tunnel and continued to use the new automated bulk-mining methods. In late October, Bunker Hill laid off 45 workers, about 20% of the mining staff. Only exploration and development were affected, not production; another 20 were laid off at yearend due to financial difficulties of the company. The company's nearby Crescent silver mine remained on a care-and-maintenance basis.

The Star Morning zinc mine in Burke, Shoshone County, reopened by Star Phoenix in late 1989, was shut down in December. The mine, which also produced silver, was previously shut down by Hecla in 1982 owing to low metal prices. Star Phoenix had a lease and purchase option on the mining complex from Hecla and the Bunker Ltd. Partnership. Hecla sought termination of the lease, claiming Star Phoenix breached terms of the agreement when it took out several lien claims against the mine. The mine is actually two mines: the Star, accessed from a portal on the west side of the ridge, is a zinc mine, and the Morning, a lead-silver mine, is entered from the east. Both are on the same vein system and are connected underground. Production was concentrated on a zinc-rich ore shoot off the Morning section. Ore was hauled to the mill at Burke by train through the 2-mile-long Star Tunnel. The Star's 52-year-old mill was extensively overhauled, including the installation of new flotation cells. Zinc concentrates were sent by truck to the Cominco smelter at Trail, British Columbia.

Hecla's Lucky Friday Mine produced zinc as a byproduct of its lead-silver production.

Industrial Minerals

Cement.—Cement production in Idaho decreased by 6% in quantity and almost 3% in value from that of 1989. The State's only cement producer was Ash Grove Cement West Inc. at Inkom, Bannock County. During the year, a new stacking and reclaiming system was installed at the plant to handle clinker. Most 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. Finished portland cement was used by the following: ready-mix concrete companies (66%); highway contractors (18%); other contractors and concrete product manufacturers (11%); and building material dealers, miscellaneous customers, and government agencies (5%). Limestone and quartzite used in cement production were quarried from near the plant.

Clays.—Clay production in Idaho dropped more than 38% in quantity and 61% in value from that of 1989. There was no reported production from the State's only bentonite mine in Clark County. A.P. Green Refractories Co. and Simplot produced kaolinite clay in Latah County. A.P. Green announced the closure of its refractory brick plant near Troy. Clayburn Industries operated a kiln at the old Simplot clay plant near Deary. The calcined clay was shipped to Clayburn's refractory brick plant in British Columbia, Canada. Common clay was mined by Interpace Corp. in various counties.

Diatomite.—Grefco Inc. continued assessment and drilling programs at two diatomite deposits. The company drilled and staked new claims at its property near Deep Creek in Owyhee County. Large 36-inch-diameter holes were drilled, and geologists were lowered up to several hundred feet deep to examine the deposit and geology. Grefco did more testing at American Diatomite's Clover Creek deposit north of Bliss in Gooding County.

Feldspar.—Output of feldspar dropped both in quantity and value from that reported in 1989. Unimin Corp. in Emmett, Gem County, was the State's only producer. The company produced a feldspar-silica sand mixture used mainly in the production of glass.

Garnet.—Idaho ranked first in the Nation in garnet production. Reported production increased more than 11% in quantity and nearly doubled in value from that of 1989. Emerald Creek Garnet Milling Co. operated the State's only commercial garnet mine near Fernwood, Benewah County, and was the Nation's largest garnet producer. 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. The company mined garnet year-round from two sites on Carpenter Creek and three locations on Emerald Creek using five washing plants. The mine site includes a shop, jig plant, and a sizing and bagging plant. The garnet produced was milled to varying coarseness for use in water filtration, sandblasting, and polishing. During the year, Emerald Creek maintained an active reclamation and reseeding program.

Gemstones.—The value of 1990 gem-stone production in Idaho dropped 36% from that reported in 1989. Many of the active gem-stone deposits were in Benewah, Boise, Clark, Clearwater, and Latah Counties. In recent years, an increasing amount of gem material has been recovered from the Sawtooth batholith, including sites within the Sawtooth National Recreation Area, which may be technically prohibited. Aquamarine, garnet (including star garnet), jasper, smoky quartz, precious opal, and topaz were among the gem materials recovered during the year.

Lime.—Idaho lime production increased by almost 10% in quantity but decreased by 33% in value from that of 1989. Amalgamated Sugar Co. operated three lime plants in Canyon, Minidoka, and Twin Falls Counties that accounted for all of the State's 1990 lime production. The raw material was shipped by rail from Ash Grove Cement's limestone quarry in Durkee, OR. The quicklime production was used by sugar manufacturers.

Perlite.—Output of Idaho perlite increased by almost 15% in quantity and 7% in value from that of 1989. National Perlite Products Co., a division of Oglebay Norton Co., mined perlite from the Oneida Mine along Wrights Creek about 25 miles north of Malad City, Oneida County; the material was processed and expanded at the company's plant at Malad City. An improved fire box and burner assembly on a dryer effectively doubled plant capacity. The expanded product was used for industrial filters, in fireproofing, and as a filter medium.

Phosphate Rock.—The quantity of phosphate produced in Idaho dropped modestly from that reported in 1989, but as a result of higher prices, the value increased significantly. Idaho remained the Nation's third ranking State in marketable phosphate output.

With two operating mines, Simplot was Idaho's largest producer of phosphate rock in 1990. Simplot mined phosphate at the Smokey Canyon Mine near the Idaho-Wyoming border in Caribou County and the Gay Mine, about 30 miles northeast of Pocatello on the Fort Hall Indian Reservation in Bingham County. Ore production from the Smokey Canyon Mine was slurried, then pumped to a calcining plant at Conda through a 27-mile-long slurry pipeline. The calcined material was shipped by rail to the company's phosphoric acid and fertilizer plant at Pocatello. In September, Simplot shut down three phosphate calciners. Simplot has developed a new processing technology using uncalcined ore in the manufacture of agricultural fertilizers, making the calcining plant obsolete. Construction was underway on a new 58-mile-long, 9-inch-diameter pipeline between Conda and Pocatello, which will allow the company to bypass the calcining plant and pump directly from the mine to Simplot's plant just west of Pocatello. It was estimated that emissions, especially dust, will drop by almost 60%.

Ore production from the Gay Mine was processed by Simplot into phosphoric acid and by FMC into elemental phosphorus at its Pocatello plant. Owing to dwindling reserves, Simplot is scheduled to phase out its Gay Mine over the next few years. FMC started development on a new phosphate mine in Dry Valley near Soda Springs, Carbon County, which will replace the dwindling reserves of high-grade ore from the Gay Mine. FMC will be the mine operator and is expected to ship the ore to Pocatello by rail.

Monsanto was Idaho's second largest phosphate rock producer. The company ceased production at its Henry Mine in Caribou County and moved to a new site in Enoch Valley, 4 miles east. For the second year in a row, Monsanto received a Governor's award for its reclamation efforts at the Henry Mine. Monsanto also operated an elemental phosphorus plant at

Soda Springs. During the year, the company rebuilt one of the plant's electric furnaces.

The third ranked phosphate rock producer was the Conda Partnership, a joint venture of NuWest Industries Inc. and Western Cooperative Fertilizer Ltd. of Calgary, Alberta, Canada. The partnership mined phosphate rock at the Mountain Fuels Mine in Dry Valley, Caribou County. The ore was beneficiated at the venture's calcining plant, and the product moved by conveyor to NuWest's nearby fertilizer plant. NuWest announced plans to invest up to $45 million in a new sulfuric acid-cogeneration plant at its Conda (formerly Beker Industries) phosphate fertilizer complex near Soda Springs. The new acid plant will replace two current plants. The construction project was expected to take 18 months. The facility would produce 2,500 metric tons of sulfuric acid and 26 megawatts of electricity daily. NuWest's Conda plant manufactures super phosphoric acid and five different dry fertilizer products.

Rhone-Polenc Basic Chemicals Co., the State's fourth ranked producer, mined phosphate rock from the Wooley Valley Mine northeast of Soda Springs. The ore was washed at a mill at the mine site and shipped to the company's elemental phosphorous plant at Silver Bow, MT. A new loading area and mill were under construction. With reserves at the Wooley Valley Mine nearly exhausted, Rhone-Polenc has applied to the BLM for approval of a mine and reclamation plan to develop a new phosphate mine on its lease at the southern end of Rasmussen Ridge, 18 miles northeast of Soda Springs. Ore would be transported on a proposed 4-mile haulage road to its mill at Wooley Valley, then shipped by rail to the company's elemental phosphorous plant in Silver Bow, MT.

Pumice.—Output of pumice in Idaho dropped by almost 20% in quantity and almost 18% in value from that of 1989. Pumice was produced by two operations in Bonneville County and by one operation 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 fine-grained pumice had a variety of uses as an abrasive, lightweight aggregate, and filler.

Amcor Inc. quarried pumice from its Fan Creek and other claims near Ammon in Bonneville County. The company mined from five pits along the west flank of the Blackfoot Mountains. The material was trucked to Idaho Falls where it was crushed, screened, and manufactured into lightweight building block.

Producers Pumice, a subsidiary of Builders Masonry Products, operated the Rock Hollow Mine near Ammon, Bonneville County. The pumice was shipped by rail to Meridian, where it was crushed, screened, and used for 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 actual data for 1988 and 1990 and estimates for 1989.

The 1990 output of construction sand and gravel in Idaho increased by 59% in quantity and more than 35% in value from 1989 estimates and more than 33% in quantity and nearly 29% in value from production surveyed in 1988. The three major producing counties were Ada, Canyon, and Kootenai. Major uses were for road base and cover (57%), concrete aggregate (17%), and asphaltic concrete (9%). More than 71% of Idaho's construction sand and gravel was transported by truck; the remainder was used on-site.

Industrial.—Industrial sand and gravel production increased by more than 20% in quantity and almost 24% in value from that of 1989. Output came from three pits in three counties: Monsanto near Soda Springs, Caribou County; Unimin Corp. in Emmett, Gem County; and FMC, Power County. Industrial sand was used in the following applications, by order of value: roofing granules, glass containers, traction sand, sandblasting sand, specialty sand, filtration medium sand, and other applications. The gravel was used for nonmetallurgical flux.

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 1988 and 1990 and actual data for 1989.

Crushed.—The production of crushed stone in Idaho was estimated to have increased more than 30% in quantity but rose only a little more than 2% in value from that in 1989.

Dimension.—Dimension stone production in the State declined by more than 15% in quantity and almost 24% in value from that of 1989. Three companies marketed Oakley Stone from quarries south of Oakley, Cassia County. Idaho Quartzite Corp. mined rock from the Emigrant Canyon quarries and shipped facing stone and sawed tiles in a variety of colors. Northern Stone Supply Co. operated the Rocky Mountain Quartzite quarry, and Oakley Valley Stone also sold stone in 1990.

Zeolites.—Teague Mineral Products Co. mined zeolites from pits on the Idaho-Oregon border just north of U.S. Highway 95 in Owyhee County. The company trucked the ore to its processing plant at Adrian, OR. Most of the product was used as a carrier for fungicides, in odor control, and as an animal feed supplement. Teague continued development of a high-grade deposit of zeolites near Oreana, Owyhee County.

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[1]State Mineral Officer, U.S. Bureau of Mines, Spokane, WA. He has 16 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 geologist, Idaho Geological Survey, Boise, ID.

TABLE 2

IDAHO: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	1,613	$5,598	$3.47
Plaster and gunite sands	48	170	3.54
Concrete products (blocks, bricks, pipe, decorative, etc.)	13	50	3.85
Asphaltic concrete aggregates and other bituminous mixtures	850	2,467	2.90
Road base and coverings	5,256	14,677	2.79
Fill	579	776	1.34
Snow and ice control	75	517	6.89
Railroad ballast	9	36	4.00
Other	779	1,299	1.67
Unspecified:[1]			
Actual	W	W	1.58
Total or average	9,222	25,590	2.77

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Antimony:			
Sunshine Mining Co.	815 Park Blvd. Suite 100 Boise, ID 83702	Mine, mill, plant	Shoshone.
Cement:			
Ash Grove Cement West Inc.	5550 SW Macadam Ave. Suite 300 Portland, OR 97201	Surface mine and plant	Bannock.
Clays:			
A. P. Green Refractories Co.	Box 158 Troy, ID 83871	Surface mine	Latah.
Interpace Corp.	3502 Breakwater Ct. Hayward, CA 94545	do.	Benewah.
Copper:			
ASARCO Incorporated	Box 440 Wallace, ID 83873	Mines and mills	Shoshone.
Sunshine Mining Co.	815 Park Blvd. Suite 100 Boise, ID 83702	Mine, mill, refinery	Do.
Garnet:			
Emerald Creek Garnet Milling Co. Inc.	Route 4, Box 190 Fernwood, ID 83830	Pits and plant	Benewah.
Gold:			
Hecla Mining Co.	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	Surface mine and leach plant	Valley.
Idaho Gold Corp.	Box 195 Arco, ID 83213	do.	Butte.
MinVen Gold Corp.	7596 West Jewell Ave. Suite 303 Lakewood, CO 80232	do.	Valley.
NERCO Minerals Co.	111 SW Columbia Suite 800 Portland, OR 97201	Surface mine, mill, leach plant	Owyhee.
Lead:			
Bunker Hill Mining Co. Inc.	Box 29 Kellogg, ID 83837	do.	Shoshone.
Hecla Mining Co.	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	do.	Do.
Lime:			
Amalgamated Sugar Co.	First Security Bank Bldg. Ogden, UT 84402	Plants	Various.
Molybdenum:			
Cyprus Minerals Co.	7200 South Alton Way Englewood, CO 80110	Surface mine and mill	Custer.
Perlite:			
National Perlite Products, a div. of Oglebay Norton Co.	520 North Michigan Ave. Chicago, IL 60611	Surface mine and plant	Oneida.
Phosphate rock:			
Conda Partnership	Box 37 Conda, ID 83230	do.	Caribou.

TABLE 3-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Phosphate rock—Continued			
Monsanto Co.	Box 816 Soda Springs, ID 83276	Surface mine	Do.
Rhone-Polenc Basic Chemical Co.	Box 160 Montpelier, ID 83254	do.	Do.
J. R. Simplot Co.	Box 912 Pocatello, ID 83201	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.
Producers Pumice	6001 Fairview Ave. Boise, ID 83704	Quarry	Bonneville.
Sand and gravel:			
Construction:			
Bryan C. Rambo Crushing Co.	8301 Cherry Lane Nampa, ID 83651	Pits	Canyon.
Nelson-Deppe Inc.	Box 768 Nampa, ID 83653	do.	Do.
Seubert Excavators Inc.	Box 57 Cottonwood, ID 83522	do.	Idaho.
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.	111 SW Columbia Suite 800 Portland, OR 97201	Surface mine, mill, leach plant	Owyhee.
Sunshine Mining Co.	815 Park Blvd. Suite 100 Boise, ID 83702	Mine, mill, refinery	Shoshone.
Stone:			
Dimension:			
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:			
Bunker Hill Mining Co. Inc.	Box 29 Kellogg, ID 83837	Mine and mill	Shoshone.

ILLINOIS

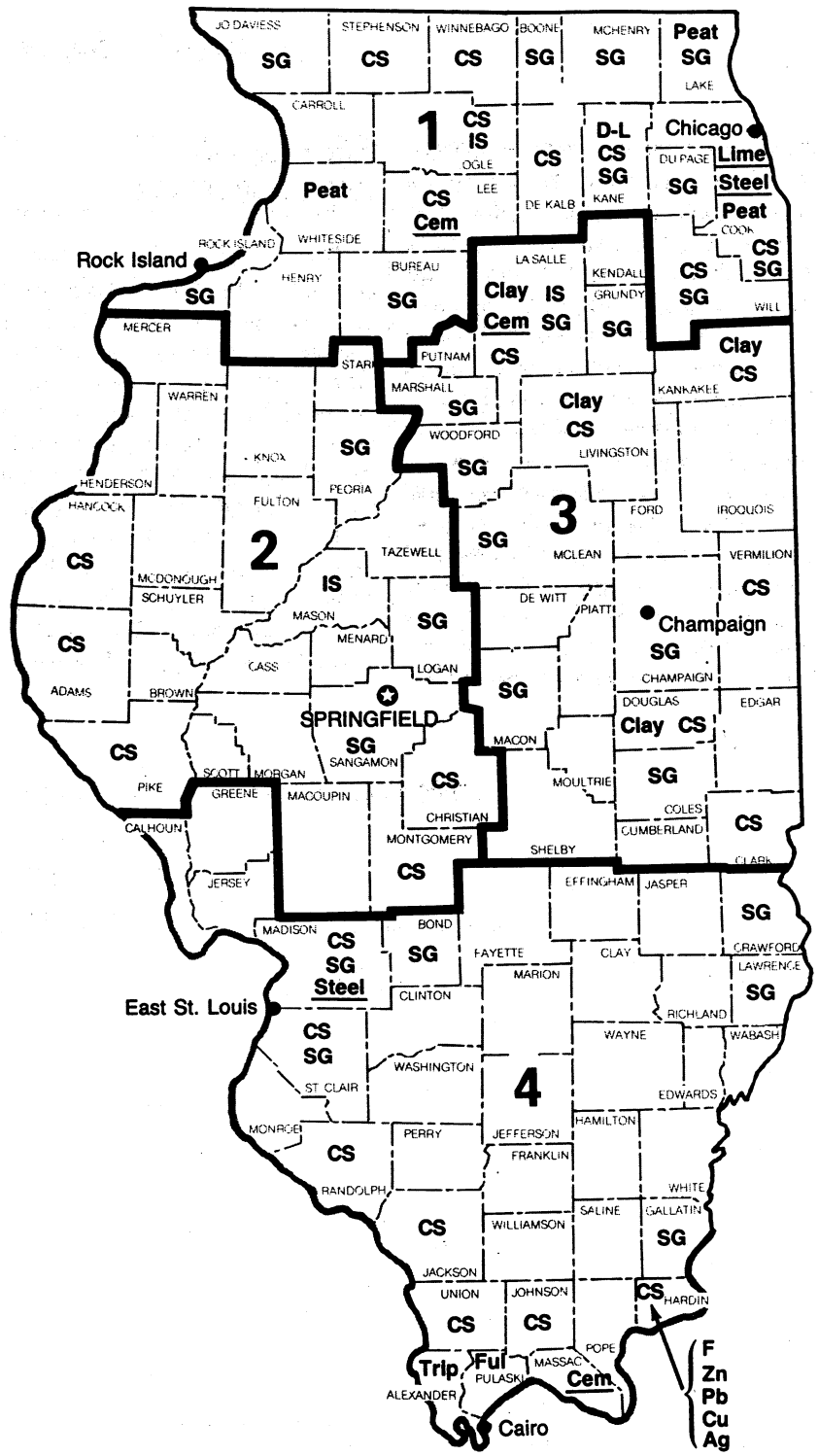
LEGEND

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

MINERAL SYMBOLS

Ag	Silver
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
Cu	Copper
D-L	Dimension Limestone
F	Fluorspar
Ful	Fuller's earth
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



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]

The value of nonfuel mineral production in Illinois increased to a record high for the fourth consecutive year in 1990. The total value rose 5% over that of 1989 to $665.1 million. Crushed stone, the State's leading nonfuel mineral commodity, was responsible for 83% of the increase as a result of its estimated value growing by $26.3 million (10.2%) to $283.1 million. Other mineral commodities that increased in value included clays and industrial sand and gravel. Illinois was the leading State in the Nation in both the quantity produced and the value of fluorspar, industrial sand and gravel, and tripoli. The State's national ranking in the value of all minerals produced rose from 17th in 1989 to 16th in 1990.

TRENDS AND DEVELOPMENTS

The increase in crushed stone production, which was largely responsible for the growth in Illinois' mineral production in 1990, resulted primarily from increased highway construction financed by an increase in the State's gasoline tax. The 6 cents-per-gallon tax was phased in in two equal increments, the first in late 1989 and the second in early 1990. The value of road contract awards increased 33.5%, from $1.2 billion to $1.6 billion. Without this boost in highway construction, crushed stone production would probably have declined in response to the recession that impacted the Nation in 1990. Had this happened, Illinois' 1990 mineral production probably would have decreased in value rather than setting an alltime high.

The recession caused a decline in the production of other mineral commodities that were more directly dependent upon industries most impacted by the economic downturn, notably construction, steel, and automobile manufacturing. Included in this group were cement, construction sand and gravel, and those items (fluorspar, metals, dimension stone, etc.) whose values are withheld.

In March, the city of Chicago announced it was considering four sites for a potential new airport to relieve

TABLE 1
NONFUEL MINERAL PRODUCTION IN ILLINOIS[1]

Use		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland)	thousand short tons	2,307	$101,760	2,776	$117,224	2,842	$116,781
Clays[2]	metric tons	163,571	704	142,207	641	598,479	2,516
Gemstones		NA	30	NA	W	NA	W
Sand and gravel:							
Construction	thousand short tons	30,098	93,504	e33,000	e108,900	32,380	104,728
Industrial	do.	4,328	56,142	4,582	52,935	4,486	62,531
Stone:							
Crushed	do.	e57,900	e251,200	[3]60,829	[3]256,832	e [3]62,700	e [3]283,100
Dimension	short tons	e1,175	e129	W	W	W	W
Combined value of barite (1989-90), cement (masonry), clays (fuller's earth), copper, fluorspar, lead, lime, peat, silver, stone (crushed sandstone, 1989-90), tripoli, zinc, and values indicated by symbol W		XX	84,157	XX	96,829	XX	95,478
Total		XX	587,626	XX	633,361	XX	665,134

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

congestion at O'Hare Airport. Included were two suburban locations, one an expansion of the regional airport in Gary, IN, and the other a southeast Chicago location. The southeast location encompasses 9,400 acres and could displace 47 businesses and 6,700 housing units. Included could be the LTV Steel Co. coke plant, Acme Steel Co.'s blast furnace and coke plant, and Republic Engineered Steels Inc. plant. The new facility has a projected cost of $4.9 billion and a completion date of the year 2010.

Illinois, and other highly industrialized Midwestern States, were expected to have to spend more to comply with the 1990 Clean Air Act than other parts of the country. Major provisions of the act would require reduction of sulfur dioxide emissions to 2.5 pounds per million British thermal unit (Btu) by 1995 and to 1.2 pounds per million Btu by the year 2000. Congressional estimates put national cleanup costs at a minimum of $25 billion annually.[2] Illinois faced the additional prospect of having thousands of coal miners unemployed as utility companies switched from locally mined high-sulfur coal to low-sulfur western coal in order to meet standards set by the legislation.

EMPLOYMENT

Illinois workers employed in mining and quarrying, including coal mining and oil and gas extraction, grew by 300 to 19,800, an increase of 1.5% over the number employed in 1989. Average hourly wages were $17.05, 60 cents more than those in 1989. Wages and average weekly hours worked dropped from 42.9 in 1989 to 41.8 in 1990. Basic steel industry workers decreased from 24,800 in 1989 to 24,500 in 1990. However, wages increased from $13.91 to $14.07, while average weekly hours worked decreased from 45.1 to 43.7 in 1989 and 1990, respectively.

There were four strikes in mineral-related industries in Illinois in 1990. The two longest, lasting 76 and 35 days, respectively, affected the steel industry. Shorter strikes affected one coal company and a crushed stone operator.

REGULATORY ISSUES

Illinois, one of the Nation's largest producers of low-level radioactive waste, formed a compact with Kentucky, one of the smallest producers, in order to comply with terms of 1985 amendments to the Low-Level Radioactive Waste (LLRW) Policy Act. LLRW requires States or groups of States to have LLRW sites by 1993. The Illinois State Geological Survey (ISGS) reviewed data from contractors related to the State's proposed LLRW disposal sites at Martinsville, Clark County, and Geff, Wayne County. The review, when completed, will form the basis for volumes 2 and 3 of the site characterization program.

President Bush, on November 28, 1990, signed into law H.R. 5428, which declared 28,000 acres of the Shawnee National Forest in southern Illinois a wilderness area. The law set aside seven tracts containing more than 26,000 acres in which timber harvesting and motorized travel are prohibited. Provisions of the law allow mining in two special areas that are scheduled to become wilderness in later years. Ozark-Mahoning, which operates fluorspar mines in the special areas, has the right to prospect for and mine fluorspar on that acreage for 20 years. At the end of that time, the land would revert to wilderness designation.

A decade-long battle between the State of Illinois and Kerr-McGee Corp., a former producer of thorium compounds, remained unresolved in 1990. Both sides claimed that a U.S. Court of Appeals ruling issued in May favored their position. The ruling defined all of the waste materials produced by the Kerr-McGee plant over a period of more than 50 years as "byproduct" for purposes of disposal. Kerr-McGee claims the decision reinforced its authority to bury more than 400,000 tons of radioactive granular materials on the 42-acre site of the plant that closed in 1973. Conversely, the State Attorney General claimed the decision allowed Illinois to force Kerr-McGee to move the material to an out-of-State site. The ruling also required the removal of almost 150,000 tons of waste material that Kerr-McGee had deposited in landfills or sold as soil conditioners in surrounding communities to be excavated and returned to the existing pile of material on Kerr-McGee's property.

In a related development, the Illinois Department of Nuclear Safety (DNS) placed radiation detection devices at sites near Kerr-McGee's property. DNS wanted to establish a baselevel against which any increases of airborne radioactivity caused by construction activity could be measured if the company is allowed to bury the waste.

On March 30, the U.S. Environmental Protection Agency (EPA) approved a plan to stabilize a waste pile containing 250,000 tons of lead slag at the site of NL Industries' defunct lead smelting operation in Granite City. In addition to the waste pile, which has an average lead content of 30%, EPA plans to remove 6 inches of lead-contaminated topsoil from a 55-block area surrounding the site and add it to the waste pile. The waste pile will then be leveled to a maximum height of 22 feet and capped with layers of plastic membranes, clay, gravel, and sod to protect it from moisture. The project was scheduled to begin in January 1992 and be completed in 1993.

Recontek Inc. began operation of a recycling facility at Newman, Douglas County, in November. Recontek specializes in recovering mainly nonferrous metals from materials classified as hazardous waste discarded by electronics, metal finishing, and aerospace companies. The company used a proprietary hydrometallurgical recovery process that it claims generates no waste byproducts. The Newman plant was Recontek's first operation.

Flood control and adequate potable water supplies were environmental issues of local concern that affected several dolomite quarries in 1990. The Chicago Metropolitan Water Reclamation District (MWRD) planned for completion by 1995 of a 12-mile, $196 million tunnel system to control wastewater runoff. MWRD

feared its plans were jeopardized by delays in acquiring a dolomite quarry that is an integral part of the plan. MWRD plans to use the north lobe of Material Service's active Thornton quarry to temporarily store up to 8 million gallons of stormwater runoff from the Calumet leg of the district's deep tunnel system. The water would later be pumped to a sewage plant for treatment. The District retained a special counsel who would be empowered to seek condemnation of the quarry under eminent domain proceedings. MWRD made the move after the Illinois Department of Transportation, which was negotiating for MWRD, reached a deadlock with Material Service in negotiations to acquire the quarry.

Du Page County officials continued debating the purchase of an abandoned stone quarry to be used as a flood-control reservoir. In November, the county board approved commitment of $10 million toward the purchase of the Elmhurst-Chicago Stone Co. quarry on Salt Creek. The company has set a price of $46 million for the quarry, which has the potential to store 9,500 acre-feet of stormwater. The county's offer was contingent upon the remainder of the money required to purchase the quarry being supplied by municipalities in the county and by State and Federal sources. In December, the city of Elmhurst pledged to contribute $3.5 million toward the project.

EXPLORATION ACTIVITIES

The ISGS compiled maps showing the locations of approximately 270 fluorspar mines, prospects, and mine shafts. Most of the fluorspar occurrences shown on the 1:24,000 scale maps are in Hardin and Pope Counties. The Illinois Geologic Mapping Advisory Committee (IGMAC) was formally organized on December 14 to assist the ISGS in selecting areas where geologic mapping is most needed, the types of geologic maps that would be most useful, and map scales that would be most appropriate for meeting the needs of potential users. Members of IGMAC represent State and local government agencies, professional organizations, and business.

ISGS received samples from 171 mineral exploration or structure test holes in 1990. Eighty-three were for test holes drilled by Ozark-Mahoning for fluorspar and other minerals in Hardin County. Another 55 were for the exploration of Pennsylvanian clays in Monroe, Perry, and St. Clair Counties by Acme Brick Co. Other clays investigated as potential sources for brickmaking clay included the Tertiary Porter's Creek Clay. Clays with high-alumina, low-alkaline, and alkaline-earths content suitable for the manufacture of high-strength cement were also being sought in locations with access to shipping facilities. These included sites near the Mississippi, Illinois, and Ohio Rivers and the Great Lakes. High-purity limestone was being sought Statewide for the industrial filler, chemical, and coal desulfurization markets.

Test hole record and plugging affidavits for 674 holes were filed by coal mining companies. This was 215 fewer than were filed in 1989 but 37 more than were filed in 1988. Approximately 220 of the holes drilled in 1990 were drilled far enough from active mines to be considered exploration tests.

A joint 5-year investigation of the Illinois Basin was organized in March by the Illinois Basin Consortium, which is composed of the Illinois, Indiana, and Kentucky Geological Surveys and the U.S. Geological Survey (USGS). Areas of joint research will include mineral resource appraisal, tectonic framework, flow paths and chemistry of basin fluids, and data base development.

LEGISLATION AND GOVERNMENT PROGRAMS

Only two bills affecting the mining industry were enacted into law in 1990. House bill 4169 amended the Illinois Oil and Gas Act by requiring that any person proposing to drill a well for oil, gas, or coal must file with the Department of Mines and Minerals (DMM) a surety bond of $2,500 for each well or $25,000 for all wells. Senate bill 2037, an act in relation to natural resources, research, data collection, and environmental studies, permitted the Coal Development Board to develop public education and awareness projects and to cooperate with the Illinois Coal Development Park in its promotion and research of Illinois coal resources.

IDMM regulated all mineral-related activity and had a staff of 133. IDMM had five divisions: Oil and Gas (OGD), Mine Safety and Training (MSTD), Land Reclamation (LRD), Explosives, and General Office. OGD issued permits for the drilling of oil and gas wells, ensured that oil wells are properly spaced, and was responsible for the prevention of pollution of land and contamination of aquifers that could result from oilfield operation. A reorganization of OGD initiated in September 1989 was completed in 1990. The reorganization was designed to provide for a fair and consistent oil and gas regulatory program in the future. Changes in the Illinois Oil and Gas Act that became effective in 1990 required the permitting of all wells drilled before the adoption of the first oil and gas act in 1939 and established a Plugging and Restoration Fund.

MSTD regulated health and safety activities for 26 underground and 16 surface coal mines operated by 24 companies. MSTD also regulated three fluorspar mines in Pope and Hardin Counties under the department's Laws and Regulations Governing the Operation of Metal Mines.

LRD regulated other mining activity, permitting, and reclamation for underground coal and fluorspar mines; surface coal and aggregate mines, including clay, limestone, sand and gravel, shale, silica, and tripoli; and other noncoal minerals. LRD was responsible for reviewing and issuing permits for most mining operations. The only exceptions were aggregate mines that affect less than 10 acres annually or excavate to a maximum depth of 10 feet. LRD employed 29 full-time professionals, including 21 land reclamation specialists or inspectors. During 1990, nine permits covering 1,152 acres were issued,

including two for newly established coal mining operations. More than 649 acres were permitted for aggregate mining. The majority of these were for limestone quarries, 326 acres, and for sand and gravel operations, 224 acres. Altogether, 2,548 surface acres were newly affected by mining compared with 2,451 acres in 1989. A total of 147,718 acres have been affected by coal mining since the State's first regulation began in 1962. Of these, 34,416 have been reclaimed.

The Abandoned Mined Lands Reclamation (AMLR) Council announced on June 28 that $154,049 had been awarded for reclamation of 12 fluorspar mines in Pope and Hardin Counties. The project represented the first time AMLR funding had been awarded for noncoal mine reclamation. Funding for both coal and noncoal mine reclamation is financed by Federal production taxes of $0.35 per ton for surface-mined coal and $0.15 per ton for underground-mined coal. Portions of the proceeds are returned to the States from which they were collected for the reclamation of abandoned mines. AMLR spends approximately $10 million yearly to reclaim coal mines that were mined and abandoned prior to 1977. In Illinois, more than 27,000 acres were mined for coal and abandoned.

The ISGS, in conjunction with the USGS, compiled aeromagnetic and gravity maps covering the entire State at scales of 1:250,000, 1:500,000, and 1:1,000,000.

The U.S. Bureau of Mines Intermountain Field Operations Center began an evaluation of Shawnee National Forest (SNF) in 1990. SNF is included within the 714,644-acre Shawnee National Forest Proclamation Area (SNFPA). SNFPA is the area in which the Forest Service is permitted by Congress to buy, sell, and trade land. Of the 714,644 acres, 451,109 are privately held. Deposits or occurrences of barite, beryllium, clays, coal, columbium, fluorspar, limestone and dolomite, oil and gas, rare-earth minerals, sand and gravel, silver, tripoli, and zinc have been reported within the area being evaluated. Fluorspar was being mined by Ozark-Mahoning, coal by Peabody Coal Co., and tripoli by Unimin Corp. and Lone Star Industries in 1990. Crushed stone and sand and gravel were being produced by numerous local operators. The Bureau study was intended to assist USFS in incorporating mineral resource data in the Forest plans, to augment the Bureau's mineral resource data base, and to determine the location and types of mineral deposits that could be mined economically.

In other Illinois-related activity, the Bureau published two papers related to mine subsidence in Illinois in 1990. Southern Illinois University received $210,058 in grants from the Minerals Research Institute (MRI), which is funded by the Bureau. From these grants, $145,000 was earmarked for generic projects related to mine systems design and ground control and $45,058 was to be used in pyrometallurgical research. MRI contributed more than $4.8 million to 18 universities.

The Clean Coal Technology (CCT) program was initiated by the U.S. Department of Energy (DOE) in response to the Clean Air Act of 1990. The program provided $5 billion in funding as incentives to improve coal utilization technology. DOE evaluated 154 proposals and selected 35 projects to be funded. Two of the projects were awarded to Illinois companies.

Organic molecules (sulfonate compounds) created by chemists at Southern Illinois University (SIU) in Carbondale have proven successful in removing sulfur from Illinois coal. Total sulfur content has been reduced by as much as 50% while preserving 80% to 90% of the coal's original Btu value. The product can be either pelletized or used in its slurry form by utility companies and other customers. The process should remove sufficient sulfur to allow Illinois coal to meet standards set in the 1990 Clean Air Act.

In another sulfur-removal project, ISGS and SIU staff members were granted patents for their invention entitled "Desulfurization of Carbonaceous Materials." The concept allows for the simultaneous removal of inorganic and organic sulfur from coal in one step using ethanol as a source of reagent hydrogen.

Other projects underway during 1990 included developing pellets of finely divided clean coal from coal cleaning processes in order to overcome problems in transporting and marketing the material. The strong, durable pellets use high-Btu, low-sulfur, low-ash, lignocellulosic material as a binder under low-temperature and medium-pressure conditions. The ISGS, Tennessee Valley Authority, and University of Illinois are working on the project. ISGS also developed a method of producing ultrafine, high-surface-area hydrated lime for the capturing of sulfur dioxide during the combustion of coal. Tests by EPA, the Consolidated Coal Co., and private research firms have demonstrated that the ISGS product is from 25% to 90% more effective in removing sulfur dioxide than commercial hydrated lime presently available.

The ISGS completed a quantitative assessment of residential and other urban land overlying mined-out areas in Illinois. Acreages of undermined areas were tabulated at the township level for 77 counties with underground coal and noncoal mines.

The U.S. Army Corps of Engineers received an application in May for the construction of a barge loading-unloading dock on the Ohio River at Elizabethtown, Hardin County. The facility would principally handle mineral commodities, fluorspar, coal, and crushed stone, as well as dry bulk fertilizer and grain.

FUELS

Perry, Saline, Franklin, and Randolph Counties accounted for 51.8% of the 61.7 million tons of coal that was produced in 19 counties in 1990. Although coal production increased by 0.6 million tons over 1989's production, the number of employees decreased by 976 to 10,129 in 1990. The State has an estimated 181 billion tons of coal reserves, but much of the shallow reserves have been depleted.

Surface mining has declined steadily since peaking in 1969 and accounted for only 30.2% of the coal mined in 1990.

Conversely, longwall mining has more than doubled in the previous 5 years and accounted for 22.3% of the underground coal mined in 1990.

Peabody Coal Co. operated an export-only terminal on the Kaskaskia River, 25 miles upstream from its junction with the Mississippi River. The terminal was capable of loading 3,000 tons of coal per hour and shipped approximately 4 million tons of steam-grade coal in 1990. The coal was mined at two open pit mines and one underground mine.

Advanced Mining Systems Inc., a major producer of underground coal mine roof-support systems, announced its selection of a site in Carbondale for a new manufacturing plant.

Illinois ranked 15th among the 32 oil-producing States in 1990. Estimated production was 19.9 million barrels, a decline of 0.7 million barrels from 1989 production and the fifth continuous year of declining production. An estimated 140,000 wells have been drilled since commercial oil production began in the early 1900's. Of the 1,850 oil companies listed as actively operating in the State in 1990, approximately 1,000 owned 5 or fewer wells, while 95 companies owned more than 100 wells each. More than 70% of the State's wells were owned by larger independent and major oil companies.

Permits were issued for 812 oil and/or gas production wells in 1990, 138 fewer permits than were issued in 1989. The number of Class II injection wells permits increased by 39 to 223 during the same period. In 1990, the ownership of 8,950 wells was transferred from one owner to another.

Indian Refining Ltd. Partnership reopened its refinery at Lawrenceville, Lawrence County, in September. The refinery, which closed in 1985, was scheduled to process about 57,000 barrels of oil daily.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Industrial minerals accounted for more than 99% of the value of all nonenergy mineral production in Illinois. The value of industrial minerals produced increased by $32 million (5.1%) over the value produced in 1989. The State ranked 11th nationally in the value of industrial minerals produced.

Cement.—Illinois ranked 9th in quantity and 10th in value with respect to the 38 States producing portland cement. Illinois also ranked fourth nationally in the amount of cement consumed in 1990. Four plants with a combined finished-production capacity of 2.75 million short tons operated at 96.8% capacity utilization during the year. All of the plants used the dry process to produce cement. The value of portland cement produced decreased by $443,000 (0.4%) from that of 1989, although the quantity of cement produced increased by 2.4% to more than 2.8 million short tons. Only one of the four companies produced masonry cement in 1989, but all four companies did in 1990. Still, masonry cement production remained comparatively unimportant, and the State ranked 27th in quantity and 29th in value when measured against the 36 States producing masonry cement.

National Cement & Ceramic Laboratories Inc., a joint venture between government and private industry, established a research facility in Evanston near Northwestern University. Opening of the laboratory was jointly announced by officials of Concrete Technology Corp. and the National Science Foundation's Science and Technology Center for Advanced Cement-Based Materials. The facility was fitted with $3 million of state-of-the-art equipment using diagnostic instrumentation routinely used in metallurgy, electronics, and biotechnical research but, until now, not applied to cementitious materials.

Lone Star Industries and 12 subsidiaries filed for Chapter 11 Bankruptcy protection in December 1990. Not included in the filing were Lone Star's domestic joint ventures or its foreign subsidiaries and joint ventures. Included in the filing was the company's cement plant at Oglesby, La Salle County.

Cement production and new construction at the Oglesby plant was interrupted in March because of picketing by union members protesting the use of nonunion contractors working on a $15 million expansion at the plant. Included in the expansion, which was completed in 1990, were a state-of-the-art grinding mill, new homogenizing silos, a new high-efficiency air separator on its finishing mill, and facilities to store and use hazardous waste as kiln fuel.

Lafarge Corp. announced on December 17, 1990, that it had entered into various purchase agreements with Cementia Holding AG of Zurich, Switzerland, and its Spanish subsidiary, Asland S.A., that will increase its annual cement production capacity by more than 20% to 15 million tons. The purchase included Missouri Portland Cement Co., Davenport Cement Co., and more than 30 related ready-mix concrete and aggregate operations, as well as ProChem Technology Inc., a chemical admixtures business with a branch at Naperville. Also included in the purchase was Cementia's 1.2-million-ton-capacity plant at Joppa on the Ohio River in Massac County and 16 terminals along the Mississippi River and its tributaries. The transactions, which will make Lafarge the second largest cement producer in the Mississippi River region, were expected to be completed in January 1991. In 1989, Lafarge's French parent, Lafarge Coppee, acquired a 60% interest in Cementia.

Lafarge also serviced customers in the Chicago area from a silo ship that it stationed in Lake Calumet harbor on Lake Michigan in 1989.

The Illinois Cement Co. at La Salle is a one dry-process kiln operation that started up in 1975. The plant used coal as primary fuel with natural gas as backup. Limestone was supplied from a company-owned quarry at the plant site, and other raw materials were obtained from reserves owned or leased by the company or purchased from outside suppliers. Cement was sold principally to ready-mix concrete producers and paving contractors in Illinois and southern Wisconsin.

Centex also operated a gypsum wallboard distribution center in Chicago.

Dixon-Marquette Cement Co. is owned by Prairie Material Sales Co., which purchased it from Lonestar Industries in 1984. The plant was constructed by Medusa Corp. in 1906 and sold to Lonestar in 1980. The operation used four dry-process kilns to produce Type I cement for general construction and Type III fast-drying, high-early-strength cement. Raw materials were obtained from a limestone quarry on the 1,500-acre plant site, and other ingredients were purchased from outside suppliers. The plant was manned by 142 salaried employees in 1990.

Dixon-Marquette supplied the cement used in a 70-story, 964-foot-high office tower that was completed in Chicago in 1990 and is the tallest reinforced-concrete building in the world. The next two tallest reinforced-concrete buildings are Two Prudential Plaza and Water Place Tower, both of which are also in Chicago.

Clays.—Nationally, Illinois ranked 17th in the quantity and 10th in the value of total clay production. Clay production was reported from only 5 of the State's 102 counties. Livingston and Pulaski Counties accounted for almost 90% of the total volume of clay produced.

Common Clay.—Common clay production increased to a record high of more than 598,000 tons, more than offsetting 3 consecutive years of declining clay production. The average value of common clay produced in Illinois was $4.20 per ton, well below the national average of $5.82 per ton. Common clay was produced by six companies in four counties. Major uses included the manufacture of quarry tile, common brick, cement, and drain tile.

Fuller's Earth.—The production of fuller's earth declined slightly in both quantity and value. Ten States produced fuller's earth in 1990, and Illinois ranked third in the quantity and fourth in the value produced. Two companies in Pulaski County, Lowe's Southern Clay Div. of Edward Lowe Industries and Absorbent Clay Products Div. of American Colloid Co., produced montmorillonite, a variety of fuller's earth. Pet-waste absorbents accounted for the end use of 78% 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.

Fluorspar.—Illinois produced more than 95% of the fluorspar mined in the United States in 1990. The only other States with fluorspar production were Nevada and Utah. Both the quantity of fluorspar mined in Illinois and its value declined in 1990. The decline resulted from a combination of increased competition from foreign imports and a decrease in the use of chloro-fluorocarbons (CFC) because of environmental concerns. Whether the development of new environmentally safe replacement CFC products that may require twice the amount of fluorspar needed in old CFC products will offset the lessening demand was being debated by industry and environment experts.

Fluorspar, the State mineral, has been mined continuously in extreme southern Illinois since the mid-1800's. The ore is found in veins that generally average 9 to 15 feet in thickness and 12 to 20 feet in width. Mines run as deep as 1,000 feet. Fluorspar is used in making steel, enamels, aluminum, toothpaste, Teflon, specialty glass, and a variety of chemicals. Fluorspar from Illinois continued to be in demand because of its high purity, especially the absence of toxic trace elements often found in imported fluorite.[3]

Effective January 1, 1990, Atochem S.A., the chemical arm of Elf Aquitaine of France, reorganized its subsidiaries, Pennwalt Corp., M&T Chemicals Inc,. and Atochem Inc., into one company called Atochem North America. Ozark-Mahoning Co. (O-M) of Rosiclare, the largest producer of fluorspar in the United States, was a subsidiary of Pennwalt and now becomes a subsidiary of Atochem. O-M operated three mines in Hardin County in 1990: the Annabel Lee and Denton Mines in the Harris Creek District and the Minerva No. 1 Mine in the Cave-in-Rock District. Production at the Minerva No. 1 Mine, formerly operated by the Inverness Mining Co., was reestablished in 1990. The Annabel Lee and Minerva No. 1 Mines were mining at record depths for the district, approximately 1,200 feet below the surface.

O-M also operated a flotation plant and dried imported fluorite to supplement its domestic production. O-M employs about 150 people in Hardin County. Imported fluorite was also dried by Seaforth Mineral and Ore Co. Inc. at its facility at Cave-in-Rock.

Lime.—Illinois ranked seventh when compared with the 30 States producing lime in both the quantity and value of lime produced in 1990. Companies producing lime were Vulcan Materials Co. in McCook and Marblehead Lime Co., a subsidiary of General Dynamics, with plants at Thornton and South Chicago.

Marblehead was the third largest lime producer in the nation in 1990. According to the General Dynamics Corp.'s annual report,[4] production of lime at its two facilities in Illinois increased from 719,000 short tons in 1989 to 822,000 short tons in 1990. The company enjoyed a profitable year in 1990, partly because it reduced its traditional reliance on lime sales to domestic steel producers, which was a weakening market. The steel industry still accounted for a majority of Marblehead's business, but new customers were found in the environmental, chemical, and glass markets. Marblehead is one of the few sources of a new dust-free lime that met environmental concerns of steel manufacturers and regulators.

Peat.—Peat was produced in 22 States in 1990. Illinois ranked sixth in the quantity mined and fourth in sales value. Peat production both in Illinois and nationally was virtually unchanged from that of 1989. 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 golf courses and nurseries.

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 1987 and 1989 and actual data for 1990.

Illinois ranked seventh nationally in both the quantity and the value of construction gravel produced. All 50 States reported construction sand and gravel production. Although the quantity produced in Illinois increased slightly to 32.4 million short tons, the value decreased by 3.8% to $104.7 million. Construction sand and gravel was mined by 105 companies from 144 pits in 55 of the State's 102 counties.

Two of the largest construction sand-and-gravel-producing companies in the Nation were headquartered in Illinois. Meyer Material Co. of McHenry ranked 6th with seven operations, and Material Service Corp. (MSC) ranked 12th with three operations. In Illinois, Meyer ranked first with five operations, and MSC ranked second with three operations. Rounding out the top 10 producing companies were Vulcan Materials Co., 2 pits; Thelen S&G Inc., 1 pit; R.A. Cullinan and Sons Inc., 10 pits; Feltes S&G Inc., 1 pit; Beverly Gravel Inc., 1 pit; Road Materials Corp., 5 pits; Mid-West S&G Inc., 3 pits; and C.A. Powley Co., 1 pit. The leading counties, in order of quantity produced, were McHenry (13 pits), Kane (9 pits), Lake (4 pits), Cook (2 pits), and Grundy (1 pit). Table 2 shows the disposition of construction sand and gravel sold or used in Illinois in 1990.

Construction sand and gravel producers were budgeting for a 5% to 10% decrease in sales in 1991 after 1990 sales dropped 3% to 5% from those of 1989.[5] One producer indicated 1990 was marked by more competitive pricing and predicted 1991 will show lower volume sold at lower prices. Sales during the first half of 1990 were slow, then boomed in the third quarter, and dropped off again in the fourth quarter.

Grassroots opposition to sand and gravel operations, especially in the fringe areas of suburbia, grew significantly in 1990. Friction between residential owners and mining companies was intense, especially in McHenry County, the State's leading county in sand and gravel production. In February, the McHenry County Board, under pressure from a citizens group, formed a five-member task force to investigate problems in the county's gravel industry. As a result of work completed by the task force, the McHenry County State's Attorney and the State Attorney General filed lawsuits against 32 gravel pits found to be operating without necessary permits.

Industrial.—Illinois ranked first nationally in both the quantity and the value of industrial sand and gravel mined in 1990. Although the quantity of industrial sand and gravel produced in Illinois in 1990 decreased by 2.1%, its value increased by 18.1% over that of 1989. The decrease in quantity produced was largely a result of a decrease in the amount of coal washing sand reported. The increase in value reflected an increase in the unit value of all but 1 of the 19 uses reported. The major uses were in the manufacture of glass containers, flat glass, and chemicals; for molding and core facing; and hydraulic frac sand.

Unimin Corp., U.S. Silica Co., Manley Brothers, and Fairmont Minerals Ltd. mined the high-purity St. Peter's sandstone in La Salle County. Manito Investment Co. mined a Quaternary quartz-feldspar dune sand in Mason County for the foundry sand market. Unimin Corp., U.S. Silica Co., and Fairmont Minerals Ltd. were the top three industrial sand and gravel producers in the United States, and Manley Brothers ranked seventh nationally.

Fairmont Minerals Ltd., formed in 1986 by the merger of Wedron Silica Co. and Best Sand Co., sold principally to the glass industry, foundries, hydraulic fracturing, and abrasives industries, with additional sales to the construction, filtration, and specialty markets.

Cabot Corp. began an $18 million expansion of its fumed silica operation at Tuscola, Douglas County, in January. The 2-year expansion will increase production capacity by 25%. Fumed silica, also known as pyrogenic or colloidal silica, is an amorphous synthetic silica used as a thixotropic agent in paints and in the manufacture of silicon rubber. Deviating from the trend of U.S. mineral companies being owned by foreign companies, Cabot, with its international headquarters at Tuscola, had operations in the Federal Republic of Germany and planned to build a plant in the United Kingdom. Cabot was also in the process of moving the operations of Tulco Inc., which were purchased in 1989, from Ayer, MA, to Tuscola.

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 1988 and 1990 and actual data for 1989.

Crushed.—Crushed stone accounted for an estimated 43% of the total value of all nonenergy mineral commodities produced in Illinois in 1990. Estimated crushed stone production in 1990 increased 3.1% in quantity and 10.2% in value over the figures reported for 1989. Nationally, Illinois ranked fourth in the quantity and sixth in the value of crushed stone production, which was reported by 49 of the 50 States. Crushed stone production was reported by more than 100 companies with operations in 55 of Illinois' 102 counties. The five largest crushed stone producers were MSC, which also ranked second in construction sand and gravel production; Vulcan Materials Co.; Prairie Materials Sales; Dravo Basic Materials Co.; and Columbia Quarry Co. Major uses for crushed stone were graded road base or subbase, coarse concrete aggregate, agricultural limestone and poultry grit or mineral food, coarse

bituminous aggregate, cement manufacture, and unpaved road surfacing.

In December, Material Service Corp., one of the Midwest's largest producers of aggregates, concrete, and concrete products, purchased Central Illinois Stone Co. to provide additional reserves.[6] Material Service was also seeking additional reserves by trading depleted properties for minable land and was exploring related business opportunities to expand its market geographically.

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 34 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, which is 2 miles southwest of South Elgin in Kane County.

The Amoco Building in Chicago was being reclad with granite from North Carolina because the original Italian-marble cladding deteriorated to the extent that it became a safety hazard. One of Amoco's major problems has been to find a use for the 6,000 tons of replaced marble panels. Amoco planned to reclad the lower two floors with the least blemished and whitest marble panels salvaged from the upper floors. About 1,000 tons will be crushed and used as decorative stone at Governor's State University in South Forest Park. Another 500 tons will be donated to an agency for the handicapped to be made into souvenirs such as bookends, pen holders, or trophy bases. The remaining stone will be stored to be used by Amoco for landscaping purposes. The project was expected to be completed in 1992 at an estimated cost of $75 million, more than the entire building cost when it was built in the early 1970's.

Tripoli.—Illinois produced almost 66% of the tripoli mined in the United States in 1990 and accounted for 86% of its value. Tripoli was mined in only three other States. Unimin Corp. became Illinois' sole tripoli producer when it purchased Illinois Mineral Corp. from Georgia Kaolin Co. Unimin had previously acquired the State's only other tripoli producer, Tammsco Inc.

Other Industrial Minerals.—Two other industrial minerals, barite and gem stones, were produced as a result of mining operations in 1990. 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 1990. Nationally, barite production from Illinois ranked sixth in quantity and seventh in value among the seven States producing barite. 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 ranked 14th out of 50 States reporting gem stone production. Fluorspar crystals found in pockets in fluorspar ore zones have long been coveted by collectors. In recent years, the demand for and the price of fluorspar crystals has soared because of what local traders refer to as "cosmic types" who believe the fluorspar crystals have mystic healing properties or allow channeling with the spirit world. During 1990, one Rosiclare dealer displayed a 15-pound specimen priced at $4,000.[7]

National Gypsum produced calcined gypsum from gypsum mined in Michigan at its wallboard plant at Waukegan in Lake County. USG Corp., a Chicago-based building and construction materials supplier, began restructuring talks with major creditors in late December. The talks were aimed at preventing USG's filing for Chapter 11 bankruptcy protection. USG was decimated when it acquired a $2.5 billion debt in a successful fight to avoid a takeover attempt by Desert Partners in 1988. U.S. Gypsum Co, USG's primary subsidiary, supplied about one-third of the Nation's demand for gypsum wallboard in 1990. Another subsidiary, DAP Inc., a major manufacturer of caulks, sealants, adhesives, and specialty chemical products, will be offered for sale as part of the restructuring. DAP operates a plant at Rosemont.

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 ranked second nationally in the value of finished iron oxide pigments produced. Illinois producers of iron oxide pigments, regenerator iron oxides, and steel plant waste iron oxides included AST Co., Granite City; Harcros Pigments Inc., East St. Louis; Prince Manufacturing Co., Quincy; and Solomon Grind-Chem Services Inc., Springfield.

The AST Co. began production of synthetic yellow iron oxide with a proprietary process in which the material is precipitated from a ferric chloride-rich pickle liquor. The process is said "to be much less energy intensive than other methods of producing regenerator oxides" (e.g., spray roasting or acid evaporation) and used a warm (170° F) hydrochloric acid bath to pickle nonscrap, low-carbon steels. The process can be perceived as double value added: not only does it accomplish the servicing of finished steel products, but it also produces synthetic iron oxide pigment. According to the developer, the process can be used to treat the pollution-plagued problem of steel plant waste streams.[8]

Pfizer Inc. divested its pigment interests in March when they were sold for $5 million to Harcros Pigments Inc., U.S. subsidiary of England's Harrisons & Crosfield PLC (H&C). Harcros had been H&C's sole U.S. distributor prior to the sale. The sale included Pfizer's pigment facilities in East St. Louis.

Prince Manufacturing Co., Quincy, ground imported manganese used in the tinting of bricks. The use of manganese schist as a brick colorant was being phased out in favor of ground imported manganese.

Illinois ranked second nationally in the value of expanded perlite sold or used in 1990. Manville Corp. manufactured roofing insulation using expanded perlite at its Rockdale plant near Joliet. Silbrico

Corp. expanded perlite primarily for the filler market at its Hodgkins, Cook County plant. Strong-Lite Products Corp. expanded perlite that was used in the manufacture of acoustical tile, horticultural aggregate, insulation, and concrete aggregate.

Olin Corp. purified wet-process phosphoric acid to produce sodium phosphates at its Joliet plant. Salt was mixed with sand for highway ice control at several sand and gravel plants in Illinois.

Illinois ranked fifth in the quantity and sixth in the value of 13 States reporting iron and steel slag sold or used in 1990. Iron and steel slag was used primarily as road base, fill, and aggregate. The slag was distributed in Illinois by Heckett Co. from plants at Bourbonnais, Chicago, and Sterling; by International Mill Service Co. from plants at Alton, Chicago, and Granite City; and by St. Louis Slag Products Co. from Granite City. Southern Illinois Transfer Co. operated a barge-loading facility at River Mile 18.5 that handles approximately 150,000 tons of slag annually from Illinois Power Co.'s plant at Baldwin. The slag was used for sandblasting, pavement, and roofing shingles.

Elemental sulfur was recovered from oil refinery operations by Marathon Oil Co. at Robinson, Shell Oil Co. at Hartford, by Unocal Corp. at Schaumburg, and by Oil Corp at Joliet. Illinois ranked seventh in both quantity and value of elemental sulfur recovered when compared with the 26 States that reported sulfur recovery.

Illinois ranked fifth of 20 States in both the quantity and value of expanded vermiculite sold or used in 1990. Exfoliated vermiculite was produced for use in insulation, aggregates, horticulture and soil conditioners, and fireproofing by W. R. Grace and Co. and by Strong-Lite Products Co.

Metals

Illinois was a minor producer of metals, ranking 19th of 21 States reporting metal production. 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.

Copper, Lead, Silver, and Zinc.—Copper, lead, silver, and zinc were produced as byproducts of Ozark-Mahoning's fluorspar mining operations in 1990. The quantity of copper and zinc produced increased over that produced in 1989. However, copper was the only one of the four metals to increase in value in 1990.

In February, Cyprus Copper Co., a subsidiary of Cyprus Minerals Corp., purchased all of the capital stock of MCR Products Inc. from Magma Copper Co. MCR, in Chicago, has a production capacity of 140,000 tons per year of 5/16-inch continuous cast copper rod, the basic feed for the wire and cable industry.

Iron and Steel.—Illinois ranked fifth nationally in the production of raw steel. In 1990, production totaled 7.8 million tons compared with 7.5 million tons in 1989. Total U.S. production was 98.9 million tons in 1990 and 97.9 million tons in 1989.

Acme Steel Co. completed a $23 million renovation of the largest blast furnace at its Southeast Chicago plant. The renovation resulted in improved removal of dust from the furnace and cleaner blast furnace gas collection. Blast furnace gas, a byproduct of smelting iron ore, was used to fuel other processes in the plant. The blast furnace process melts iron ore into molten iron which is later processed into steel. Acme Steel produced steel, strapping, and tubing primarily for the automotive industry. Acme also spent $3.5 million to modernize the major cold reduction mill at its suburban Chicago Riverdale plant.

Birmingham Steel Co. completed a 5-year, $60 million expansion and renovation of its Illinois Steel Div. plant at Kankakee. The plant will have the most modern equipment and largest capacity of any of Birmingham's plants. A Danieli electric arc furnace manufactured in Italy highlighted the renovation. The three-electrode furnace melts scrap steel, recycled from previous uses, in 70-ton batches. The new furnace produced a higher quality steel by minimizing the amount of slag that was incorporated in the finished steel by discharging from the bottom. Old steel furnaces tilted to discharge molten steel from the top and incorporated more of the slag, which floats to the top in the finished steel. The molten steel is continuously cast to form 5.25-inch-square billets that are 23 feet long. Up to four lines of billets can be created simultaneously.

Japan's NKK Corp. announced in April that it had completed an agreement with National Intergroup Inc. to boost NKK's ownership share of National Steel Corp. from 50% to 70%. Under the agreement, National will sell 20% of National Steel to NKK for $147 million and will reduce its holdings by another 20% over the next 10 years. At that time, National Intergroup will have retained only 10% of National Steel's common stock. National Intergroup officials said the company wanted to divest its metals operations in favor of its distribution operations, including a $22.4 billion wholesale pharmaceutical distribution business.

Granite City Steel, a division of National Steel Corp., began operating the second continuous steel casting unit at Granite City plant on December 1, 1990. The new $140 million caster was scheduled to begin full-time production by mid-January 1991. Continuous casting replaced the ingot process where molten steel was poured into cast iron molds, cooled, removed, reheated, and then rolled into slabs at mills. The continuous caster receives the molten steel directly and immediately molds it into a slab. Cooling of the slab is computer controlled to produce a more consistent steel. When construction of the caster was announced in 1989, company officials indicated that it would eliminate 120 jobs. The company now indicates that most of the workers whose jobs would have been affected will be retained and moved to other departments. Granite City Steel also conducted a successful trial of a new coal that will be used in 1991 to improve

the quality of coke produced and reduce blast furnace production costs.

In November, Northwestern Steel and Wire Co. announced that startup of its new continuous casting facility would be delayed from December 1990 until February 1991. The delay resulted from a trucking accident that damaged an electrical control panel in transit to the mill. The caster, designed to make jumbo blank beams, would complement the plant's two existing casters.

Stockholders of Bliss & Laughlin Industries (B&L) approved in May the sale of 40% of the company to Canadian steelmaker Stalco Enterprises. B&L, based in the Chicago suburb of Harvey, is the United States' oldest producer of cold-finished steel bars.

The Amsted Corp., headquartered in Chicago, added a second shift to its American Steel Foundries plant in Granite City after completing a $1.5 million refurbishing. The plant, which reopened in 1989 after being mothballed for more than 6 years, manufactures railroad car side frames and bolsters.

In August, Sterling Alloy Casting Corp., headquartered in Sterling, Whiteside County, filed for Chapter 11 bankruptcy protection. Sterling manufactured iron castings and specialized in roof caps.

Granite City Pickling and Warehouse Co. started a subsidiary operation recycling waste chemicals used in the pickling process at local steel manufacturing operations. The pickling chemicals are processed into ferric oxide, which is sold to electronics manufacturers.

Other Metals.—Illinois ranked fourth nationally in both the quantity and value of primary aluminum produced. Reynolds Metals began a $30 million, 2-year expansion and modernization program at its McCook County aluminum plant. The expansion was designed to boost aluminum-plate capacity by 1% to 80 million pounds per year and to increase plate-machining capacity for wing skins by 50%. The expansion will include a new five-axis skin mill, an aging furnace, and two plate ingot soaking furnaces. Existing aging furnaces will be upgraded, and the plant's ultrasonic inspection tank will be expanded. The McCook operation specifically targets the aerospace-aircraft market in the United States and overseas.

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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 Illinois for 1990. Assistance in the preparation of the chapter was given by Wanda West and Maylene Hubbard, editorial assistants.

[2]Stone Review. Clean Air Act Amendments of 1990. June 1991, p. 27.

[3]Mining Engineering. Annual Review 1990, Illinois. V. 43, No. 5, May 1991, p. 498.

[4]General Dynamics Corp. 1990 Annual Report.

[5]Rock Products. Forecast 1991. V. 92, no. 12, Dec. 1990, p. 42.

[6]Work cited in footnote 4.

[7]Chicago Tribune. A Real Rock of Crystal Trade. Dec. 17, 1990.

[8]U.S. Bureau of Mines. Iron Oxide Pigments in 1990. Mineral Industry Surveys, Aug. 5, 1991, 11 pp.

TABLE 2

ILLINOIS: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	15,332	$44,238	$2.89
Plaster and gunite sands	239	876	3.67
Concrete products (blocks, bricks, pipe, decorative, etc.)	855	2,855	3.34
Asphaltic concrete aggregates and other bituminous mixtures	2,626	9,776	3.72
Road base and coverings[1]	4,906	21,461	4.37
Fill	3,700	9,354	2.53
Snow and ice control	106	289	2.73
Railroad ballast	74	278	3.76
Other[2]	83	638	7.69
Unspecified:[3]			
Actual	1,548	5,314	3.43
Estimated	2,910	9,651	3.32
Total[4] or average	32,380	104,728	3.23

[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.

TABLE 3

ILLINOIS: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	10,710	32,902	514	1,469	2,959	6,748	1,150	3,118
Plaster and gunite sands	—	—	W	W	201	759	W	W
Concrete products (blocks, bricks, etc.)	627	2,117	118	348	62	201	48	188
Asphaltic concrete aggregates and other bituminous mixtures	1,646	6,410	430	1,291	348	1,660	202	415
Road base and coverings[1]	2,658	12,917	822	2,975	996	3,857	429	1,712
Fill	2,019	5,395	403	675	851	2,363	427	920
Snow and ice control	83	211	W	W	W	W	—	—
Railroad ballast	—	—	W	W	W	W	—	—
Other miscellaneous[2]	46	203	12	43	118	712	42	153
Unspecified:[3]								
Actual	1,548	5,314	—	—	—	—	—	—
Estimated	1,183	3,437	830	3,777	627	1,616	270	821
Total[4]	20,519	68,907	3,129	10,578	6,164	17,915	2,569	7,328

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[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.

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. Inc., a subsidiary of Centex Corp.	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 division of Cementia Holdings AG	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.
Streator Brick Systems Inc.	West 9th St. Streator, IL 61364	do.	Livingston.
Fluorspar:			
Ozark-Mahoning Co., a subsidiary of Pennwalt Corp.[1]	Box 57 Rosiclare, IL 62982	Underground mines and plant	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 Steel Co.	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	Cook.
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 footnotes at end of table.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Perlite (expanded):			
Manville 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.	Shipyard Rd. Seneca, IL 71611	do.	La Salle.
Sand and gravel:			
Construction:			
Feltes Sand & Gravel Co. Inc.	Rural Route 25, Box 159 North Aurora, IL 60542	Pits and plants	Kane and Kendall.
Material Service Corp., a division of General Dynamics Corp.	300 West Washington St. Chicago, IL 60606	do.	Grundy, Kane, McHenry.
McHenry Sand & Gravel Co. Inc.	Box 511 McHenry, IL 60050	do.	Boone, Kane, McHenry.
Midwest Sand & Gravel Inc.	Box 218, 101 South Main La Rose, IL 61541	do.	Marshall.
Road Materials Corp.	Box 209 Algonquin, IL 60102	do.	Kane, McHenry, Peoria.
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	Champaign, Livingston, McHenry, Macon.
Industrial:			
Manito Investment Co.	Box 166 Tremont, IL 61568	Pit and plant	Mason.
Manley Bros. of Indiana Inc.	Box 538 Chesterton, IN 46304	Pits and plant	La Salle.
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	Whiteside.
International Mill Service Co.	1818 Market St. Philadelphia, PA 19103	do.	Madison.
St. Louis Slag Products Co. Inc., a division of Standard Slag Co.	Box 430 Granite City, IL 62040	Plant	Do.
Stone (crushed limestone-dolomite):			
Columbia Quarry Co.	Box 128 Columbia, IL 62236	Underground mine, quarries, plants	Johnson, Monroe, Puaski, St. Clair, Union.
Material Service Corp., a division of General Dynamics Corp.	300 West Washington St. Chicago, IL 60606	do.	Cook, Logan, Menard, Montgomery, St. Clair, Vermilion, Will.
Rein, Schultz & Dahl, Inc.	5960 Falcon Rd. Rockford, IL 61109	Quarries and plants	Carroll, Douglas, Kane, Stephenson, Will.
Vulcan Materials Co.	Box 7497 Birmingham, AL 35253	do.	Clark, Cook, Iroquois, Kankakee, Livingston, Will.
Sulfur (recovered):			
Marathon Oil Co.	Robinson, IL 64254	Plant	Crawford.

See footnotes 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	do.	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.
Stong-Lite Products Corp.	Shipyard Rd. Seneca, IL 71611	do.	La Salle.

[1]Also barite, copper, lead, silver, and zinc.

INDIANA

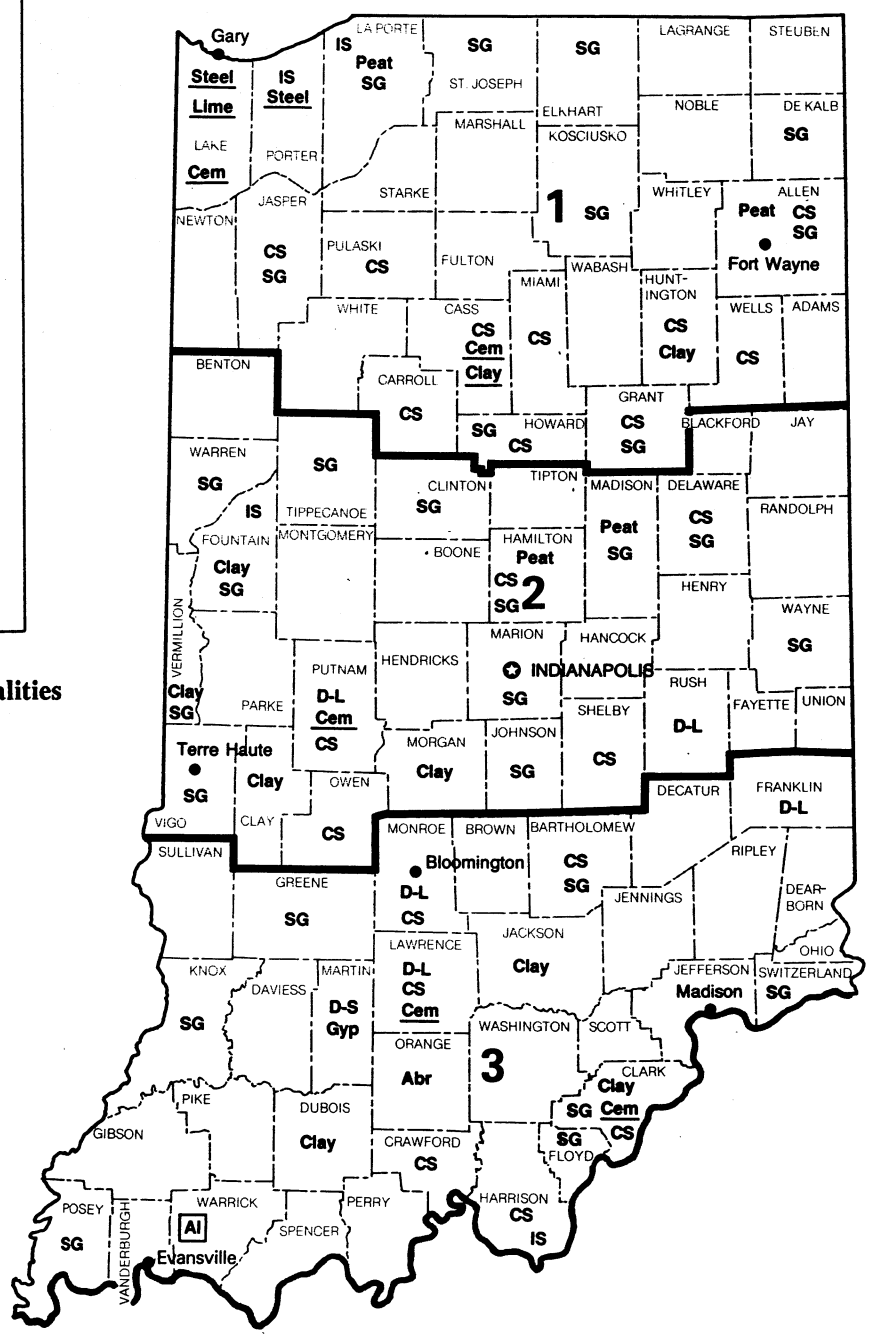
LEGEND

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

MINERAL SYMBOLS

Abr	Abrasives
Al	Aluminum plant
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
D-L	Dimension Limestone
D-S	Dimension Sandstone
Gyp	Gypsum
IS	Industrial Sand
Lime	Lime plant
Peat	Peat
SG	Sand and Gravel
Steel	Iron and Steel plant

Principal Mineral-Producing Localities



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 Wanda J. West[1]

Nonfuel mineral production in Indiana during 1990 was valued at $431.8 million, slightly less than the record established in 1989 and the first decline in 8 years. Increases in total values for cement, peat, industrial sand, and crushed and dimension stone sales were offset by declines reported for clays, gem stones, gypsum, lime, and construction sand and gravel. Crushed stone, portland cement, and construction sand and gravel, the leading minerals produced, accounted for 79% of the total value. Nationally, Indiana ranked 25th in nonfuel mineral value, supplying about 1% of the Nation's total. Indiana produced more dimension stone than any other State, and it ranked second and fourth, respectively, in masonry cement and peat sales. No metallic ores were mined in the State; however, it was the leading producer of pig iron and raw steel and ranked fourth in aluminum output.

The State's position as the Nation's leading steel producer was solidified by several events, including completion of the $525 million I/N Tek cold rolling mill at New Carlisle in March. Other noteworthy developments were the first full year of operation at Nucor Corp.'s new $270 million steel minimill near Crawfordsville and major modernization programs at integrated steel mills.

Main segments of the construction industry, which are primary users of Indiana's nonfuel minerals, experienced contrasting rates of activity during 1989. A slowdown in new home construction caused the number of private and public residential units authorized to fall to 25,002 in 1990, almost 6% fewer than in 1989. The decline in demand for raw materials by the homebuilding industry was partially offset by a sharp increase in commercial and industrial construction, particularly in eastern and central Indiana.[2] According to the U.S. Department of Commerce, Bureau of the Census, value of all nonresidential

TABLE 1
NONFUEL MINERAL PRODUCTION IN INDIANA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	405	$27,442	357	$24,054	368	$27,813
Portland	do.	2,315	107,179	2,364	108,297	2,417	114,414
Clays	metric tons	1,035,837	4,630	871,179	3,836	[2]1,051,703	[2]3,273
Gemstones		NA	10	NA	W	NA	W
Peat	thousand short tons	54	W	34	607	37	W
Sand and gravel:							
Construction	do.	25,923	79,985	e29,600	e99,200	23,879	76,886
Industrial	do.	362	1,829	W	W	W	W
Stone:							
Crushed	do.	e36,600	e130,000	[3]36,188	[3]136,252	e [3]36,700	e [3]147,700
Dimension	short tons	e195,444	e24,956	[3]198,531	[3]27,212	e [3]194,728	e [3]29,504
Combined value of abrasives (1988-89), lime, stone (crushed marl and miscellaneous stones, 1989-90, dimension sandstone, 1989-90), and values indicated by symbol W		XX	30,358	XX	34,657	XX	32,176
Total		XX	406,389	XX	434,115	XX	431,766

eEstimated. 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.

construction totaled $2,377 million, a 59% increase over that of 1989. Work on several of the major highway resurfacing or rehabilitation projects that began in 1989 continued into 1990. The value of State road contracts awarded in 1990 declined, however, to $633 million, about one-fifth less than the value of 1989 awards.[3]

EMPLOYMENT

Indiana's civilian labor force totaled 2.83 million in 1990, a decline of 48,000 persons from the number employed in 1989, according to the Employment Security Division, Indiana Department of Employment and Training Services. For the first time in 8 years, there was an increase in the State's overall unemployment rate. The 5.3% rate reported was almost 13% higher than the 1989 level and equal to that of 1988. However, continued strong demand for minerals increased employment at mining and quarrying operations to 8,100 persons, 3% more than in 1989. Employment at steel mills (38,600 persons) also remained consistent during 1990, with an increase of slightly less than 1% reported. Average hourly earnings climbed from $14.58 to $15.50 at mines and quarries and from $16.20 to $16.88 at steel mills. Average hours worked each week at mines and quarries increased from 45.7 to 47.3, the highest average weekly hours among the Indiana goods- and service-producing industries. The average number of hours worked each week at steel mills remained at 43.4.

REGULATORY ISSUES

Amendments to the Federal Clean Air Act, enacted on November 15, 1990, as Public Law 101-549, were of considerable concern to two of Indiana's main mineral producing-processing industries. Coal producers were concerned about the law's tougher standards aimed at reducing acid rain caused by coal-fired powerplants and its provision that required sulfur-dioxide emissions to be cut 50% by 1995 and 65% at the turn of the century. United Mine Workers of America officials feared that 20% of the State's approximately 4,000 union miners could lose their jobs if utilities switch to low-sulfur Western coal instead of retrofitting plants with pollution-control equipment to comply with the new standards. Retrofitting of plants would allow them to continue using Indiana coal, most of which has a high sulfur content. Steel companies operating integrated mills expected to make massive expenditures for cutting coke oven emissions in the coming years to comply with the law's curb on toxic air pollutants. Studies of methods to alleviate pollution related to coke ovens were initiated. The State's approximately 150 foundries also could be affected by the limitations.

A number of legal or administrative actions were filed against Indiana steel producers by, or on behalf of, the U.S. Environmental Protection Agency (EPA) and the Indiana Department of Environmental Management (IDEM) for alleged violations of various Federal and State environmental laws. Litigation continued on some lawsuits filed in previous years. In one of the largest settlements ever of an environmental lawsuit, USX Corp. agreed in late July to pay an estimated $34.1 million in penalties and cleanup costs for dumping wastewater from its Gary steel mill into the Grand Calumet River. The out-of-court settlement resolved a 1988 lawsuit filed by the EPA alleging that USX illegally bypassed its blast furnace wastewater treatment system and dumped polluted water from the Gary mill directly into the Grand Calumet River and Lake Michigan on several occasions. About $25 million of the settlement costs were to be used to clean up operations at the Gary mill, $2.5 million to study contamination of a 12-mile stretch of the Grand Calumet River, $5 million to clean up contamination of the river, and the remaining $1.6 million represented a civil penalty. The settlement was a consent decree, under which the company made no admission to any of the violations. EPA expected USX to complete the improvements in 2 years, with the company complying with more than 100 requirements and meeting 70 deadlines.[4]

EXPLORATION ACTIVITIES

The Department of Natural Resources' (DNR) Division of Reclamation, which handles permits for coal exploration and mining, received 31 notices of intent to conduct exploration core drilling operations. Exploration for industrial limestone continued during 1990, and the Indiana Geological Survey (IGS) further delineated the high-purity reefal limestone deposit discovered by the Survey near Kokomo.

LEGISLATION AND GOVERNMENT PROGRAMS

Mineral-related legislation enacted in 1990 pertained mainly to coal. Senate bill 52 declared that control of pollution from test holes relating to coal exploration was the responsibility of the Division of Surface Mine Reclamation. Regulations covering applications for self-bonds and the posting of bonds for surface coal mine reclamation were included in the measure. It also established permit requirements and a permit fee of $100 for noncoal test holes drilled to a depth of 200 feet or more.

Provisions of House Enrolled Act 1269 required an insurer that proposed to issue or renew a property insurance policy covering a building in 1 of 14 particular Indiana coal-producing counties to inform the policyholder or perspective policyholder of the availability of mine subsidence coverage and the amount of the premium of that coverage.

Other legislation passed by the Indiana General Assembly included measures related to establishing solid waste management districts and providing technical assistance to small businesses for solving environmental problems.

An executive order was signed by the Governor on May 30, creating the Indiana Coal Forum. Objectives of the forum were to recommend long and short range goals and strategies for encouraging responsible development of Indiana's coal

reserves by State and local governments and the private sector.

Late in 1990, the Indiana DNR established a toll-free telephone line within its reclamation division where Indiana residents could call for information about the mining of coal, clay, shale, and oil shale. Division personnel also responded to inquiries regarding the reclamation of lands disturbed to extract those minerals.

A DNR organizational change, effective July 1, 1990, was made with the enactment of Senate bill 362 that created the Bureau of Mine Reclamation. The new bureau, which is responsible for regulating surface and underground mining in the State, consists of the following divisions--IGS, Reclamation, and Oil and Gas. Senate bill 362 also added sections to the State's coal mine land reclamation law that would facilitate its implementation.

The IGS at Bloomington continued studies on the State's industrial minerals and fossil fuels resources, ground water geology, and various aspects of environmental geology. During the fiscal year that ended June 30, 1990, the IGS issued 6 reports, 2 new maps, and 72 revised maps. Timely dissemination of information also was achieved through technical papers, oral presentations, and personal responses to a wide range of public inquiries. Research by IGS's Industrial Minerals Section focused on clays and shales, shoreline and lake level behavior of Lake Michigan, geologic factors affecting underground limestone mines, and sedimentary features of the Salem Limestone. The Section published a report[5] describing the large limestone reef in northern Indiana, whose discovery was announced by IGS in 1989. A current catalog of all material published by the IGS, entitled "Geologic Publications of Indiana," is available from its Bloomington office.

The Division of Reclamation is responsible for administering and enforcing State and Federal laws requiring the restoration of lands disturbed by the mining of coal, clay, shale, and oil shale. During 1990, a major priority for the division was the development of a Procedures Manual for administering the Surface Mining Control and Reclamation Act. A rule revision project was under way to align State rules more closely with Federal rules. Issues such as bonding, archaeology, civil penalty assessments, soils, blasting, and revegetation standards were to be resolved in the rewrite and incorporated in the Procedures Manual. A video presentation on coal mining, reclamation, and the Division of Reclamation was prepared for use in the division's outreach and education efforts. Division personnel approved 13 surface mine permits during 1990 and made several thousand inspections of mine facilities.

Federal funding received by the Division of Reclamation for fiscal year 1989-90 (ending July 30, 1990) included the following: $2.3 million for the operating expenses of the administrative, enforcement, technical services, and restoration sections; $1.3 million for the 100% federally funded Abandoned Mine Lands administrative grants; and $1.1 million as the Federal Government's 50% share of the Administration and Enforcement grant.

U.S. Bureau of Mines grants to Purdue University at West Lafayette during fiscal year 1990 totaled $270,049 under provisions of Public Laws 98-409 and 100-483, the State Mining and Mineral Resources Research Institute Program. The basic allotment grant of $145,000 was supplemented by additional funds for pyrometallurgy and mineral industry waste treatment and recovery research. Funds provided under the act support basic research in the mineral sciences and engineering, and they are matched by State funds on a 2:1 basis.

In April, the U.S. Department of Agriculture, Forest Service, issued a Draft Environmental Impact Statement and a Draft Amendment to the Hoosier National Forest Plan. Once finalized, the proposed 10-year management plan would replace one issued in 1985. Eight management alternatives were developed and described in the documents for consideration and comment by the public. The draft plan identified 85,500 acres of the forest where oil, gas, and minerals leasing might occur. As part of the Forest Service's objective to establish a plan more acceptable to the general public, one of the alternatives included a ban on mineral leasing and mining on Federal lands in the 188,000-acre forest in south-central Indiana. This proposal was of particular concern to one of the gypsum producers, because it could have meant the loss of access to potentially minable gypsum deposits that underlie part of the forest land. At yearend, Forest Service personnel were revising the documents after considering public input to the draft. The Final Amendment to the Plan, the Final Environmental Impact Statement, and the Record of Decision were expected to be released early in 1991.

FUELS

Most of Indiana's mineral production value is derived from the fossil fuels sector. The State ranked ninth among 27 States in coal production. According to the U.S. Department of Energy (DOE), 35.9 million short tons of coal, with an average value of $23.91 per ton, was produced in Indiana in 1990.[6] The $858 million value was nearly double the combined value of nonfuel minerals produced. Five underground and 54 surface mines were active in 13 counties in the southwest quarter of the State.

Black Beauty Coal Co. began the permitting process for developing an underground mine complex near Monroe City in Knox County. The company planned to develop three underground mines by 1995 that would tap a rare low-sulfur coal reserve, 75% of which contained less than 1.6% sulfur. Approximately 4 million tons of coal was expected to be produced annually at the three mines over a 25-year period.[7] As of yearend, permitting had been completed for one of the mines.

Crude petroleum production, mainly from the Trenton Field in eastern Indiana, also contributed significantly to the State's mineral value; some natural gas was produced as well.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Cement.—In terms of value, cement was the second leading nonfuel mineral commodity produced in the State, following crushed stone, and it provided about one-third of the total nonfuel mineral value in 1990. Indiana ranked 12th among the 38 States producing portland cement and 2d among 36 masonry-cement-producing States. Portland cement sales were 2% greater than those of 1989 and the highest since 1978; masonry cement sales increased about 3%. Attendant values for both types reached record highs during the year, with portland's value increasing about 6% and masonry's about 16% over those of 1989.

Wet-process plants were operated by Essroc Materials Inc. (formerly known as Coplay Cement Co.), a subsidiary of Societe des Ciments Francais, at Speed, Clark County, and Lone Star Industries Inc. at Greencastle, Putnam County. Dry-process plants were operated by Lehigh Portland Cement Co. near Mitchell, Lawrence County, and Essroc Materials near Logansport, Cass County. Both masonry and portland cements were produced at each of the four plants. Sales of gray portland Types I and II, general use and moderate heat, and Type III, high-early-strength were reported from all of the plants, with Lehigh also reporting some sales of waterproof portland. Two companies sold small amounts of white portland cement as well. Lehigh continued to produce aluminous cement (calcium aluminate cement) at its Buffington Station plant at Gary, Lake County. This specialized cement, not included in U.S. Bureau of Mines statistics, is produced at only three plants in the Nation.

About 78% of the portland cement sales was to ready-mixed concrete companies. Other customers included concrete product manufacturers (11%), highway contractors (5%), building material dealers (4%), and other miscellaneous customers. Nearly all of the cement was trucked in bulk form to consumers. The plants operated at approximately 97% of their combined 2.6-million-short-ton clinker capacity compared with a national average of 86% utilization. About 4.8 million tons of raw material was consumed in the manufacturing process, including 3.7 million tons of limestone, 614,000 tons of clay and shale, 164,000 tons of gypsum, and smaller amounts of fly ash, pyrite, sand, and slag.

Cement shipments to and within Indiana from all domestic sources included 1.9 million tons of portland cement and 100,000 tons of masonry cement, only slight variations from 1989 figures.

In December, Lone Star Industries Inc. filed for protection from creditors under chapter 11 of the U.S. Bankruptcy Code. The company said it was filing for protection because it could not meet certain obligations under its agreements with creditors and because it had been hurt by diminishing housing construction starts and greater foreign competition. Lone Star, one of the largest cement companies in the Nation, operated plants in several States, including one at Greencastle in Putnam County.

Clays.—Indiana ranked ninth in common clay and shale output among 43 producing States. Eight companies reported production from 11 pits in 8 counties. Spurred by increased demand, especially for cement and brick manufacture, output rose about 21% over that of 1989 to its highest level since 1979. However, a sharp decline in the average value per short ton (from $3.99 to $2.82) resulted in a 15% decline in total value. Indiana's clay was used captively or sold mainly for manufacturing portland cement, bricks, and concrete blocks. Some was also used in drain tile manufacture.

Yellow Banks Clay Products Inc. mined ball clay in Dubois County for use as an absorbent and as a filler for various products. In August, the operation was acquired by United Clays Inc., a division of The WBB Group of the United Kingdom.

Gypsum.—Crude gypsum production fell about 3% from the record output of 1989, and total value declined 28%. Indiana ranked seventh among 20 producing States. National Gypsum Co. and USG Corp. each operated an underground mine near Shoals in Martin County and calcined gypsum at wallboard plants adjacent to the mines. USG also manufactured wallboard at East Chicago using crude gypsum shipped in by lake freighter from Michigan. Production from Indiana's three calcining plants decreased 3% in quantity and 16% in value. Reduced wallboard demand resulting from a decline in new home construction during 1990 was alleviated somewhat by increased demand for commercial construction use, an increase in the average home size, and growth in the repair and remodeling markets. A 13% drop in the average value of the calcined product mirrored a 5-year national trend of declining wallboard prices.

USG's Shoals Mine was the fourth largest of 58 U.S. mines active in 1990. For the sixth time in 12 years, the mine was awarded the prestigious Sentinels of Safety Trophy, in the underground nonmetal category, by the American Mining Congress. The award was based on the 181,706 employee hours worked in 1989 without a lost-time injury.

A DOE-sponsored clean-coal technology project will develop a new source of gypsum for wallboard production. A flue gas desulfurization system (scrubber) under construction at Northern Indiana Public Service Co.'s (NIPSCO) Chesterton plant in Porter County, which will enable the plant to continue burning high-sulfur Midwest coal while meeting new clean air standards, also will produce commercial-grade synthetic gypsum as a byproduct. When the $110 million scrubber begins operating in mid-1992, NIPSCO expects to be producing enough gypsum to make 150 million square feet of wallboard annually, adequate for 18,750 single-family homes.[8] In December, NIPSCO entered into a contract with USG Corp. for purchase of the synthetic gypsum. USG will use the material at its East Chicago wallboard

plant, which currently uses crude gypsum shipped through the Great Lakes from Michigan.

Lime.—Inland Steel Co. and Marblehead Lime Co. produced quicklime from Michigan limestone at plants in Indiana Harbor and Gary (Buffington Station), respectively. Indiana ranked 11th of 32 lime-producing States. Production decreased 14% from the 1989 output. However, a 10% increase in the unit price resulted in a decline of only 5% in total value. Most of the lime was used in steel manufacture at local mills. In 1990, Marblehead's Buffington plant ranked ninth in output among the Nation's 114 lime-producing plants.

Nationally, Indiana ranked third, behind Pennsylvania and Ohio, in lime consumption. Lime shipments to and within Indiana, from all domestic sources, totaled 1.5 million short tons of quicklime and 31,000 short tons of hydrated lime, only slight variations from quantities consumed in 1989.

Peat.—Peat sales increased almost 9% over those of 1989. In spite of the gain, Indiana dropped from the third place ranking it held nationally in 1988 and 1989, and it ranked fourth in 1990 among the 22 peat-producing States. A marked increase in sales by Minnesota producers elevated that State to the third ranking position, behind Michigan and Florida.

Five companies harvested peat 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; some humus peat also was produced. About 84% of the sales was for general soil improvement, with lesser amounts reported for use as an earthworm culture, on golf courses, as an ingredient for potting soils, for use by nurseries, and for packing plants, shrubs, etc.

Perlite (Expanded).—Perlite mined in Western States was expanded at four Indiana plants. Sales (23,000 short tons valued at $5.9 million) were up slightly over those of 1989. The expanded product was used in concrete, for horticultural purposes, and in plaster aggregates, fillers, filter aids, and insulation.

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 1988 and 1990 and estimates for 1989.

Indiana was the Nation's 12th largest producer of construction sand and gravel in 1990. Construction sand and gravel continued as the State's third leading nonfuel mineral commodity in terms of value, supplying 18% of the total. However, production decreased 19% in quantity and 22% in value from the record highs estimated for 1989. Sixty-eight companies reported production from 108 operations in 57 of the State's 92 counties.

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.

On January 31, CSR Ltd., an Australian sugar company with an interest in building and construction materials, acquired ARC America Corp. ARC's holdings in Indiana included three quarries and three sand and gravel pits operated by American Aggregates Corp.

Industrial.—Industrial sand production fell sharply for the second consecutive year. Chrisman Sand Co. Inc. produced refractory sand near Portage, Porter County. U.S. Silica Co. began commercial production of sand for a variety of special uses at the former Card Industrial Sand Co. plant at Elizabeth, Harrison County. U.S. Silica acquired the property from Card in 1989.

Slag, Iron and Steel.—Indiana ranked second, behind Ohio, among 28 States in sales of iron and steel slag. Three companies processed slag from local steel mills at four locations in Huntington, Lake, and Porter Counties. Sales increased for the seventh consecutive year. This trend parallels the constancy of the State's pig iron production and also reflects the effectiveness of slag's use in many markets traditionally served by natural aggregates. Most of the product was sold for road base construction, with the remainder used for a wide variety of other purposes.

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 1988 and 1990 and actual data for 1989.

Crushed.—About 34% of the State's nonfuel mineral value was from crushed stone sales. Demand for crushed stone remained strong, and, in 1990, production was estimated at 36.7 million short tons, approximating the output of each of the 2 previous years. Value of production was $147.7 million, about 8% over figures published for 1989 and a new State record.

On January 31, CSR Ltd., of Australia, acquired ARC American Corp., whose holdings in Indiana included three quarries and three sand and gravel pits operated by American Aggregates Corp.

Dimension.—The resurgent use of the world-famous Indiana building stone continued, recapturing a larger share of the construction market where the use of aluminum, glass, and steel predominated for modern architectural designs in recent years. Although its 1990 dimension stone production was estimated to have declined slightly (2%) from that of 1989, Indiana again led the Nation, outranking 33 other producing States. Total value of production rose 8% to a record high. Limestone/dolomite accounted for practically all of the output, with Lawrence and Monroe Counties in the famed south-central Indiana limestone belt the production leaders. Some dimension sandstone was produced from Martin County quarries.

Sulfur (Recovered).—Amoco Oil Co. operated a sulfur extraction plant at its Whiting petroleum refinery in Lake County. Recovered byproduct sulfur sales increased moderately.

Metals

Aluminum.—Indiana again ranked fourth of 14 States producing aluminum. A downturn in the market, which began late in 1989, continued into 1990, driving down prices throughout the year.[9] Although production declined only slightly, total sales value fell almost 16%. The Aluminum Company of America (Alcoa) Warrick Operations at Newburgh, Warrick County, was the State's only producer of primary aluminum. Although the operation's 330,000-metric-ton-capacity smelter was the largest in the United States, it only supplied one-half of the plant's metal requirements for the thin metal sheet it produced for the container industry. The remainder came from the company's aluminum can recycling facility, the largest operation of its kind in the world. In 1990, the Warrick plant recycled a record 9 billion beverage containers. Alcoa's Warrick Operations contributed $385 million to the area's economy in 1990, including $152 million in payroll. Approximately 3,800 people were employed at the plant.[10]

A modernization of Alcoa's can sheet plants at Warrick and at Alcoa, TN, that would increase productivity and can sheet quality was nearly completed at yearend. Total cost of the upgrade, which began in the mid-1980's at the two plants, was about $900 million, according to company officials.

Iron and Steel.—Raw steel production from Indiana mills totaled more than 21.2 million short tons in 1990, an increase of about 2% over the 1989 figure and the highest since 1981, according to the American Iron and Steel Institute. The State's peak production was in 1978 when 24.4 million tons was reported. In 1990, Indiana again led all other States in production and supplied almost 22% of the Nation's total output.

Industry highlights in 1990 included the startup of I/N Tek's $525 million cold-rolling sheet finishing mill at New Carlisle in St. Joseph County. It also marked the first full year of operation of Nucor Corp.'s $270 million minimill south of Crawfordsville in Montgomery County. The new mill uses scrap steel to produce steel slabs 52 inches wide and 2 inches thick--the first U.S. minimill to produce flat-rolled steel. At yearend, the mill was operating close to its design capacity of 800,000 short tons per year, and approximately 400 workers were employed at the plant. Development and adoption of new technology continued to be a major thrust with Northwestern Indiana steelmakers. Approximately $5.2 billion had been invested in recent years in the massive restructuring to update facilities and improve product quality.[11]

Bethlehem Steel Corp. completed installation of a $50 million vacuum degasser at its Burns Harbor plant. Construction began on a new 72-inch coating line capable of producing 450,000 short tons of hot-dip galvanized and galvanealed sheets annually. The state-of-the-art line was scheduled to be in production in 1993. Annual production capability of the Burns Harbor plant was 5.2 million short tons of raw steel and 4 million short tons of cast slab.[12]

Bethlehem formed a joint venture with Feralloy Corp. of Chicago and Signode Corp. of Glenview, IL, to construct a $12 million pickling line in Portage that will clean steel for Bethlehem's Burns Harbor plant and other industries. The venture, to be known as Indiana Pickling & Processing Co., expected the 600,000-ton-per-year facility to be in operation late in 1991 and to employ about 65 persons.

Bethlehem received a $31.6 million grant from DOE and a $1.2 million loan from Indiana's Corporation for Science and Technology as partial funding for a $144 million project to investigate the feasibility of using pulverized coal as a fuel and partial substitute for coke in blast furnaces. By 1994, two blast furnaces at the Burns Harbor mill would be converted to the coal injection process in which finely ground coal would be blown into the furnace, replacing oil or natural gas and reducing coke consumption. Coals of varying sulfur content and of various sizes would be used in the tests, which were scheduled to run from late 1994 through 1996. DOE funds were provided through its Clean Coal Technology Demonstration Program under which Government and industry seek to develop advanced technologies that would allow utilities and industries to use coal while protecting the environment. As part of its agreement with DOE, Bethlehem would share test results with other U.S. steel companies. The project could increase the use of Indiana coal, alleviate environmental problems associated with coke plant operations, and cut steelmaking costs.

At its Indiana Harbor Works, Inland Steel Co. continued a modernization program that, since 1984, had cut 24% from the cost of producing a ton of steel.[13] The first phase of a $100 million capital improvement program at the East Chicago mill of Inland's wholly owned subsidiary, Inland Bar & Structural Co., was completed during 1990 when a new ladle metallurgy facility came on-stream. Work continued on modifications to two electric furnaces, a billet caster, and two bar mills. Completion of the project was scheduled for 1991.

Late in the year, Inland Steel Co. announced plans to study the possibility of replacing five of its six cokemaking facilities with an innovative process that would significantly cut air and water emissions and enable the company to meet new environmental standards. The proposed heat-recovery coke facility would operate under negative pressure, thereby eliminating substantially all air pollutants, and it would not involve any water discharge. If constructed as proposed, the facility would be built in conjunction with an electric generating plant that would use the waste heat from the coking process. It would be the first such plant in the steel industry.[14]

In December, Inland announced that it would close its 74-year-old structural mill in 1991. About 325 workers would be

affected by the closure. The company had been focusing more on its bar steel production in the past 2 years and cited increasing competition from minimills, which could produce structural products more efficiently, as one of the factors in its decision.

Production of cold-rolled sheet steel began in mid-March at the new I/N Tek plant at New Carlisle, St. Joseph County, following nearly 3 years of construction. The $525 million facility, reportedly the world's most advanced cold-rolling steel finishing mill, was a joint venture between Inland Steel Co. (60%) and Nippon Steel Corp. (40%). The mill's continuous process integrated the pickling, tandem rolling, annealing, temper rolling, and inspection of the steel coils and reduced the processing time to less than 1 hour from the 12 days necessary for traditional cold-rolling processes. At full capacity, the plant was designed to produce 1 million short tons of cold-rolled steel annually and to employ about 230 people. Steel feedstock for the plant was received by railcar from Inland's Indiana Harbor Works. At yearend, construction was about 90% complete on the adjacent $450 million I/N Kote plant that would add zinc coatings to some of the sheet steel produced at I/N Tek. The plant, also a joint (equally owned) partnership of Inland and Nippon Steel, was scheduled for completion in 1991. Separate electrogalvanizing and hot-dip galvanizing lines were to have a combined annual capacity of 900,000 short tons. I/N Kote was expected to employ about 170 workers.

LTV Steel Co. Inc. installed vacuum decarburization and ladle reheating systems and made various other improvements at its Indiana Harbor Works in East Chicago. The integrated mill complex employed about 3,500 workers and produced a variety of flat-rolled products.

The modernization program that began at USX Corp.'s Gary Works in 1989 continued during 1990, with completion scheduled for July 1991. Construction was interrupted by a labor dispute, from October 23 through November 7, when 400 craft union members went on strike over a hiring incident. Completion of the new 1.6-million-short-ton slab caster would make the Gary Works 100% caster reliant and increase its annual casting capability to just over 7 million short tons, according to the company's annual report. Installation of automatic gauge control equipment that would enable the company's 160-inch plate mill to roll plate to more exacting tolerances also was part of the upgrade underway.

Beta Steel Corp. began construction of a $100 million mill at Portage in Porter County. When completed in 1991, the plant would process annually about 400,000 short tons of steel slabs, purchased from area mills, into coils up to 60 inches wide. Customers for the sheet steel would reportedly include steel service centers and tube and pipe manufacturers that previously imported steel to meet their requirements. About 170 people were expected to be employed at the plant.

Magnetics International Inc., a subsidiary of Inland Steel Co., began construction of a $25 million facility to process spent hydrochloric acid used in steel mills, known as pickle liquor, for reuse in the mills. The solution, which is used to clean steel, would contain about 20% iron when it enters the plant for recycling, and the company planned to recover about 25,000 short tons per year of iron oxide from about 35 million gallons of pickle liquor. The facility would reportedly be Indiana's first producer of iron oxide. No date had been set for construction of a companion plant that would refine the iron oxide into hard and soft ferrite powder for magnetic applications.

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[1]Former editorial assistant, U.S. Bureau of Mines, Minneapolis, MN. She has 36 years of experience in mineral-related work with the U.S. Bureau of Mines and has covered the mineral activities in Indiana for 2 years.

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[3]Highway and Heavy Construction. Market Update: Highway Construction Booming to New Heights. V. 133, No. 6, Apr. 1990, pp. 34-37.

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[5]Ault, C. H., and M. V. Ennis. Discovery of Thick Reefal Limestone in Howard County, Indiana. IN Geol. Surv. IC 3, 1990, 4 pp.

[6]U.S. Department of Energy. Coal Production 1990, Energy Information Administration. DOE/EIA-0118(90), 1991, p. 41.

[7]Sunday Herald-Times (Bloomington). Coal Company Welcomes New Laws. July 1, 1990, p. C2.

[8]Chicago Tribune (IL). Utility to Generate Walls as Well as Watts. Apr. 22, 1990.

[9]Aluminum Company of America. 1990 Annual Report to Stockholders, 52 pp.

[10]Evansville Press. Alcoa Plant Output Hits Record Levels. June 5, 1991.

[11]Michigan City News Dispatch. Leaders Say Region Ready if Recession Hits. Dec. 6, 1990.

[12]Bethlehem Steel Corp. 1990 Form 10-K Report, p. 8.

[13]Muncie Star. Inland, Nippon Steel Firms to Dedicate Joint Venture. Apr. 24, 1990.

[14]Inland Steel Industries. 1990 Annual Report to Stockholders, p. 4.

TABLE 2

INDIANA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	7,055	$18,511	$2.62
Plaster and gunite sands	106	444	4.19
Concrete products (blocks, bricks, pipe, decorative, etc.)	580	1,691	2.92
Asphaltic concrete aggregates and other bituminous mixtures	1,750	5,547	3.17
Road base and coverings[1]	2,514	8,931	3.55
Fill	2,440	5,749	2.36
Snow and ice control	219	673	3.07
Railroad ballast	W	W	1.67
Other[2]	503	1,965	3.91
Unspecified:[3]			
Actual	7,762	30,775	3.96
Estimated	951	2,600	2.73
Total or average	[4]23,879	76,886	3.22

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules and 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.

TABLE 3

INDIANA:[1] SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	1,238	3,364	2,113	7,713	3,703	7,435
Plaster and gunite sands	W	W	64	230	W	W
Concrete products (blocks, bricks, etc.)	43	155	429	1,204	107	333
Asphaltic concrete aggregates and other bituminous mixtures	660	2,107	478	1,636	565	1,616
Road base and coverings[2]	509	1,384	1,651	6,346	306	1,099
Fill	652	1,322	1,208	3,438	581	989
Snow and ice control	46	107	140	484	33	82
Railroad ballast	W	W	—	—	—	—
Other miscellaneous[3]	279	1,328	138	585	128	267
Unspecified:[4]						
Actual	266	1,023	6,718	2,6771	777	2,981
Estimated	407	1,126	544	1,474	—	—
Total[5]	4,099	11,916	13,484	49,879	6,201	14,802

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Excludes 94,949 short tons valued at $289,564 not reported by county.
[2]Includes road and other stabilization (cement and lime).
[3]Includes roofing granules and 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.

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	Pits and plant	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. Plant	Do. Lake.
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	Lake.
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.
Filbrun Peat Moss	Route 2, Box 269 Pendleton, IN 46064	do.	Madison.

See footnotes at end of table.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Peat—Continued			
Hyponex Corp.	14111 Scotslawn Rd. Marysville, OH 43041	do.	Hamilton.
Millburn Peat Co. Inc.	Box 236 La Porte, IN 46350	do.	La Porte.
Perlite (expanded):			
Chemrock Corp.	Box 5465 Lafayette, IN 47903	Plant	Tippecanoe.
Grefco Inc.	Box 48 Crawfordsville, IN 47933	do.	Montgomery.
National Gypsum Co.	2001 Rexford Rd. Charlotte, NC 28211	do.	Martin.
USG Corp.	101 South Wacker Dr. Chicago, IL 60606	do.	Do.
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.
Hilltop Basic Resources Inc.	630 Vine St. Cincinnati, OH 45202	Pit and plant	Switzerland.
Irving Materials Inc.	Box 369, Route 5 Greenfield, IN 46140	Pits and plants	Fayette, Hamilton, Madison, Wayne.
Martin Marietta Aggregates	Box 30013 Raleigh, NC 27622	do.	Clark, Hamilton, Howard, Marion, Vermillion, Vigo.
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	Fountain, Greene, Knox, Morgan, Owen, Warren.
Vulcan Materials Co.[1]	Box 7497 Birmingham, AL 35253	do.	St. Joseph and 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.
Slag:			
Iron and steel:			
The Levy Co. Inc.	Box 540 Portage, IN 46368	Plant	Porter.
Steel:			
Heckett Co.	Box 1071 Butler, PA 16001	do.	Lake.
Stone (1989):			
Crushed:			
Limestone:			
American Aggregates Corp., a division of CSR America Inc.	Drawer 160 Greenville, OH 45331-0160	Quarries and plants	Hamilton and Marion.
Beazer USA	1850 Koppers Bldg.Pittsburgh, PA 15219	do.	Allen, Jennings, Putnam, Riley, Scott, Washington.

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			
Irving Bros. Stone & Gravel Inc.	Box 300, Rural Route 13 Muncie, IN 47302	do.	Blackford, Delaware, Grant, Huntington, Wells.
Mulzer Crushed Stone Inc.	Box 248 Tell City, IN 47586	Quarries, mine, plants	Crawford.
Rogers Group Inc.	Box 849 Bloomington, IN 47402	Quarries and plants	Greene, Lawrence, Monroe, Newton, Putnam.
Marl:			
Vernon M. Kaufman	Route 1 Topeka, IN 46571	Pit	Lagrange.
Dimension, limestone:			
Elliot Stone Co. Inc.	Box 743 Bedford, IN 47421	Quarry and plant	Lawrence.
B. G. Hoadley Quarries Inc.	Box 1224 Bloomington, IN 47402	do.	Do.
Independent Limestone Co.	6001 South Rockport Rd. Bloomington, IN 47401	do.	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.
Victor Oolitic Stone Co.	Box 668 Bloomington, IN 47402	Quarries and plant	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.

IOWA

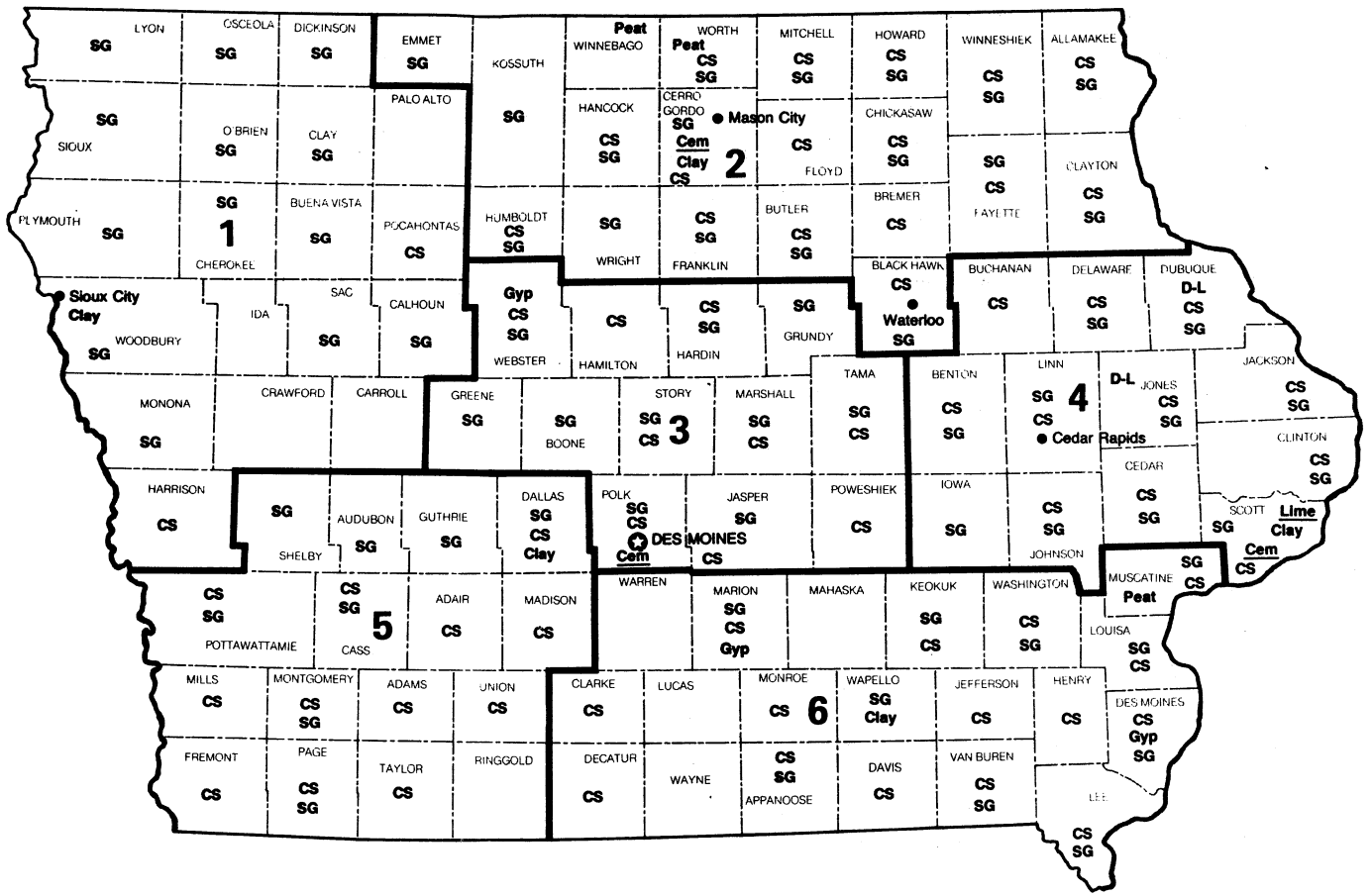
LEGEND

- 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



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 Donald K. Harrison[1] and Robert M. McKay[2]

The value of nonfuel mineral production in 1990 was at an alltime high of $316.4 million, a $33.7 million increase compared with the 1989 value. Portland cement, crushed stone, construction sand and gravel, and gypsum accounted for the majority of the State's mineral production value. Most of these commodities were utilized by the construction industry. Other mineral commodities produced included masonry cement, clays, lime, peat, and dimension stone. Nationally, Iowa ranked 32d in the value of nonfuel mineral production. The State ranked first in crude gypsum output and value and second of 28 States that reported calcined gypsum production.

Construction activity in the State, which depended heavily on the availability of mineral commodities, remained steady in 1990. The number of private and public residential units authorized in the State rose 3.3%, from 7,392 units in 1989 to 7,637 units in 1990. The value of nonresidential construction also rose slightly (up 1.5%), from $571 million in 1989 to $579 million in 1990. Value of State road contracts awarded remained relatively unchanged at $1.07 billion. As a result of the continuing healthy construction activity, demand for portland cement, crushed stone, and construction sand and gravel remained strong. Output of portland cement, the State's leading mineral commodity in terms of value, rose almost 22% in 1990. Estimated output of crushed stone, the State's second leading mineral commodity, rose 4%, while construction sand and gravel production increased almost 17% from 1989 levels.

EMPLOYMENT

In 1990, the average number of workers[3] employed in the nonfuel minerals industries in Iowa was 2,341. This included 214 workers at underground mines, 1,434 at surface plants, and 693 workers at mills and preparation plants in the State. In addition, about 100 workers were employed in coal mining. In the mineral-dependent construction industry, the annual average number of workers was about 45,000--up from an average of 40,500 in 1989. Stone, clay, and glass product employees averaged 5,800, and primary and fabricated metal product employees numbered about 26,000 workers.

TABLE 1
NONFUEL MINERAL PRODUCTION IN IOWA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	W	W	47	$4,450	53	$5,054
Portland	do.	2,029	$98,930	2,072	$102,387	2,525	122,466
Clays	metric tons	403,923	1,588	439,323	1,773	423,227	1,376
Gemstones		NA	W	NA	10	NA	14
Gypsum (crude)	thousand short tons	2,047	13,710	2,273	16,884	2,192	14,243
Peat	do.	15	433	W	W	W	W
Sand and gravel (construction)	do.	11,880	36,087	e12,800	e37,800	14,953	46,432
Stone:							
Crushed	do.	e29,200	e128,500	28,049	111,182	e29,000	e118,600
Dimension	short tons	W	e588	15,151	613	W	W
Combined value of other industrial minerals and values indicated by symbol W		XX	10,420	XX	7,603	XX	8,185
Total		XX	290,256	XX	282,702	XX	316,370

eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included ith "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

REGULATORY ISSUES

Early in the year, Iowa joined with 28 other States in suing asbestos companies to have them pay for removing the substance from public buildings. One estimate of ridding the State's public buildings of asbestos was close to $500 million. Nationally, the price tag was estimated to be as high as $750 billion. The suit, led by the State of Washington, alleged that the almost 30 defendants (primarily asbestos companies) had the responsibility to provide products that were safe for their intended uses or warn the States of the danger posed by their products.[4]

LEGISLATION AND GOVERNMENT PROGRAMS

A number of bills concerning mineral-related or environmental issues were introduced by the Iowa Legislature in 1990. Topics addressed included sales tax exemptions for precious metals, establishing a mineral severance tax, reorganizing the Department of Natural Resources (DNR), and the issuing of environmental quality control permits by the DNR. All of these bills died while still in committee. However, in February, Senate Resolution 108 was adopted by the State Legislature. This resolution proposes that September 23 be designated "American Coal Miners' Memorial Day" to honor U.S. coal miners. The purpose of the holiday would be to educate school children about the dangers of coal mining and the importance of the Nation's coal industry.

The Iowa Geological Survey Bureau (IGSB) continued work on its Ground Water Vulnerability Mapping Program. Part of the effort involved the continuation of preparing a bedrock topographic map for the State. This tool, scheduled for completion in 1992, will benefit minerals explorationists in addition to ground water researchers. Work also continued on an unconsolidated material thickness map. This project, also expected to be completed in 1992, will be useful to aggregate producers in identifying new sources of crushed stone. In April, the IGSB published results of the AMOCO Production Co. M.D. Escheid No. 1 deep petroleum test done in Carroll County in 1987. The 17,851-foot deep dry hole was plugged and abandoned but provided information on potential oil source rocks elsewhere in the region.

The Federal Office of Surface Mining, in January, awarded the State $500,000 in grants for abandoned mine reclamation projects. Part of the grant will be used for a reseeding project at the Rouwenhorst West reclamation project, site of an abandoned mine near Knoxville. About $334,000 of the money is to be used to defray the cost of administering the State's abandoned mined lands reclamation program.

Under the State Mining and Mineral Resources Research Institute Program Act (Public Law 98-409), the U.S. Bureau of Mines awarded a basic allotment grant of $145,000 to Iowa State University. The monies were used to perform basic and applied research related to Iowa's mineral resources and for the general benefit of the Nation's mineral industry. Under stipulations of the act, the State of Iowa was required to match this grant on a 2:1 basis.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Cement.—Four companies produced cement in Iowa in 1990. Two of the companies produced both portland and masonry cement; two produced only portland cement. The companies that produced both cements were the Davenport Cement Co., which operated a plant near Buffalo, Scott County, and Holnam Inc., Dundee Div. (formerly Northwestern States Portland Cement Co.) at a plant near Mason City. Lehigh Portland Cement Co. also operated a plant near Mason City and produced only portland cement and Monarch Cement Co. ground clinker from its Humboldt, KS, facility at a plant in Des Moines, Polk County. All of the plants are foreign-owned except for Monarch Cement. Principal markets for the cement were ready-mix concrete companies, concrete product manufacturers, highway contractors, and building material dealers.

In January, Northwestern States Portland Cement Co. stockholders approved the company's acquisition by Dundee Cement Co. Purchase price of the Mason City operations was $44 million. The Mason City cement plant has an annual capacity of 900,000 short tons of portland and masonry cement. Dundee, with headquarters in Dundee, MI, is a subsidiary of Holderbank Financiere Glarus AG of Switzerland.

In mid-December, Lafarge Corp., Reston, VA, began transactions to acquire various operations of Cementia Holdings AG of Zurich, Switzerland, including the Buffalo, IA, plant of its Davenport Cement Co. subsidiary. Also included in the proposed agreement would be cement manufacturing plants in Illinois and Missouri, more than 30 related ready-mixed concrete and aggregate operations, and 16 terminals along the Mississippi River and its tributaries. Lafarge reportedly would become the second largest cement producer in the Mississippi River region, with a combined capacity of 3.8 million short tons of cement. The transactions were expected to be completed in January 1991.

Gypsum.—Iowa ranked first in the Nation in crude gypsum output and second in calcined gypsum production. Crude gypsum was mined by five companies at six mines and processed at five plants. Both underground and open pit mining methods were used. In 1990, production and value of crude gypsum declined 3.6% and 15.6%, respectively, from 1989 levels. Total gypsum calcined in 1990 amounted to 1,505,792 short tons, a 1% increase from that of 1989.

USG Corp.'s Sperry Mine in Des Moines County was a runner-up in the underground nonmetals category for the prestigious Sentinels of Safety award. The annual award is presented by the

Federal Mine Safety and Health Administration and the American Mining Congress to honor the mines in each of six categories that have worked the most employee-hours during the year while suffering no lost-time injuries. In terms of total output, the Sperry Mine was the fifth largest in the Nation. The adjoining Sperry plant ranked fourth in production of 71 calcining plants in the Nation.

Lime.—Lime production and value remained unchanged in 1990. Linwood Mining & Minerals Corp., the State's only producer, produced lime at a plant in Scott County. Most of the production was quicklime; a small amount of hydrated lime also was produced.

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 1988 and 1990 and estimates for 1989.

Iowa construction sand and gravel statistics are compiled by geographical districts. Table 3 presents end-use statistics for the six districts outlined in the State map.

Construction sand and gravel was the third leading mineral commodity produced in the State. In 1990, production and value increased 17% and 23%, respectively. These increases were largely attributable to the continuing strong construction activity in the State. A total of 109 companies mined construction sand and gravel from 172 operations in 65 counties. Leading counties, in order of output, were Polk, Washington, and Sioux. The material was used mainly for concrete aggregate, asphaltic concrete, road base and coverings, and fill.

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 1988 and 1990 and actual data for 1989.

Crushed.—Crushed stone, the second leading mineral commodity produced in the State, accounted for 37% of the State's nonfuel mineral value. Limestone-dolomite was the only type of crushed stone produced in the State. Estimated 1990 production and value increased 3% and 7%, respectively. Major uses were for road base, cement manufacturing, and agricultural limestone.

In February, Kuhlman Construction Co., Colesburg, received the Recognition of Excellence for Outstanding Achievement award, the highest safety award presented by the Iowa Limestone Producers Association. Employees of Kuhlman, a construction aggregate producer, had worked a total of 20 years without incurring a single lost-time accident.

Dimension.—Dimension limestone was produced by one company in Jones County. Most of the stone was sold for irregular-shaped stone, veneer, sawed blocks, and flagging.

Other Industrial Minerals.—Four companies mined clay in 1990. Production and value decreased 4% and 22%, respectively, from 1989 levels. The clay was used primarily in manufacturing portland cement and for common brick. The estimated value of gem stones, collected by amateur collectors and rockhounds, was $14,000 in 1990. Two companies produced peat from bogs in Muscatine and Worth Counties. The peat was used primarily for general soil improvement and as a seed inoculant. National Gypsum Co. expanded crude perlite, received from out-of-State, at two plants in Webster County. The expanded perlite was used primarily for plaster aggregate.

Metals

Several mineral commodities produced in other States were processed or refined in Iowa. Aluminum Co. of America (Alcoa) operated an aluminum rolling complex near Davenport. In 1990, a new rolling mill was started up at the plant. The new rolling mill was part of a $1.2 billion plant and equipment program that began at the complex in 1983. The Davenport Works, which employs almost 2,800 workers, produces more than 600 million pounds of aluminum per year and generates $1 billion in sales revenues annually. The primary markets served by the plant are the aerospace, automotive, and light sheet metal industries.

Quanex Corp., a Houston, TX, metals firm, announced plans to build a $60 million aluminum minimill in Davenport. The new mill will be adjacent to the company's existing Nichols-Homeshield aluminum operations. The proposed plant will melt aluminum scrap and process it into sheets of aluminum for the homebuilding industry. The expected plant completion date is mid-1992.

Keokuk Ferro-Sil Inc. produced silvery pig iron and 50% ferrosilicon at a plant in Keokuk. The plant was the Nation's only producer of silvery pig iron, which is used to manufacture steel alloys.

PMX Industries, a subsidiary of Poongsan Corp. of Seoul, South Korea, continued construction of its new 80,000-ton-per-year copper, brass, and specialty steel mill at Cedar Rapids. In October, the U.S. Congress, as part of an appropriations bill, attached a provision granting the PMX operation Free Trade Zone Status. This status grants the facility special import benefits, and, for the first time, circumvents the zone creation process overseen by the U.S. Commerce Department.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related experience and has covered the mineral activities in Iowa for the past 2 years. Assistance in the preparation of the chapter was given by Wanda West and Sally J. Stephenson, editorial assistance.

[2]Geologist, Iowa Department of Natural, Geological Survey Bureau, Iowa City, IA.

[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 in 1990.

[4]Des Moines Register. Iowa, 28 States Sue Asbestos Companies. Jan. 31, 1990, p. 3M.

TABLE 2

IOWA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	2,098	$7,321	$3.49
Plaster and gunite sands	47	209	4.45
Concrete products (blocks, bricks, pipe, decorative, etc.)	101	378	3.74
Asphaltic concrete aggregates and other bituminous mixtures-	417	1,264	3.03
Road base and coverings[1]	1,704	4,116	2.42
Fill	707	1,381	1.95
Snow and ice control	88	313	3.56
Railroad ballast	W	W	4.33
Other[2]	56	448	8.00
Unspecified:[3]			
Actual	7,857	26,310	3.35
Estimated	1,879	4,693	2.50
Total[4] or average	14,953	46,432	3.11

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes road and other stabilization (cement).
[2]Includes roofing granules.
[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.

TABLE 3

IOWA: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, BY DISTRICT AND USE[1]

(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)	412	1,336	465	1,569	247	661	447	1,716
Plaster and gunite sands	11	46	9	50	W	W	22	92
Concrete products (blocks, bricks, etc.)	W	W	38	177	14	37	W	W
Asphaltic concrete aggregates and other bituminous mixtures	95	272	125	308	W	W	43	185
Road base and coverings[2]	569	1,167	209	577	231	464	W	W
Fill	210	326	90	195	83	159	53	153
Snow and ice control	20	48	21	80	9	34	26	104
Railroad ballast	—	—	W	W	—	—	—	—
Other miscellaneous[3]	22	65	22	179	71	181	45	312
Actual	1,276	4,314	320	1,174	2,574	9,613	190	557
Estimated	330	618	507	1,691	140	448	460	1,032
Total[5]	2,944	8,192	1,804	5,999	3,369	11,597	1,286	4,151

	District 5		District 6	
	Quantity	Value	Quantity	Value
Concrete products (blocks, bricks, etc.)	—	—	W	W
Asphaltic concrete aggregates and other bituminous mixtures	W	W	73	254
Road base and coverings[2]	251	675	W	W
Fill	27	53	244	495
Snow and ice control	2	5	8	33
Railroad ballast	—	—	—	—
Other miscellaneous[3]	13	72	449	1,250
Actual	282	1,207	416	1,573
Estimated	—	—	441	905
Total[5]	591	2,056	2094	6,348

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Excludes 2,864,172 short tons valued at $8,088,961 not reported by county.
[2]Includes road and other stabilization (cement).
[3]Includes roofing granules.
[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.

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Davenport Cement Co., a subsidiary of Cementia Holdings AG.[1]	Box 4288 Davenport, IA 52801	Quarry, clay pit, plant	Scott.
Lehigh Portland Cement Co., a subsidiary of Heidelberger Zement AG.[1]	Box 1882 Allentown, PA 18105	do.	Cerro Gordo.
Monarch Cement Co. Holnam Inc.,	Humboldt, KS 66748	Plant	Polk.
Dundee Div.	Box 1008 Mason City, IA 50401	Quarry and plant	Cerro Gordo.
Clays:			
Midland Brick Co.	Box A Redfield, IA 50233	Pits and plants	Dallas and Wapello.
Sioux City Brick & Tile Co.	Box 807 Sioux City, IA 51102	do.	Dallas and Woodbury.
Gypsum:			
Celotex Div., a subsidiary of Jim Walter Corp.	4010 Boy Scout Blvd. Tampa, FL 33607	Open pit mine and plant	Webster.
Georgia-Pacific Corp.	133 Peachtree St., NE Atlanta, GA 30303	do.	Do.
Kaser Corp.	Box 3569 Des Moines, IA 50322	Underground mine and plant	Marion.
National Gypsum Co.	2001 Rexford Rd. Charlotte, NC 28211	Open pit mine and plant	Webster.
USG Corp.	101 South Wacker Dr. Chicago, IL 60606	Underground mine and plant Open pit mine and plant	Des Moines. Webster.
Lime:			
Linwood Mining & Minerals Corp.	Route 2 Davenport, IA 52804	Plant	Scott.
Peat:			
Colby Pioneer Peat Co.	Box 8 Hanlontown, IA 50444	do.	Worth.
Pikes Peat Co.	Route 6, Box 21 Muscatine, IA 52761	do.	Muscatine.
Perlite (expanded):			
National Gypsum Co.	2001 Rexford Rd. Charlotte, NC 28211	do.	Webster.
Sand and gravel (construction):			
Acme Fuel & Material Co.	Route 5, Box 34 Muscatine, IA 52761	Pit and plant	Muscatine.
Basic Materials Corp.	Box 2277 Waterloo, IA 50704	Pits and plants	Black Hawk and Waterloo.
A. Finley Co.	Box 406 Harlan, IA 51537	do.	Cass, Dallas, Montgomery, Page, Pottawattamie, Shelby.
Hallett Construction Co.	Box 13 Boone, IA 50036	do.	Audubon, Boone, Buena Vista, Cherokee, Dallas, Greene, Marshall, Osceola,Polk, Sac, Story.
Martin Marietta Aggregates,	Box 30013 Raleigh, NC 27622	do.	Various (20 counties).
Stevens Sand & Gravel Co. Inc.	Route 4, Box 35 Iowa City, IA 52240	do.	Johnson and Washington.

See footnotes at end of table.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone (limestone, 1989):			
Crushed:			
Kaser Corp.	7200 Hickman Rd. Des Moines, IA 50322	Underground mines, quarries, plants	Des Moines, Jasper, Keokuk, Mahaska, Marion, Monroe, Washington.
Martin Marietta Aggregates, Central Div.	Box 30013 Raleigh, NC 27622	do.	Clarke, Decatur, Linn, Madison, Marshall, Polk, Story.
P. Niemann Construction Co.	106 North Maple St. Sumner, IA 50674	Quarries and plants	Black Hawk, Bremer, Buchanan, Butler, Chickasaw, Fayette, Winneshiek.
River Products Co.	220 Savings and Loan Bldg. 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, Madison, Pottawattamie, Union.
Vulcan Materials Co.	5300 North Park Place NE Box 1428	do.	Benton, Buchanan, Clinton, Jackson, Johnson, Jones, Linn, Tama.
Dimension:			
Weber Stone Co.[2]	Route 1 Anamosa, IA 52205	Quarry and plant	Jones.

[1]Also clay.
[2]Also crushed limestone.

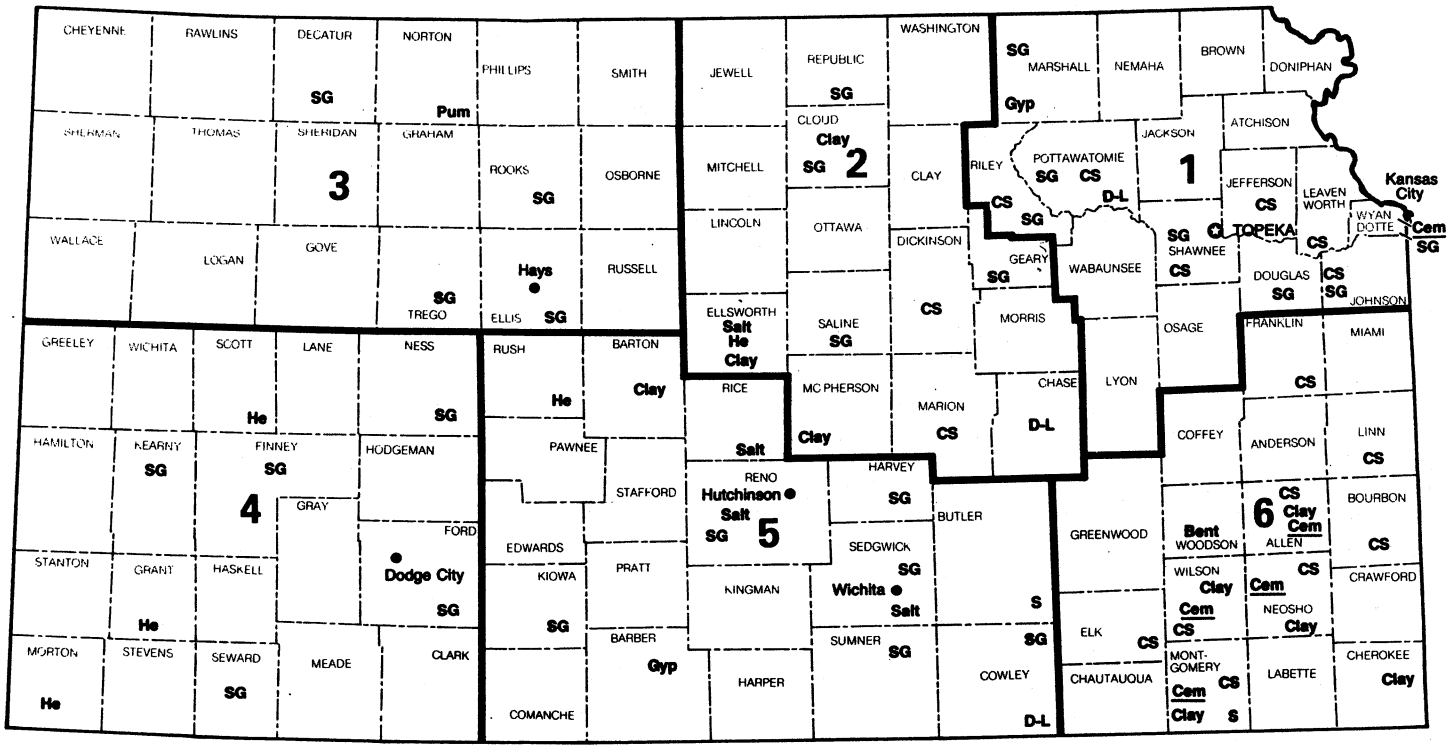
KANSAS

LEGEND

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

MINERAL SYMBOLS

Bent	Bentonite
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
D-L	Dimension Limestone
Gyp	Gypsum
He	Helium
Pum	Pumice
S	Sulfur
Salt	Salt
SG	Sand and Gravel



Principal Mineral-Producing Localities

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 Doss H. White, Jr.,[1] and David A. Grisafe[2]

The value of nonfuel mineral production in Kansas in 1990 was $346.1 million, an increase of $28 million over that reported by the State's mineral producers in 1989. This was a new State record for nonfuel mineral value; the previous record of $322 million was established in 1985. The new record was attained primarily because of increased sales and/or value of portland cement, salt, and crushed stone. Sales of these three commodities exceeded the 1989 level by $39 million. Although salt retained its first place ranking among the mineral commodities produced in-State, its contribution to the new record was second to crushed stone. Kansas ranked 31st nationally in mineral value and continued as the Nation's leading producer of crude and refined helium. The State contributed 1.04% of the Nation's mineral value of $33.3 billion.

TRENDS AND DEVELOPMENTS

During the decade of the 1980's (1981-90), the value of Kansas mineral production totaled $2.6 billion. The new Kansas record for mineral value was established, in part, because of an increased demand for crushed stone and salt. An 8-year highway enhancement program, passed by the Kansas Legislature in 1989, created a strong demand for aggregate and cement.

Several of the developments in the State's mineral industry during 1990 were in the salt sector. Ownership of two of the State's rock salt mines changed hands; one company announced plans for a salt mine expansion; a railroad line abandonment was proposed that would effect the competitiveness of a salt mine; and a records-storage company

TABLE 1
NONFUEL MINERAL PRODUCTION IN KANSAS[1]

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
Cement:							
Masonry	thousand short tons	50	$2,988	42	$2,514	39	$2,011
Portland	do.	1,569	72,805	1,505	69,390	1,707	76,564
Clays[2]	metric tons	555,739	2,632	533,099	2,700	625,969	4,056
Gemstones		NA	3	NA	W	NA	W
Salt[3]	thousand short tons	1,284	55,753	1,948	82,212	2,390	92,119
Sand and gravel:							
Construction	do.	10,760	25,329	e13,000	e33,200	10,863	24,170
Industrial	do.	W	W	230	2,690	W	W
Stone:							
Crushed	do.	e17,300	e72,700	r15,850	r56,976	ee20,800	ee79,200
Dimension short tons		e6,889	e219	W	W	W	W
Combined value of clay (bentonite, crude and Grade-A), pumice, salt crude and Grade-A), pumice, salt (brine) stone (crushed sandstone and quartzite, 1989-90), and values indicated by symbol W		XX	59,284	XX	68,449	XX	67,999
Total		XX	291,713	XX	318,131	XX	346,119

eEstimated. 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 salts in brines; value included with "Combined value" figure.
[4]Excludes certain stones; kind and value included with "Combined value" figure.

considered the purchase of a salt mine for storage purposes.

Other mineral industry developments included permitting of three rock quarries by Geary County officials and a controversy in Douglas County over a new quarry. A controversy also developed over proposed saltwater injection wells in Ellis County. Work was ongoing on a sulfur recovery unit at a Wichita refinery.

In September, Lone Star Industries announced it would stop cement production at its Bonner Springs plant. By yearend, approximately 100 workers were laid off, and only a few employees were retained to operate the planned storage facility for wholesale cement sales.

In December, Lone Star Industries filed for reorganization under chapter 11 of the Federal Bankruptcy Act and announced plans to sell its marginal cement operations, including the plant at Bonner Springs. The parent company said a combination of subsidized imports plus a downturn in the construction industry were the major reasons for the reorganization, a route the company elected to follow despite two offers from foreign investors.

EMPLOYMENT

At yearend, total mineral industry employment was 19,700, an increase of 2,500 over the same period in 1989. Employment in the nonfuel mining sector increased from 9,200 in December 1989 to 10,500 in December 1990. For the same period, employment in the oil and gas extraction sector increased from 8,000 to 9,200.[3]

EXPLORATION ACTIVITIES

During 1990, approximately 7,500 feet of drilling was completed by Kansas Geological Survey (KGS) personnel. Projects ranged from monitor-well installation to wireline coring for stratigraphic studies.

LEGISLATION AND GOVERNMENT PROGRAMS

Senate bill 614 and House bill 2911 requiring reclamation of all quarries were introduced during the 1990 Kansas legislative session. The Senate bill would have expanded an existing reclamation act applying to coal mines to cover limestone quarries. The House bill was similar, but included all quarries and used new phraseology to require quarry reclamation. Both bills died in committee. The Kansas Aggregate Producers Association and the Kansas Ready Mix Concrete Association began working on what they described as "user friendly" legislation for permitting and reclamation of industrial mineral quarries.

House bill 2716, which was enacted into law, allowed the Department of Health and Environment to transfer money from the Mined-Land Reclamation Fund to the Mined-Land Conservation and Reclamation Fund. The money was from forfeited bonds of bankrupt coal mines and would be used to help pay administrative expenses connected with reclamation activities. The bill also allowed a mining operator to satisfy up to 50% of a bonding requirement with a first mortgage on real estate. The change conformed Kansas law to Federal regulations.

Several State and Federal government programs, ongoing during the year, were of potential interest to the Kansas mineral industry. The KGS published two maps showing the locations of all active and abandoned nonfuel industrial mineral operations and updated the KGS Directory of Industrial Mineral Producers.

The Kansas Department of Health and Environment was awarded $387,000 for a 2-year study on the effects of lead and cadmium from abandoned mines on residents in the Galena area. The study, funded by the Agency for Toxic Substances and Disease Registry, will involve the University of Kansas Medical Center. The Galena area is a "subsite" in a U.S. Environmental Agency Superfund Project to provide a new water supply to several Kansas communities because of heavy metals in the ground water and drinking water supply. Studies have shown that six chronic diseases are more prevalent in the Galena area than in two towns of similar size in southeast Kansas.

Scientists with the U.S. Bureau of Mines published Report of Investigations 9303, Electromagnetic Investigations of Abandoned Mines in the Galena, KS, area. As part of an investigation to mitigate hazards associated with abandoned mine openings, the Bureau conducted a series of electromagnetic surveys in the Galena area of the tristate mining district. The application of ground-penetrating radar (GPR) and inductive electromagnetic methods for detecting and delineating hazardous mine openings and attendant features was demonstrated to be feasible for shallow mine workings occurring below flat-lying areas. Features such as mine voids, fractures, and zones of subsidence were located beneath the Mainstreet (State Highway 26) site using the GPR system. Both the GPR and inductive electromagnetic techniques satisfactorily located mine openings and pillars at the Hell's Half Acre site.

The Water Resources Division of the U.S. Geological Survey continued its program of monitoring the flow of the State's waterways.

The U.S. Army Corps of Engineers released the results of its lengthy study on the impact of sand and gravel dredging along the Kansas River and issued restrictions on the quantity of sand and gravel that can be removed annually from certain segments of the river. The production restrictions virtually eliminated new operations on the lowest portions of the river and required some existing operators near Kansas City to seek alternative and more costly sources.

FUELS

Oil and gas value continued as the major segment of the Kansas mineral value. Oil production was relatively flat, while gas output declined 5.5% compared with that of 1989. Oil prices increased 28%; natural gas prices were up about

2%. The combined value of oil and gas was almost $2.15 billion, about 86% of the State's total mineral value of $2.5 billion.

Coal output declined almost 16% from the 1989 production. The decline was primarily due to the shifting of one company's operations to Missouri.[4]

Kansas City Power and Light and Kansas Gas and Electric filed a suit in Federal court (Kansas City) against Amax Inc., accusing the coal supplier of overcharging them by more than $24 million. In addition to seeking at least that amount, the suit also sought a court order that could end the 20-year contract Amax has to supply coal to the utilities.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Thirteen industrial minerals were mined, manufactured, or recovered as byproducts during 1990, and several crude industrial minerals were shipped into the State and processed into higher value commodities. The leading industrial mineral commodities, in terms of value, salt, cement, and crushed stone, accounted for almost 72% of the 1990 nonfuel mineral value.

Cement.—Portland and masonry cement sales, $78.6 million, ranked the commodity second among the industrial minerals produced in-State and accounted for 23% of the total 1990 Kansas mineral value. The State ranked 14th in output among the 38 portland cement-producing States and 20th in output among the 35 States with masonry cement facilities.

The Kansas cement industry operated four plants in the Allen, Montgomery, Neosho, and Wilson contiguous-counties area in the southeastern part of the State and one plant in the Kansas City area of Wyandotte County. The five companies operated eight wet-process and seven dry-process kilns.

Sales of portland cement were $7.2 million above the 1989 level, and masonry cement sales were $500,000 below those reported in 1989.

Lone Star Industries Inc. announced in September that it would terminate cement manufacture and the associated mining activity at its Bonner Springs plant. The plant would be operated as a storage facility for wholesale cement sales. Lone Star filed for reorganization under chapter 11 of the Federal Bankruptcy Act in December. The firm planned to sell its marginal operations, including the Bonner Springs facility. A combination of cement imports subsidized by the Government of the country of origin and a downturn in construction activity were the reasons for the reorganization.

Clays.—Kansas ranked 19th among the 36 clay-producing States, and clay sales accounted for 1% of the Kansas mineral value in 1990. Only common clay output was reported. Common clay tonnage and value rose 93,000 metric tons and $1.3 million above the figures reported by the industry in 1989.

Common clay production was reported by 10 companies operating 20 mines in 11 counties. The three leading counties, Allen, McPherson, and Wilson, accounted for 52% of the tonnage produced. Principal end uses reported by the clay producers included portland cement manufacture (57%); common and face brick and lightweight aggregate accounted for the remainder.

Gypsum.—Two companies, Georgia Pacific Corp. in Marshall County in northeast Kansas and National Gypsum Co. in Barber County in the south-central part of the State, composed the gypsum sector of the Kansas mineral industry. Both companies calcined the crude ore at plants near their mines. Crude gypsum output and value decreased slightly below the level reported by the two producers in 1989. Principal sales were for the manufacturing of wallboard.

Helium.—Both crude (50% purity or greater) and Grade-A (99.995% + purity) helium were produced in-State from natural gas. Crude helium output increased slightly above the 1989 level. Price, per thousand cubic feet, remained constant at $22.00. Grade-A helium output remained flat and value remained at $37.

Crude helium extraction facilities were operated by three firms: Enron Helium Co., Bushton; OXY Cities Services Helex Co., Ulysses; and Kansas Nebraska Energy, Scott City. Grade-A helium was produced by the Kansas Refined Helium Co., Otis, and Union Carbide with plants at Bushton and Ulysses.

Crude helium was sold to the fuel and chemical markets. Crude helium surplus was stored under contract in the Federal Government's Cliffside Storage Reservoir. The stored helium is returned to the owners for purification when demand exceeds production.

Pumice (Pumicite, Volcanic Ash).—The Calvart Corp. and Kansas Minerals Inc. operated the State's only pumice mines in Norton and Jewell Counties. Output and value increased slightly. The processed pumice was sold for abrasive and specialty applications.

Salt.—The State continued to rank fifth among the 15 salt-producing States. Salt sales, excluding salt in brines, accounted for 27% of the 1990 Kansas mineral value. Salt production and value increased 442,000 short tons and $9.9 million above the 1989 levels.

Several firms produced salt from the Ellsworth, Rice, Reno, and Sedgwick contiguous-counties area in the south-central part of the State. Two companies operated both underground mines and brine wells, three firms operated underground room-and-pillar mines, and one company operated brine recovery wells.

Lyons Salt Co., a subsidiary of BSC Holding, Inc., Mission, purchased a salt mine and mill in Lyons from the North American Salt Co. The sale completed a transaction with the U.S. Justice Department in which North American Salt agreed to sell two of its mines to settle an antitrust lawsuit. BSC operated sand and gravel business in-State and in

Illinois and mixed salt with sand for highway ice control.[5]

North American Salt sold its second mine in Hutchinson, the Carey Salt operation, to Hutchinson Salt Co., Hutchinson. The mine, owned by the Carey family until 1969, was sold to the Hutchinson Salt Co. on August 1.[6]

Cargill Inc. announced plans for a $3.9 million expansion of its salt mine near Hutchinson. The expansion would increase salt production by 40,000 short tons per year and create seven new jobs. The company requested a 5-year tax reduction from Hutchinson City Commission, amounting to a $256,000 tax abatement.[7]

Plans by the Santa Fe Railroad to abandon two lines through Lyons met with opposition from mining firms and Farmers Union Cooperatives. A salt company representative testified at a hearing that abandonment would mean the North American Salt Mine southeast of Lyons would be less competitive because of increased shipping rates. The Farmers Union Cooperative testified that shipping costs would increase $500,000.[8]

Hutchinson Underground Vault and Storage Inc. leased about 20 acres of mined-out space in Hutchinson Salt Co.'s mine. When the mine was on the market in the first half of the year, the storage company officials were considering the purchase of the mine. The mine was later sold to the Hutchinson Salt Co., and the storage company continued to lease storage space.[9]

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 1988 and 1990 and estimates for 1989.

The mining and sales of sand and gravel accounted for 7% of the Kansas mineral value in 1990. The production was 103,000 short tons above the tonnage reported by industry in 1988, indicating a slight increase in construction activity. Value, however, fell $1.2 million below that reported by industry in 1988.

Kansas construction sand and gravel statistics are compiled by geographical districts as depicted on the State map. Table 2 presents end-use data for this commodity in the six Kansas districts.

The Kansas sand and gravel industry consisted of 104 companies operating 256 mines in 61 counties. The five leading counties, Finney, Johnson, Reno, Sedgwick, and Shawnee, accounted for 45% of the 1990 tonnage. Stationary processing plants were used at 76 mines, portable plants were operated at 37 sites, and 26 mines marketed their sand without processing. End uses were unreported for 2.6 million tons. End uses reported included road base and cover (28%), concrete aggregate (27%), asphaltic concrete (15%), fill (12%), and plaster and gunite (2%).

Industrial.—Production of industrial sand was reported by three firms operating mines in Republic and Wyandotte Counties. Output and value decreased below the 1989 levels. The average price per short ton was $11.37; in 1989 it was $11.70. The producers reported sales for fiberglass production (78%), sand blast applications (10%), and for traction sand (9%).

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 1987 and 1989 and estimates for 1990.

Crushed.—The output of crushed stone, based on three quarters of industry data and a fourth-quarter U.S. Bureau of Mines estimate, was 20.8 million short tons valued at $79.2 million. This was an increase of 5 million tons over the 1989 reported production. Value increased approximately $22 million. Stone sales accounted for 23% of the State's mineral value in 1990, and nationally Kansas ranked 23d in crushed stone output.

In 1989, the most recent year with a full-year industry canvass, the crushed stone industry reported the operation of 135 quarries in 43 counties. Limestone, sandstone, and quartzite were the stone types quarried. Limestone comprised more than 95% of the total.

In 1989, limestone production was reported by 45 firms operating 132 quarries in 42 of the State's 105 counties. The five leading counties, in terms of decreasing tonnage produced, were (1) Johnson, (2) Wyandotte, (3) Franklin, (4) Wilson, and (5) Lincoln. End uses reported by the limestone producers were for cement manufacture (25%), graded road base (19%), and concrete aggregate (15%). Other major uses included bituminous aggregate, unpaved road surface, and fill material.

Sandstone and quartzite were quarried by three companies operating four quarries in Lincoln, Graham, Phillips, and Neosho Counties during 1989. Quartzite (a silicified chalk) was produced by one firm from a quarry in Smith County and sold for landscaping applications. Sandstone sales were for cement manufacture and unspecified uses.

The National Stone Association selected Killough Inc., Ottawa, to receive the 1990 Good Neighbor Award for outstanding achievement in community relations.

Dimension.—The Kansas dimension stone industry, 8 companies operating 14 quarries in 8 counties, produced both limestone and sandstone; output and value decreased significantly below those reported in 1989.

Sulfur (Recovered).—Two firms, Texaco Refining Marketing Inc., El Dorado in Butler County, and Farmland Industries Inc., Coffeyville in Montgomery County, recovered sulfur as a byproduct of petroleum refining. Recovery and sales exceeded the 1989 level reported by the two companies.

Other Industrial Minerals.—Several industrial minerals, not included in the tonnage and value on table 1, were shipped into the State and manufactured into higher value products. Perlite was expanded by one firm at a plant in

Wyandotte County. The crude perlite was obtained from mines in the Western United States. Sales were for cavity fill insulation and horticultural aggregate.

Dimension stone, primarily granite and marble, were shipped to a number of stone companies throughout Kansas and sold for cemetery monuments and for building applications.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 30 years of mineral-related industry and government experience. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

[2]Associate scientist, Technical Information Services, Kansas Geological Survey, Lawrence, KS.

[3]Kansas Department of Human Resources, Labor Market Information Services. Monthly Labor Summary. Jan. 24, 1991.

[4]Kansas Department of Revenue.

[5]Baxter Springs Citizen. Hutchinson Sells to Bingham Firm. Aug. 7, 1990.

[6]Hutchinson News. Hutchinson Salt Locally Owned Once Again. Feb. 3, 1991.

[7]———. City Votes To Grant Tax Break. Feb. 14, 1990. [8]Lyons Daily News. Railroad Believed Vital to Economy. Nov. 16, 1990.

[9]Hutchinson News. Underground Vaults and Storage Studies Purchase of Local Mine. May 2, 1990.

TABLE 2

KANSAS: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	2,258	$4,880	$2.16
Plaster and gunite sands	178	383	2.15
Concrete products (blocks, bricks, pipe, decorative, etc.)	64	201	3.14
Asphaltic concrete aggregates and other bituminous mixtures	1,212	2,868	2.37
Road base and coverings[1]	2,448	5,150	2.11
Fill	1,013	1,495	1.48
Snow and ice control	60	157	2.62
Railroad ballast	W	W	2.86
Other	676	1,581	2.34
Unspecified:[2]			
Actual	1,929	4,618	2.39
Estimated	1,026	2,839	2.77
Total[3] or average	10,863	24,170	2.22

W Withheld to avoid disclosing company proprietary data; included with "Other."
[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.

TABLE 3

KANSAS: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	577	,252	222	561	103	217,972
Plaster and gunite sands	9	29	8	31	2	4,200
Concrete products (blocks, bricks, etc.)	W	W	W	W	1	2,000
Asphaltic concrete aggregates and other bituminous mixtures	W	W	311	935	W	W
Road base and coverings[1]	121	292	252	642	506	763,457
Fill	175	275	95	153	22	41,023
Snow and ice control	26	64	5	15	W	W
Railroad ballast	—	—	—	—	—	—
Other miscellaneous	276	1,013	40	177	60	133
Unspecified:						
Actual	1,179	3,002	—	—	—	—
Estimated	7	27	5	11	—	—
Total[2]	2,370	5,954	938	2,525	695	1,162

	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	294	781	1,061	2,067,498	—	—
Plaster and gunite sands	31	70	128	248,695	—	—
Concrete products (blocks, bricks, etc.)	48	93	W	W	—	—
Asphaltic concrete aggregates and other bituminous mixtures	233	501	436	874,325	—	—
Road base and coverings[1]	830	1,835	647	1,429,573	92	187
Fill	118	213	602	812,987	—	—
Snow and ice control	10	21	9	21,632	—	—
Railroad ballast	—	—	W	W	—	—
Other miscellaneous	164	247	393	709	—	—
Unspecified:						
Actual	154	402	455	1,073	142	142
Estimated	189	642	824	2,159	—	—
Total[2]	2,071	4,806	4,556	9,396	234	329

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."

[1]Includes road and other stabilization (cement and lime).

[2]Data may not add to totals shown because of independent rounding.

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]	7701 East Kellogg St. Suite 240 Wichita, KS 67207	do.	Wilson.
Heartland Cement Co.[4]	Box 428 Independence, KS 67301	do.	Montgomery.
Lone Star Industries Inc.[5]	Box 12449 Dallas, TX 75225	do.	Wyandotte.
The Monarch Cement Co.[6]	Box 187 Humboldt, KS 77648	do.	Allen.
Clays:			
Acme Brick Co., Justin Industries Inc.	Box 247 Weir, KS 66781	Pits and plants	Cherokee and Ellsworth.
Buildex Inc., a division of Clemens Coal Co.	Box 15 Ottawa, KS 66067	Pit and plant	McPherson.
Cloud Ceramics, a division of General Finance Inc.	Box 369 Concordia, KS 66901	Pits and plant	Cloud.
Kansas Brick & Tile Co. Inc.	Box 450 Hoisington, KS 67544	Pit and plant	Barton.
Gypsum:			
Georgia-Pacific Corp.	133 Peachtree St., NE Atlanta, GA 30303	Underground mine and plant	Marshall.
National Gypsum Co.	2001 Rexford Rd. Charlotte, NC 28211	Open pit, underground mine, plant	Barber.
Helium:			
Kansas Refined Helium Co.	Otis, KS 67565	Plant	Rush.
Union Carbide Corp., Linde Div.	Box 444 Somerset, NJ 08873	Plants	Ellsworth, Grant Morton, Rush.
Perlite (expanded):			
Lite-Weight Products Inc.	1706 Kansas Ave. Kansas City, KS 66105	Plant	Wyandotte.
Pumice and pumicite:			
Calvert Corp.	Box 97 Norton, KS 67654	Pit and plant	Norton.
Salt:			
Carey Salt Inc.	6950 West 56th Mission, KS 66202	do.	Reno.
Cargill Inc., Salt Div.	Box 1403 Hutchinson, KS 67501	Wells	Do.
Hutchinson Salt Co.	3300 Carey Blvd. Hutchinson, KS 67501	Underground mine	Do.
Independent Salt Co.	Box 36 Kanopolis, KS 67454	do.	Ellsworth.
Lyon's Salt Co.	4919 Lamar Missions, KS 66202	Underground mine	Rice.
Morton Salt Co., a division of Morton Thiokol Inc.	110 North Wacker Dr. Chicago, IL 60606	Wells	Reno.
North American Salt Co.	6950 West 56th Mission, KS 66202	Wells and underground mine	Rice.

See footnotes at the end of table.

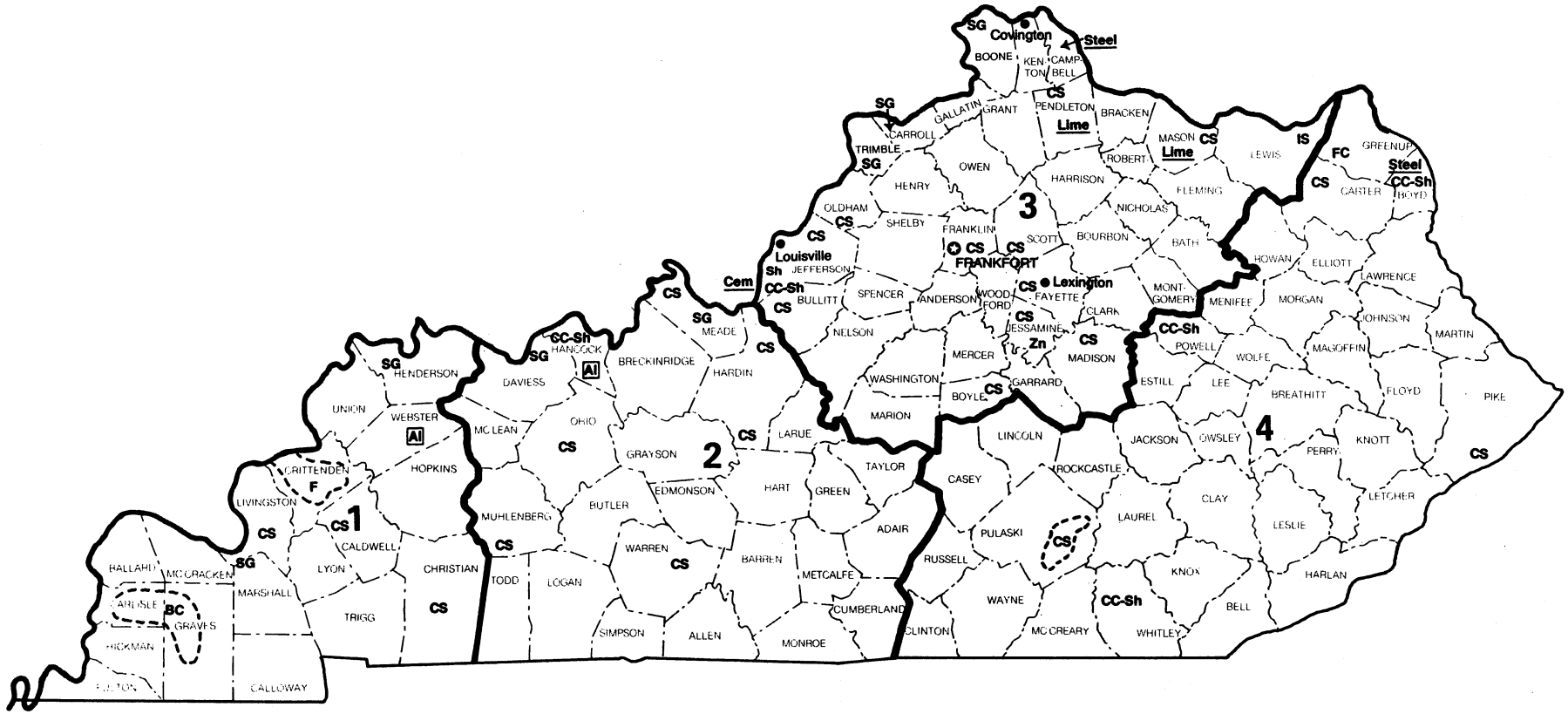
TABLE 4-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Salt—Continued			
Vulcan Materials Co., Chemical Div.	Box 7689 Birmingham, AL 35223	Wells	Sedgwick.
Sand and gravel (construction):			
Builders Sand Co.	4150 Kansas Ave. Kansas City, KS 66106	Dredges and plants	Johnson, Shawnee, Wyandotte.
L. A. Knebler Construction Inc.	Box 429 Augusta, KS 67010	Dredge	Dickinson and Sedgwick.
Ritchie Sand Co., a division of Ritchie Corp.	6500 West 21st St. Wichita, KS 67204	Dredge and plant	Sedgwick.
J. H. Shears & Sons Inc.	Hutchinson, KS 67501	Pits and plant	Reno.
Stone:			
Crushed:			
N. R. Hamm Quarry Inc.	Box 17 Perry, KS 66073	Quarries and plants	Various (9 counties).
Inland Quarries, a subsidiary of Americold Inc.	Box 2249 Kansas City, KS 66110	Underground mine and plant	Wyandotte.
McAdam Construction Co. Inc.	Main Street Moran, KS 66755	Quarries and plants	Allen, Anderson, Bourbon, Linn.
Martin Marietta Aggregates, Central Div.	Box 30013 Raleigh, NC 27622	do.	Various (7 counties).
Midwest Minerals Inc.	Box 412 Pittsburg, KS 66762	do.	Cherokee, Crawford, Labette, Montgomery, Neosho, Wilson.
Dimension:			
Bayer Stone Inc.	6th and Mission St. Marys, KS 66536	Quarries	Pottawatomie and Riley.
H. J. Born Stone Co. Inc.	Route 3, Box 312 Silverdale, KS 67005	do.	Chase and Cowley.
Sulfur (recovered):			
Farmland Industries Inc.	North Linden St. Coffeyville, KS 67337	Secondary recovery plant	Montgomery.
Texaco Refining & Marketing Co.	Box 1650 Tulsa, OK 74102	do.	Butler.

[1]Also clays in Neosho County.
[2]Also crushed stone in Johnson, Linn, and Neosho Counties.
[3]Also clays and crushed stone in Wilson County.
[4]Also clays and crushed stone in Montgomery County.
[5]Also crushed stone in Wyandotte County.
[6]Also clays and crushed stone in Allen County.

KENTUCKY



LEGEND

MINERAL SYMBOLS

State boundary	Al Aluminum plant	IS Industrial Sand
County boundary	BC Ball Clay	Lime Lime plant
Capital	CC-Sh Common Clay & Shale	SG Sand and Gravel
City	Cem Cement plant	Steel Iron and Steel plant
Waterway	CS Crushed Stone	Zn Zinc
Crushed stone/sand & gravel districts	F Fluorspar	Concentration of mineral operations
	FC Fire Clay	

Principal Mineral-Producing Localities

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 1990 of $359 million was the highest reported in State history. Substantial increases in output and value were reported for clays, lime, and construction sand and gravel. Nationally, Kentucky ranked 30th in the value of nonfuel mineral production.

The State was a major producer of aluminum and coal, ranking second in output in the United States in both of those commodities.

TRENDS AND DEVELOPMENTS

Traditionally, Kentucky's mining industry has been dominated by coal. The State has produced in excess of 160 million short tons of coal each year since 1984. In 1990, about 179 million tons was reported by the Kentucky Department of Mines and Minerals. The State has accounted for about 20% of U.S. production annually since 1966.

Future coal production in Kentucky was expected to be affected by enactment of amendments to the Federal Clean Air Act late in 1990. The amendments would require reduced sulfur dioxide emissions from coal-burning plants and were expected to result in increased competition between Kentucky coal and the low-sulfur coal mined in the Western United States, particularly in Wyoming. The installation of scrubbing systems for flue gas desulfurization at coal-fired plants, however, would permit the continued burning of higher sulfur coals and would increase the demand for lime and limestone used as reagents in sulfur dioxide removal.

During the past 5 years, the State's industrial mineral producers and metal manufacturers increased production and expanded operations. In 1990, Kentucky was among the leading States in production of a number of mineral commodities, ranking 1st in ball clay, 2d in aluminum, 4th in lime, 6th in ferroalloys, and 10th in crushed stone.

LEGISLATION AND GOVERNMENT PROGRAMS

In 1990, the Kentucky Revenue Cabinet began sending assessment notices for ad valorem taxation of unmined coal reserves in Kentucky. The Cabinet started its assessment program in 1989, after the Kentucky Supreme Court ruled in March 1988 that the State must tax unmined coal at the same rate as other real estate. That decision raised the State rate from one-tenth of 1 cent for every $100 of assessed value to about 21 cents

TABLE 1
NONFUEL MINERAL PRODUCTION IN KENTUCKY[1]

Mineral	1988		1989		1990	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2] metric tons	762,324	$3,217	716,990	$3,357	826,205	$8,282
Gemstones	NA	3	NA	W	NA	W
Sand and gravel (construction) thousand short tons	6,325	15,243	e5,500	e15,100	8,802	29,581
Stone (crushed) do.	e50,700	e207,900	[3]48,178	[3]187,849	e[3]50,100	e[3]182,900
Combined value of cement, clays (ball clay, fire clay, 1988-89), lead (1990), lime, sand and gravel (industrial, 1988-89), silver (1990), stone (crushed dolomite, 1989-90), zinc (1988, 1990), and values indicated by symbol W	XX	118,616	XX	124,353	XX	138,101
Total	XX	344,979	XX	330,659	XX	358,864

eEstimated. 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.

for each $100.[3] The Cabinet determined the following basic valuations: In eastern Kentucky, a base value of 18 cents per ton for unmined coal; 22 cents per ton if the coal is in a permitted tract; and 36 cents per ton if it is part of an active mining operation. In western Kentucky, a base value of 8 cents per ton; 10 cents per ton if permitted; and 16 cents per ton if part of an active mining operation. The assessments were expected to be adjusted as additional information was collected and analyzed by the Revenue Cabinet.

The Kentucky Geological Survey (KGS) completed a study on the use of dolomite lime, and limestone, and for sulfur dioxide emission control in flue gas desulfurization and fluidized-bed combustion systems.[4] During the year, the KGS published a report on low-sulfur coals in western Kentucky.[5]

An investigation of limestone deposits in southeastern Kentucky focused on low-silica stone suitable for use as rock dust in coal mines also was completed. Results of this KGS study were expected to be published in 1991.

In cooperation with the U.S. Geological Survey, the KGS continued work on a study of coal resources in eastern Kentucky available for mining after environmental and technological restrictions were considered. The U.S. Bureau of Mines joined the study to provide mining and cost modeling expertise in an effort to determine the amount of recoverable coal and its cost to mine, process, and reclaim.

The U.S. Bureau of Mines also conducted health and safety coal mine research projects in Kentucky. A field study of three longwall pillar systems to evaluate the effectiveness of pillar design for gate road stability was published.[6] The geology of hillseams as it relates to roof instability in drift mines in eastern Kentucky was also investigated by the Bureau. Examples of hillseams were described in both outcrops and coal mine roof to establish their geologic character and contribution to roof failure.[7]

The Energy Information Administration published a State Coal Profile for Kentucky.[8] According to this report, more than 1,200 coal mines were operating in Kentucky (1988), the largest number in any State.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Lime.—Dravo Lime Co. was the Nation's leading producer of lime. The firm operated underground limestone mines at Maysville and Carntown. Late in the year, Dravo was negotiating a contract to supply utility grade lime to Cincinnati Gas & Electric Co. Through the contract agreement, Dravo was expected to provide 200,000 short tons of lime for 10 years. The lime was expected to be manufactured at the Black River plant in Carntown.

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 1988 and 1990 and estimates for 1989.

Kentucky sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 3 presents end-use statistics for Kentucky's four districts.

Output of construction sand and gravel of 8.8 million short tons was the highest in Kentucky since 1979, when 11.7 million tons was produced. In 1990, production increased by about 3.3 million tons compared with the 1989 total. Most of the gain was reported from western Kentucky (district 1). Statewide, 20 sand and gravel pits were operated in 1990; 23 operated in 1988. District 3 led the State in output, accounting for about 60% of the State total.

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 1988 and 1990 and actual data for 1989.

Crushed stone was the leading industrial mineral produced in Kentucky, accounting for slightly more than one-half of the State's total value of nonfuel mineral output. The estimated production of 50.1 million short tons of crushed stone in 1990 was the second highest output recorded in State history. The alltime high total of 50.7 million tons was reported in 1988.

In 1990, a number of independent family-owned stone operations were sold to major corporations. The sale of Reed Crushed Stone Co. to Vulcan Materials Co. was completed. With that purchase, Vulcan Materials, the Nation's leading producer of mineral aggregates, became the owner of the top-producing quarry in the country. Rogers Group Inc., one of the Nation's top 10 crushed stone-producing companies, purchased two quarries in Jefferson County. Rogers Group had operated four quarries in Kentucky and was the State's fifth leading producer of stone before purchasing the quarries from Billy Holloway Aggregates Co.

Also during the year, Kentucky's seventh leading crushed stone producer, Lexington Quarry Co., was purchased by a partnership of Allen Co. Inc. and Sterling Enterprises Inc. Lexington Quarry produced limestone at an underground mine in Jessamine County. Nally & Haydon Inc. bought Ward & Montgomery Co.'s quarry near Lebanon, Marion County.

According to the Kentucky Geological Survey, wet-scrubbing systems already installed by utilities in Kentucky require about 800,000 short tons per year of limestone and an estimated 425,000 tons per year of lime (see Legislation and Government Programs).

Metals

Small quantities of fluorspar and zinc were recovered from an open pit operation in Crittenden County of the western Kentucky fluorspar district.

Aluminum.—Southwire Co. bought out its partner, National Aluminum Corp., and became the sole owner of the Hawesville smelter in Hancock County. Southwire agreed to pay $17.4 million cash, $60 million over 10 years based on aluminum prices, and to assume $22.6 million in debt on the 172,000-ton-per-year primary aluminum smelter.[9]

Alcan Aluminum Corp. produced primary aluminum at a 163,000-ton-capacity smelter in Sebree, Webster County. In 1990, combined output at the Hawesville and Sebree smelters ranked Kentucky second nationally in production. Also during the year, the two aluminum producers reached an agreement on power rates with Big Rivers Electric Corp.

Iron and Steel.—Armco Advanced Materials Co., a division of Armco Inc. and Acerinox S.A. of Madrid, Spain, began construction of a 150,000-short-ton-per-year stainless steel rolling mill in Carrollton. The company, called North American Stainless, was a 50-50 joint venture of the two companies. Previously, most U.S. steel industry partnerships have been with firms from Japan. Last year, Armco entered a joint venture with Kawasaki Steel Corp. of Japan. Construction of the $222 million facility, which includes a 60-inch-wide sheet mill, was expected to be completed in 1992. Available river and rail transportation, proximity to the interstate highway system, and State funding for building a barge dock contributed to the decision to select Carrollton as the site.

In 1990, Armco completed construction and began operating a $60 million continuous slab caster at its Ashland plant. The caster has about a 1.5-million-short-ton-per-year capacity. Armco also announced plans to install new air pollution control equipment at the Ashland plant in a $51.7 million project expected to be completed in 1992.

In September, NS Group Inc. began operation of a new continuous slab caster at its Newport Steel Corp. plant. The project, which also included a reheat furnace, cost $45 million and had begun in early 1988.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related industry and government experience and has covered the mineral activities in Kentucky for 5 years. Assistance in the preparation of the chapter was given by Sally Stephenson, editorial assistant.

[2]Geologist, Coal and Minerals Section, Kentucky Geological Survey, Lexington, KY.

[3]Lexington Herald-Leader. Officials Send Out Appraisals of Unmined Coal. Mar. 28, 1990, p. 1.

[4]Denver, G. R., Jr. Use of Limestone, Lime, and Dolomite for 2_2 Emission Control in Kentucky. KY Geol. Surv. IC 31, Series XI, 1990 14 pp.

[5]William D. A., C. T. Helfrich, J. C. Hower, F. L. Fiene, A. E. Bland, and D. W. Koppenaal. Amos and Foster Coals: Low-Ash and Low-Sulfur Coals of Western Kentucky. KY Geol. Surv. RI 5, Series XI, 1990, 34 pp.

[6]Barton, T. M., and C. Mark. Field Evaluation of Three Longwall Pillar Systems in Kentucky Coal Mine. BuMines RI 9283, 1989, 13 pp.

[7]Moebs, N. N., and G. P. Sames. Hillseam Geology and Roof Instability Near Outcrop in Eastern Kentucky. BuMines RI 9267, 1989, 33 pp.

[8]Weekly Coal Production, State Coal Profile: Kentucky. DOA/EIA-0218 (90-31), July 28, 1990, pp. 3-5.

[9]The Courier-Journal (Louisville). Southwire Buys Out Its Partner in Hawerville Aluminum Plant. Mar. 28, 1990, p. 1.

TABLE 2

KENTUCKY: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	557	$1,675	$3.01
Plaster and gunite sands	W	W	3.07
Concrete products (blocks, bricks, pipe, decorative, etc.)	45	270	6.00
Asphaltic concrete aggregates and other bituminous mixtures	76	181	2.38
Road base and coverings	W	W	3.14
Fill	287	415	1.45
Other[1]	94	683	7.27
Unspecified:[2]			
Actual	7,010	24,207	3.45
Estimate	733	2,150	2.93
Total or average	8,802	29,581	3.36

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes filtration.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 3

KENTUCKY: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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	150	450	W	W	36	170
Plaster and gunite sands	—	—	—	—	W	W	W	W
Concrete products (blocks, bricks, etc.)	—	—	—	—	—	—	45	270
Asphaltic concrete aggregates and road base and coverings[1]	W	W	57	123	280	345	29	139
Other miscellaneous[2]	141	422	—	—	272	711	51	594
Unspecified:[3]								
Actual	2,309	14,063	—	—	4,700	10,144	—	—
Estimated	219	717	277	838	234	585	3	9
Total[4]	2,669	15,202	485	1,411	5,486	11,785	162	1,184

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes fill.
[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.

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Aluminum (primary):			
Alcan Aluminum Corp.	Sebree, KY 42555	Smelter	Webster.
Southwire Co.	Box M Hawesville, KY 42348	do.	Hancock.
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 Inc.	Middletown, OH 45202	do.	Boyd.
NS Group Inc.	9th & Lowell Sts. Newport, KY 41072	Plants	Boyd and Campbell.
Lime:			
Dravo Lime Co.[2]	One Gateway Center Pittsburgh, PA 15222	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.
Ingram Materials Inc.	10 Fatherland St. Nashville, TN 37213	Dredges	Livingston.
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.
Stone (crushed):			
Beazer East Inc.	436 7th Ave. Pittsburgh, PA 15219	Underground mines, quarries, plants	Various.
Lafarge Corp.	Route 60 Olive Hill, KY 41164	Quarry	Carter.
Lexington Quarry Co.	Catnip Hill Nicholasville, KY 40356	do.	Jessamine.
Medusa Aggregates Co.	Suite 101, 880 Corporate Dr. Lexington, KY 40503	Quarries and plants	Nelson, Ohio, Pendleton, Warren.

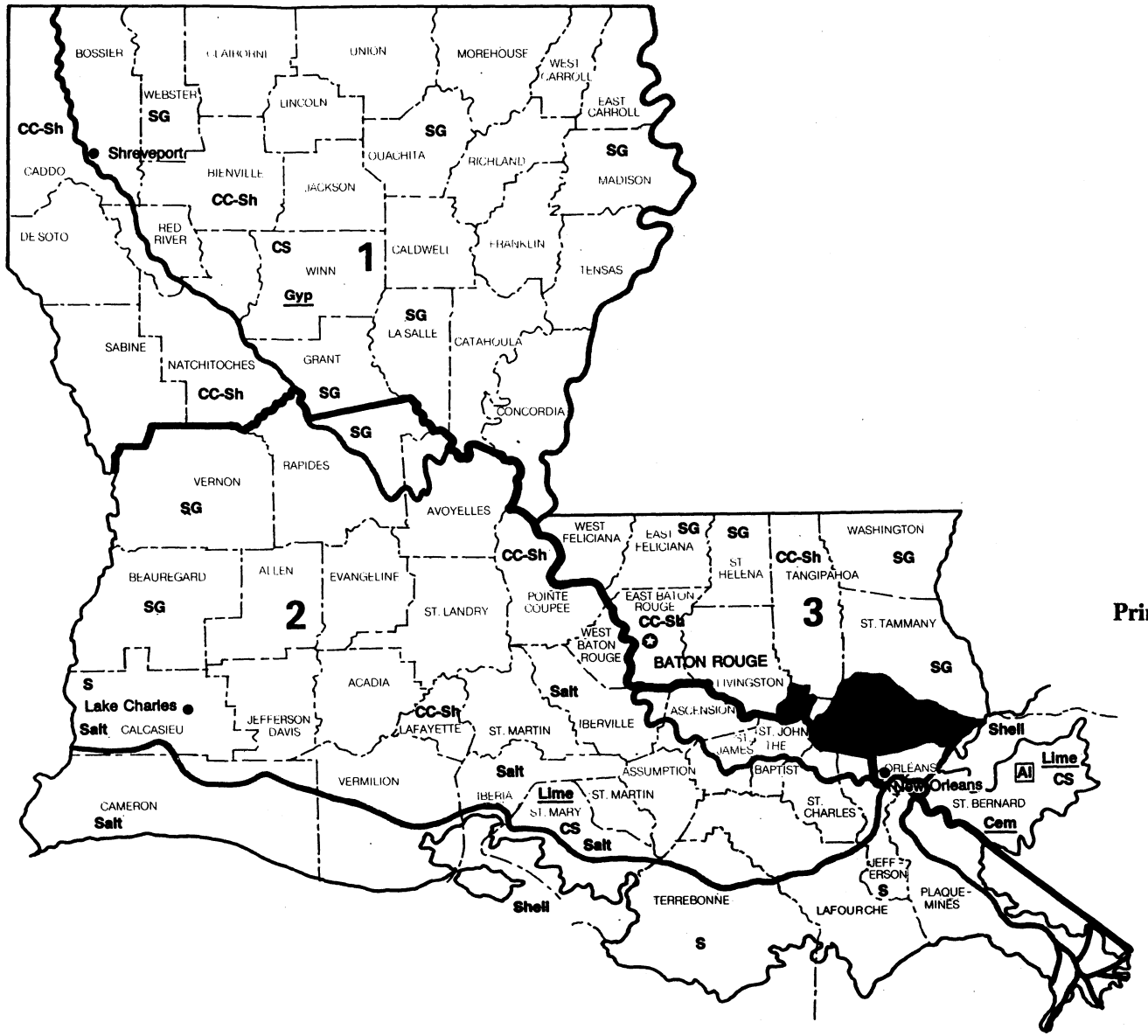
See footnotes at end of table.

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	Quarry	Scott.
Rogers Group Inc.[3]	Box 310 Shepherdsville, KY 40165	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.
Zinc:			
Triple M Mining Corp.	Box 497 Salem, KY 42078	Mine	Crittenden.

[1]Also clays.
[2]Also stone.
[3]Also sand and gravel.

LOUISIANA



LEGEND

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

MINERAL SYMBOLS

Al	Aluminum plant
CC-Sh	Common Clay & Shale
Cem	Cement plant
CS	Crushed Stone
Gyp	Gypsum plant
Lime	Lime plant
S	Sulfur
Salt	Salt
SG	Sand and Gravel
Shell	Shell

Principal Mineral-Producing Localities

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] John Johnston,[2] and W. E. Marsalis[3]

Louisiana's 1990 nonfuel mineral production was valued at $367.9 million. This was an $11.8 million decline below that reported to the U.S. Bureau of Mines by the State's mineral producers in 1989 and $215.9 million below the $583.8 million record for nonfuel mineral output established in 1980.

The decrease in the 1990 mineral value below that reported in 1989 was due to a decline in sales of clays, gypsum, stone, and sulfur. Nationally, Louisiana dropped one position to 29th in nonfuel mineral value. The State, accounting for 1.1% of the $33.3 billion of mineral commodities produced in the United States in 1990, led the Nation in salt output and ranked second in sulfur production.

TRENDS AND DEVELOPMENTS

Louisiana has a sparsity of hard-rock resources because of the State's geological setting in the Gulf Coastal Plain; surface and near-surface strata are predominantly clays, gravels, and sands. For many decades, oyster shells dredged from State lakes and coastal waters have been used as a substitute for crushed stone in the construction of road foundations. During the past several years, dredges operating on Lake Pontchartrain have supplied the bulk of the shell used in Louisiana highway construction. Shell dredging leases were issued by the Louisiana Department of Wildlife and Fisheries.

In 1983, an environmental group sued the Wildlife and Fisheries Department and asked that the court declare dredging leases illegal. Four years later, in 1987, the trial court issued a judgment stating that the leases were illegal because public bidding was not involved. In 1988, the 4th Circuit Court affirmed the decision.

Later in 1988, the Louisiana Legislature passed and the Governor signed Act 41 of 1988, which authorized shell dredging without lawful leases until new leases were issued after public bidding. In September 1988, a preliminary injunction against dredging was issued by the original trial court. The injunction stated that dredging rights must be issued according to Louisiana law. On the same day the injunction was issued, the Wildlife and Fisheries and industry signed new shell dredging leases that the industry contended complied with the State bid law.

In January 1990, the 4th Circuit Court issued a ruling that terminated dredging

TABLE 1
NONFUEL MINERAL PRODUCTION IN LOUISIANA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	340,900	$9,535	233,992	$6,115	368,322	$1,066
Gemstones		NA	3	NA	14	NA	7
Salt	thousand short tons	14,274	108,982	13,218	115,203	14,348	120,827
Sand and gravel:							
Construction	do.	14,233	52,820	e13,600	e54,400	14,589	55,902
Industrial	do.	318	4,786	572	9,664	559	10,003
Stone (crushed)	do.	e[2]3,700	e[2]29,200	3,206	24,414	e2,100	e16,800
Sulfur (Frasch)	thousand metric tons	1,719	W	1,334	W	1,337	W
Combined value of cement (masonry, [1988], portland, [1988]), gypsum (crude), lime, stone (crushed miscellaneous, 1988), and values indicated by symbol W		XX	229,210	XX	169,912	XX	163,313
Total		XX	434,536	XX	379,722	XX	367,918

eEstimated. 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 stones; kind and value included with "Combined value" figure.

until the dredgers could return to district court and prove the validity of their leases. Industry attorneys filed for a rehearing on the 4th Circuit Court ruling. Later in the year, an agreement was reached between the dredging companies, the State, and the environmentalists that significantly raised royalties on dredged shell. Previous leases required dredging firms to pay $1.27 per cubic yard for Pontchartrain shell and $0.91 per cubic yard for shell dredged from coastal waters. Under the new terms, the State was to receive a minimum royalty of one-eighth of the selling price of the shell. This equated to $11 per cubic yard for lake shells and $7 per cubic yard from shells dredged from gulf coastal waters.

Within a few days of the new royalty agreement, the Department of Environmental Quality (DEQ) ruled that the water quality in Lake Pontchartrain was excessively degraded by the shell removal, and the Governor permanently terminated dredging in the lake. Coastal dredging was unaffected.

Following the Governor's action, a resolution was introduced into the Louisiana House of Representatives suspending the law under which the DEQ and the Governor terminated dredging. The resolution was later withdrawn.

The ban on Lake Pontchartrain dredging increased the demand for offshore (Gulf of Mexico) shell and delayed work on a $17.5 million project to relocate a portion of U.S. Highway 90. In June, the dwindling shell supplies, which sold for $12.50 per cubic yard, were partially replaced with limestone shipped to Louisiana from other States. The limestone was selling for $19.50 per cubic yard.[4]

Road construction bid specifications had to be amended in June to allow contractors to estimate the higher cost of shell from Gulf of Mexico reefs. Reef shell dredgers had a backlog of orders for the Gulf shells.

The termination of Lake Pontchartrain dredging came at a time when synthetic aggregate was gaining acceptance for many applications for which shell was used. Synthetic aggregate, fabricated by one firm from hydrofluoric gypsum, was 40% cheaper than shell dredged under the original royalty system. The termination of shell dredging in Lake Pontchartrain was expected to create new markets for synthetic aggregate.

In other developments, Freeport-McMoRan Inc. continued plans to develop its sulfur discovery on its Main Pass lease about 17 miles east of Venice, LA. At yearend, McDermott International Inc. had completed the underwater framework for the first drilling platform at its Morgan City facility. The $804 million project will include a 1.1-mile-long sulfur mining complex of six interconnected platforms costing $554 million and four additional platforms for oil and production costing $250 million. The Frasch process mining operation will tap 67 million tons of sulfur occurring in the caprock of a salt dome 1,200 feet beneath the floor of the Gulf of Mexico in approximately 200 feet of water. Sulfur production is scheduled to begin in 1992.

The Freeport-McMoRan project is not the largest, dollar-wise, scheduled for offshore Louisiana waters. Shell Oil Co. will invest approximately $1.3 billion in its auger tension leg platform to be installed at a record depth of 2,860 feet of water more than 200 miles south of New Orleans. The platform is scheduled for installation in 1993.[5]

Work was underway on a new wet-process phosphoric acid purification plant at Geismar. Rhone-Poulenc is the owner of the facility.

A study by Louisiana Tech University's Business Research Division found that mining income in Louisiana was up 11.3% to $2.3 billion. The national mining growth rate was 12.8%.[6]

REGULATORY ISSUES

Several Louisiana firms that processed mineral commodities used deep-well injection to dispose of waste materials. The Resources Conversion and Recovery Act banned deep-well injection unless alternative disposal methods were unavailable. Ten firms were seeking exemption from the act.[7]

Despite the protests of certain environmental groups, the State Department of Natural Resources' Office of Conservation granted nine permits to the Texas Brine Corp. to drill brine solution mining wells into the body of the Starks Salt Dome. A cavity would be developed for the storage of light hydrocarbons. Opponents feared the contamination of the Chicot Aquifer that supplies drinking water for southwest Louisiana and southeastern Texas. Concerns were also voiced over the earthquake potential of the area and the effects of an earth tremor on hydrocarbons stored in a dome cavity.[8]

LEGISLATION AND GOVERNMENT PROGRAMS

The Louisiana Geological Survey (LGS) continued or completed work on several studies on the State's mineral resources. As part of a cooperative central gulf coast gas atlas project, work was underway on a gas atlas of Louisiana that was scheduled to be completed by the end of 1991 and published by the Texas Bureau of Economic Geology during 1992. A sand and gravel resource study was ongoing in association with the Louisiana Transportation Research Institute and the Louisiana State University Department of Civil Engineering. An analysis of mineral production statistics in Louisiana using historical severance tax data was underway; parish (county) records were available on severance tax collection by mineral back to the 1930's, and, because the severance tax rates are known, mineral production by mineral and by parish could be calculated. A study on the location and uses of Louisiana salt domes was also underway. The LGS was continuing an investigation of mineral resources in the Gulf of Mexico; an investigation showing that Ship Shoal could be an economic source of sand for Louisiana's future was completed in cooperation with the U.S. Minerals Management Service (MMS). The ongoing National Coal Resource Data System (lignite) program, a cooperative

one with the U.S. Geological Survey begun in 1982, continued with another 1,000 shallow well logs analyzed for the occurrence of lignite and added to the data base. Two studies on offshore sand resources, one in cooperation with the MMS and one in cooperation with the U.S. Bureau of Mines Marine Minerals Technology Center, were underway.

The Office of Mineral Resources (OMR) was responsible for governing mineral activity on 5 million acres of State-owned properties. The responsibilities included leasing, monitoring of lease operations, royalty accounting, and reacquisition of nonproductive or nonutilized leases.

During 1989-90, OMR awarded 282 leases totaling 106,457 acres for cash payments of $19 million. Royalty volumes accredited to the State included 6.8 million barrels of oil and 65.9 billion cubic feet of gas for total royalties of $250.1 million. With the addition of bonuses, rentals, plant products, and other minerals, $276.2 million was added to the State's treasury. The average price per barrel of oil and billion cubic feet of gas was $22.78 and $1.71, respectively.

The State Department of Transportation and Development, faced with the problem of finding a shell substitute for road base material, tested a number of substitutes on a new section of U.S. Highway 90 near Gibson. Four test sections composed of a layer of woven polyester geotextile fabric and varying thicknesses of sand were tried. A fifth used the fabric and Gravelite, an expanded clay lightweight aggregate produced by Big River Industries Inc. Gravelite's lighter weight made it an attractive alternative to shell or other aggregates.[9]

In September, the Louisiana Department of Conservation (DOC) submitted a regulator reform package on coal mining to the U.S. Office of Surface Mining (OSM). The package was the result of an effort to ensure that the State's surface mining regulations were equal to those mandated by OSM. DOC personnel were working on guidelines for the submission of "Probable Hydrologic Impact" documents by mine operators and guidelines for the "Cumulative Hydrologic Impact Assessment" of all anticipated mining.

During the year, the State began development work on a noncoal regulatory program as part of the abandoned mine land program. State personnel met with mine operators to develop legislation acceptable to both State regulators and the mining industry. Legislation on the noncoal regulatory program is to be submitted to the 1991 State legislature.[10]

Senate and House bills that had the potential for affecting Louisiana mineral operators included (1) H.B. 538, defining ownership of nonnavigable waterbottoms; (2) H.B. 539, defining seashore as land in the open coast over which water of the sea directly spreads; (3) H.B. 705, prohibiting the granting of mineral leases or the issuance of drilling permits in Lake Pontchartrain; and (4) S.B. 973, addressing the management of State waterbottoms. All of the aforementioned bills were tabled, but are expected to be resubmitted during the 1991 legislative session.

The U.S. Office of Surface Mining completed the installation of Louisiana's Technical Information Processing System computer equipment and provided State personnel with training on the system's use.

The U.S. Army Corps of Engineers awarded $147 million in contracts for South Louisiana flood control. Included were contracts to improve 83 miles of levees in Plaquemines Parish. The project, to provide protection from hurricane tidal overflow, will require almost 30,000 tons of riprap as wave berm. During the year, more than 453,000 squares of flexible concrete mats were placed at nine construction sites, eight reinforcement sites, and eight maintenance sites. The Corps awarded a $4 million contract for a stone bank paving project along the Mississippi, Atchafalaya, and Red Rivers and at Old River Control.[11]

The Corps began a search for a source of lightweight material to replace shell used previously in Corps projects. The recent State ban on Lake Pontchartrain shell dredging and the "Buy American" clause on the Corps' contract specification have had a negative impact on Corps projects when lightweight materials were needed.

FUELS

Preliminary statistics indicate that 148.2 million barrels of oil and condensate and 1,711.2 billion cubic feet of natural gas and casinghead gas were produced Statewide during 1990. (These figures include production from State-owned properties.) Of the 1,707 permits issued Statewide, 1,408 wells were drilled and 817 wells completed. No requests were submitted for geothermal wells or lignite leases.[12]

Commercial lignite mining in Louisiana began in August 1985 with the opening of the Dolet Hills Lignite Project, a joint venture of two utility companies, CLECO and SWEPCO. During 1990, the Dolet Hills Mining Venture, a contract miner, produced 2,746,096 short tons of lignite for the project; it fueled a 640- megawatt mine-mouth powerplant. The Red River Mining Co., a joint venture of Phillips Coal Co. and North American Coal Corp., opened the Oxbow Mine in September 1989; during 1990, the mine produced 440,097.4 short tons of lignite.[13]

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Louisiana's 200-plus mineral producers mined 8 different mineral commodities during the year. In addition, several minerals were imported or shipped into the State and processed into a higher value product or used as plant feed to develop a higher value material.

Clays.—Louisiana's ranking of 24th among the 44 clay-producing States remained unchanged. Clay value

accounted for less than 1% of the State's total mineral value.

During the year, five companies operated five mines in five parishes to produce 368,000 metric tons of common clay with a value of $1.1 million. This was an increase of 134,000 metric tons but a decrease of $5 million below that reported by the five firms in 1989. Caddo and Pointe Coupee Parishes again accounted for more than one-half of the clay produced in the State. Clay output was used in the manufacture of concrete blocks, common and face bricks, and in highway surfacing.

One firm, Big River Industries Inc., mined and calcined clay in Pointe Coupee Parish to produce a lightweight aggregate. The material was used in the manufacture of lightweight concrete blocks and fire retardant materials. The aggregate was barged as far North as Minnesota for use in lightweight products manufacture. During the year, the Department of Transportation tested several tons of the lightweight aggregate as a substitute for shell as a road base material.

Gemstones.—A black opal deposit was reported in northwestern Vernon Parish. Developers of the Hidden Fire opal mine announced plans to open a campground and gem washing facility in the spring 1991.[14]

Gypsum.—Anhydrate, a variety of gypsum, was mined by Winn Rock Inc. from a quarry near Winnfield. The company crushed the material and sold it for use on surfacing access roads to oil and natural gas wells. Production and value decreased below that reported in 1989, reflecting the depressed state of hydrocarbon exploration in Louisiana.

Lime.—Quicklime and hydrated lime were produced by USG Corp. at a plant in Orleans Parish. Both calcite and limestone were used in the lime manufacture; calcite was obtained from mines in the Bahamas, and limestone was shipped from a quarry in Missouri. Lime sales were to both the chemical and industrial sectors. Output declined, but value increased slightly.

Salt.—The State continued as the first ranked salt producer in the United States, accounting for 34% of the Nation's total. Salt accounted for 33% of the State's mineral value in 1990.

Mine production was reported by three firms, Akzo Salt Inc., Morton International Inc., and Carey Salt Co., with underground room-and-pillar mines at Avery Island, Weeks, and Baldwin. Several other firms produced salt or a salt-bearing medium from (1) the mechanical evaporation of brine, and (2) salt brine. Production increased 1.1 million short tons, and value was up $5.6 million. The recession had little effect on the chemical industry sector that used salt as a feedstock. According to State severance tax data, Louisiana salt producers reported the production of almost 6 million tons of rock salt and 11.3 million tons of salt brine.

Sand and Gravel.—Sales of sand and gravel ranked third in Louisiana's mineral value. Production in 1990, as reported to the U.S. Bureau of Mines by the State's sand and gravel producers, totaled 15.1 million tons worth $65.9 million. This exceeded the 1989 estimate by 1.9 million short tons and $900,000. The State's sand and gravel producers paid severance tax on 8.8 million tons of sand and 11 million tons of 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 1988 and 1990 and estimates for 1989.

Louisiana ranked 20th in tonnage among the 50 States reporting construction sand and gravel production. Output, 14.6 million short tons valued at $55.9 million, was 1 million short tons and $1.5 million above that estimated for the sand and gravel industry in 1989. In 1990, 51 companies returned U.S. Bureau of Mines canvass forms. They operated 85 mines in 24 parishes. The 5 leading parishes were: (1) St. Tammany, with 8 companies operating 13 mines; (2) St. Helena, with 7 companies and 11 mines; (3) Washington, with 5 firms operating 8 mines; (4) Rapides, with 4 firms mining 7 properties; and (5) East Feliciana, with 7 companies and 8 mines. These five accounted for about 56% of the production. End uses for approximately 67% of the production were unspecified. Of the remaining tonnage, about 79% was used as concrete aggregate, 13% for asphaltic concrete, and 4% for road base and cover.

Louisiana construction sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 3 presents end-use data for the State's three districts.

Industrial.—Louisiana continued to rank 12th among the 38 States with industrial sand and/or gravel output. Production totaled 550,000 short tons valued at $10 million, and output fell below the 1989 level by 13,000 short tons; however, value exceeded the 1989 figure by $300,000.

Four firms operated four mines in Allen, East Baton Rouge, Red River, and Webster Parishes. Red River and Webster Parishes were again the leaders in terms of tonnage produced. Major sales were to the sand blasting, glass container, silicon carbide, chemical, and foundry industries.

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 1988 and 1990 and actual data for 1989.

The State's stone output, including shell dredged from the Gulf of Mexico and Lake Pontchartrain, was estimated at 2.1 million short tons valued at $16.8 million. This was a decrease of 1.1 million tons and $7.6 million. This significant downturn was due primarily to the termination of shell production in Lake Pontchartrain. Shell production,

according to severance tax data, totaled 1.8 million tons.

Two conventional surface mines produced sandstone in Sabine Parish and anhydrite from a quarry in Winn Parish. Shell was dredged from waters in St. Mary and St. Tammany Parishes. Severance tax data indicated that almost 252,000 short tons of stone was produced in 1990.

Much of the stone used in Louisiana is barged to State ports on the Mississippi River from quarries in Arkansas, Kentucky, Missouri, and Illinois. Vulcan Material Inc. shipped stone to distribution yards in the New Orleans area from a quarry in Mexico's Yucatan Peninsula.

Three firms produced a synthetic aggregate to supplement Louisiana's stone requirements. Louisiana Stone Aggregates Inc. (formerly Louisiana Synthetic Aggregates Inc.), Geismar; Marine Shale Processors Inc., Amelia; and Dow Chemical U.S.A., Plaquemine, produced a useful synthetic aggregate material from several waste products. Louisiana Stone Aggregates mined and crushed a solidified calcium sulfate sludge, a waste material from a freon chemical plant. The material was sold for road construction and agricultural purposes. Marine Shale produced a nonhazardous (U.S. Environmental Protection Agency classification) slaglike material during the high-temperature destruction of hazardous wastes. The byproduct slag was sold for road base and fill. Dow Chemical's Plaquemine facility operated a medium-Btu coal gasifier. A byproduct granulated slag was used as an asphalt filler in road surfacing.

Sulfur.—Once again, sulfur was the State's leading mineral commodity, accounting for more than 40% of the 1990 mineral value. Louisiana was one of two States with Frasch sulfur production and one of 26 with byproduct sulfur recovery from petroleum and/or natural gas refining. Louisiana's 1.4 million metric tons of Frasch sulfur production ranked it second behind Texas's 2.3 million metric ton output. It is expected that Louisiana will take the lead in Frasch sulfur output when the Freeport-McMoRan Inc. Gulf of Mexico property begins production in 1992.

Current Frasch sulfur production is from Freeport Minerals Co's. operations at Garden Island Bay, Grand Isle, and Caminada Pass. Byproduct sulfur was recovered by seven companies.

Titanium Dioxide.—Work was ongoing on the two largest structures at Kronos Louisiana Inc.'s (formerly NL Chemicals) Westlake titanium dioxide complex. By midyear, the chloride process I and finishing buildings were 80% and 30% completed, respectively. Completion of the 90,000-short-ton, 400-plus employee chloride process facility is scheduled for mid-1991. The new facility will increase the titanium dioxide capacity from 360,000 short tons per year to 450,000 short tons per year and raise the company's output from 11% to 13% of the worldwide titanium dioxide industry. Work began on the $200 million plant in 1989.

Other Industrial Minerals.—In addition to the commodities listed in table 1, several minerals were shipped into the State for processing into higher value products.

The Port of New Orleans Public Bulk Terminal was the principal point of entry for minerals imported into Louisiana. In 1990, 25% of the shipments through the terminal was metallic alloys, ferrochrome, silicon, manganese, and ferrosilicon; approximately 35% was "other minerals and sands"; 28%, fertilizers; 7%, barite; and 5%, miscellaneous ores. The commodities were imported from Australia, Brazil, China, Ireland, Norway, Republic of South Africa, Turkey, and Yugoslavia.[15]

Hydrated alumina was imported from Ireland by Alumina Products Inc. for the production of sodium aluminate. The sodium aluminate was sold to the aluminum, paper, titanium dioxide, and water purification industries.

Anhydrous ammonia was produced by 14 companies for sales to the chemical industries. The annual capacity of the 14, in excess of 7 million short tons, was about 40% of the Nation's capacity.

Barite, a barium sulfate used in chemical manufacture and oil well drilling fluids, was obtained from foreign and domestic producers and crushed, ground, and bagged by Mil-Park Drilling Fluids, Baroid Drilling Fluids Inc., and Old Soldiers Ltd. Much of the imported barite, purchased from China, was shipped through the Port at Lake Charles.

Calcined bauxite was imported by Carbo Ceramics, New Iberia. The material was used to manufacture proppants for the petroleum industry.

Synthetic calcium chloride was recovered by Allied Signal Inc. as a byproduct at its Baton Rouge plant using hydrochloric acid and limestone. Texas United Chemical Corp. produced calcium chloride from a plant near Lake Charles. The synthetic material was used to speed concrete setup, for dust control, in oil and gas drilling, and for road deicing.

Garnets were reclaimed by International Garnet Abrasives Inc. at a 10,000-ton-per-year plant in Harvey. Garnet concentrates were imported from foreign producers.

Graphite (synthetic) was used by Reynolds Metals Co. in the production of carbon anodes at a Lake Charles plant. During the year, work was ongoing on a $47 million expansion that included a furnace renovation and dock and ancillary facilities improvements.

Perlite was expanded by Filter Media Co. Inc. at a plant in Reserve. The raw material was obtained from New Mexico perlite producers. Principal markets were the filter, insulation, and lightweight concrete industries.

Phosphate rock for a Geismar phosphoric acid plant was imported from the Moroccan BouCraa phosphate rock mine. The plant produced super phosphoric acid for liquid fertilizer.

Pumice pebbles from Turkey were imported through the Port of New Orleans for firms producing "stone-washed" jeans. The pebbles and newly manufactured jeans were machine washed together to produce jeans with the "stone-washed" appearance.

Stone (dimension) was shipped into the State from domestic and foreign quarries and fabricated into building products, grave markers, and monuments.

The vermiculite exfoliating plant of W. R. Grace & Co. at New Orleans was inactive during the year. In past years, the plant exfoliated material obtained from mines in South Carolina.

Metals

Alumina.—The Ormet Corp., Kaiser Aluminum & Chemical Corp., and LaRoche Chemicals Inc. operated alumina refineries at Burnside and Gramercy. The Ormet Corp.'s 600,000-short-ton-per-year facility at Burnside reopened in 1988 after a 3-year closure. The Burnside facility was in its second year of a 3-year tolling agreement to provide alumina to several firms at a guaranteed production level and at a fixed price. Kaiser Aluminum operated a smelter at Gramercy. During the year, major expansion work was completed to raise the smelter capacity from 795,000 metric tons per year to 1 million metric tons per year. Alumina from the Kaiser smelter was sold on the open market. Laroche Chemicals also operated a smelter in Gramercy to produce alumina for the specialty and industrial alumina markets. Vista Chemicals completed modernization of its Lake Charles facility, which increased capacity by 31%.[16]

Iron and Steel.—Louisiana's only steel mill in LaPlace was operated by Bayou Steel Corp. The facility was equipped with two 65-ton electric furnaces with an annual capacity of 700,000 short tons of raw steel.

Uranium.—Freeport Uranium Recovery Co. operated a 700,000-pound-per-year uranium oxide plant at Uncle Sam. Much of the facility's output was purchased by the electric utility industry.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 30 years of mineral-related industry and government experience and has covered the mineral activities in Louisiana since 1989. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

[2]Deputy State Geologist, Louisiana Geological Survey.

[3]Chief Geologist, Office of Mineral Resources, Louisiana Department of Natural Resources.

[4]Baton Rouge State Times. Is Louisiana Getting Its Fair Share From Lake Shell Dredging? June 11, 1990.

[5]Times-Picayune (New Orleans). Major Sulfur Find to Reap Billions for Louisiana Economy. Sept. 28, 1990.

[6]State Times (Baton Rouge). Survey Shows Gains in Louisiana Personal Income. Jan. 24, 1991.

[7]———. Greenpeace Seeks Deep-Well Disposal Ban. Mar. 9, 1990.

[8](Sulphur) Daily News. Texas Brine Gets Permit. Mar. 21, 1990.

[9]Louisiana Contractor. Relocated Highway 90 Creeps Through the Swamplands Between Morgan City and Houma. V. 38, No. 1, Jan. 1991, pp. 62-64.

[10]National Association of State Land Reclamationists Newsletter. Oct. 1990, p. 6.

[11]Louisiana Contractor. Corps of Engineers Awards $147 Million in Contracts During 1990 for South Louisiana Flood Control. V. 38, No. 1, Jan. 1991, p. 99.

[12]Louisiana Department of Natural Resources, Geological and Engineering Division.

[13]Louisiana Geological Survey.

[14]State Times (Baton Rouge). Opal Mine Operator Hopes to Strike Gold for Area's Economy. Nov. 19, 1990.

[15]Port of New Orleans Record. Public Bulk Terminal Has Flexibility, Accessibility. V. 48, No. 1, Summer 1990, p. 16.

[16]Houston Business Journal. Feds' Antitrust Questions Stalling Buyout of Vista Chemical. June 3, 1991.

TABLE 2

LOUISIANA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,715	$12,126	$3.26
Plaster and gunite sands	W	W	3.11
Asphaltic concrete aggregates and other bituminous mixtures	568	5,771	10.16
Road base and coverings	247	737	2.98
Fill	131	244	1.86
Railroad ballast	W	W	1.45
Other	1,752	2,673	1.53
Unspecified:[1]			
Actual	5,704	25,059	4.39
Estimated	2,473	9,292	3.76
Total or average	[2]14,589	55,902	3.83

W Withheld to avoid disclosing company proprietary data; included with "Other."
[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.

TABLE 3

LOUISIANA: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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]	954	3,212	764	3,815	2,025	5,186
Asphaltic concrete aggregates and other bituminous mixtures	W	W	W	W	—	—
Road base and coverings	74	116	18	54	155	566
Fill	W	W	W	W	114	210
Railroad ballast	—	—	—	—	W	W
Other miscellaneous	997	2,164	473	4,970	838	1,256
Unspecified:[2]						
Actual	675	3,315	1,390	10,344	3,638	11,400
Estimated	367	1,604	592	3,585	1,515	4,103
Total[3]	3,067	10,411	3,237	22,769	8,285	22,722

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes plaster and gunite sands.
[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.

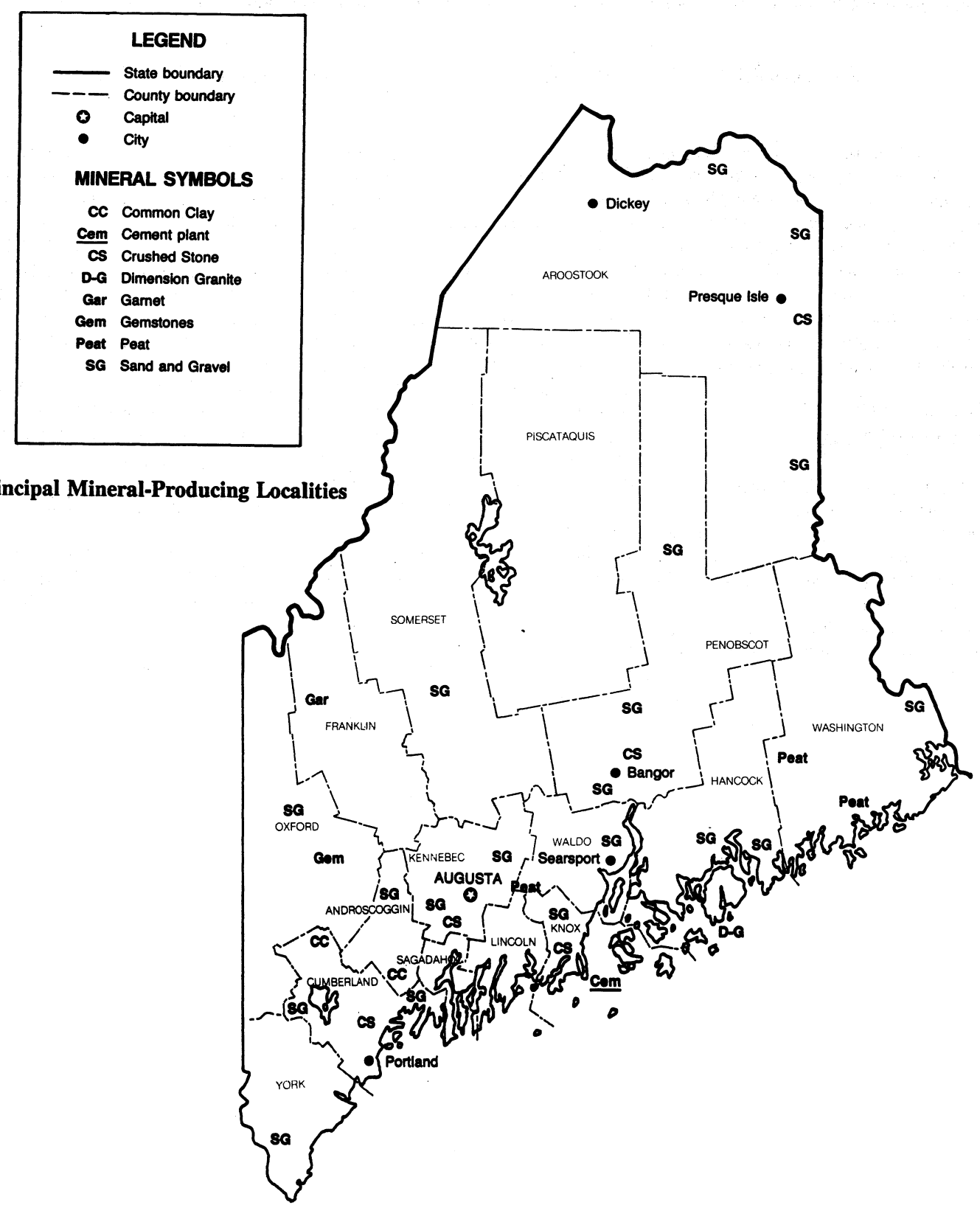
TABLE 4
PRINCIPAL PRODUCERS

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.	101 South Wacker Dr. Chicago, IL 60606	do.	Orleans.
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, LaSalle, Ouachita, Rapides, St. Tammany.
Pontchartrain Dredging Corp.	Box 8005 New Orleans, LA 70182	Quarry and plant	Winn.
Dravo Lime Co.	One Gateway Center 7th Floor Pittsburgh, PA 15222	Dredges	Orleans and St. Mary.
Winn Rock Inc.	Box 790 Winnfield, LA 71483	Quarry and plant	Winn.
Sulfur:			
Native:			
Freeport Minerals Co.	200 Park Ave. New York, NY 10166	Frasch process	Jefferson and Plaquemines.
Recovered:			
Cities Service Oil Co.	Box 300 Tulsa, OK 74102	Refinery	Calcasieu.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	Parish
Sulfur—Continued			
Recovered—Continued			
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.

MAINE


LEGEND
State boundary
County boundary
Capital
City
MINERAL SYMBOLS
CC Common Clay
Cem Cement plant
CS Crushed Stone
D-G Dimension Granite
Gar Garnet
Gem Gemstones
Peat Peat
SG Sand and Gravel
Principal Mineral-Producing Localities
AROOSTOOK
Dickey
Presque Isle
PISCATAQUIS
SOMERSET
PENOBSCOT
FRANKLIN
Gar
Bangor
HANCOCK
WASHINGTON
Peat
OXFORD
Gem
KENNEBEC
AUGUSTA
WALDO
Searsport
ANDROSCOGGIN
KNOX
LINCOLN
SAGADAHOC
CUMBERLAND
Cem
D-G
Portland
YORK
SG
CS
CC

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 1990 was $62.5 million, a $2.1 million decrease compared with that of 1989. Construction sand and gravel accounted for almost one-half of the State's total mineral value. Other commodities produced, in descending order of value, were portland cement, crushed stone, dimension stone, masonry cement, gem stones, clay, and peat.

TRENDS AND DEVELOPMENTS

In 1990, the value of total construction contracts, which relied heavily on mineral aggregates, was down 23% from that of 1989. The hardest hit sector was in residential construction, which fell 39% from $308 million in 1989 to $189 million in 1990. The value of nonresidential building construction contracts was down 13% from $127 million to $110 million. The only increase reported was in nonbuilding construction contracts, which rose by 23% from $149 million to $183 million in 1990. However, the increase in this category was not enough to offset the losses in the other two categories. As a result of these construction declines, demand for aggregates and building materials remained soft in 1990. Decreases in output were reported for construction sand and gravel, common clay, and portland and masonry cement. Estimated crushed stone output remained essentially the same as that of 1989.

However, there were some bright spots for the construction and mineral industries. A $40 million bond issue for a passenger rail line had been passed, and the installation of new wastewater treatment systems, which received the bulk of the public works funds, was scheduled to continue. A 30-mile-long portion of the Maine Turnpike was also scheduled for expansion.[4]

Over the past decade, many mining companies have been exploring throughout the State primarily for massive sulfide-base deposits. At least three companies have announced a desire to obtain the environmental permits necessary to place three deposits into production. As a result of this renewed interest in metal mining in the State, new legislation to rewrite the State's mining regulations was signed into law in 1990. The present rules were not written with mining in mind and would effectively preclude any metal mining activities in Maine. The State's last metal mine ceased operations in 1977.

REGULATORY ISSUES

The Maine Low Level Radioactive Waste Authority (MLLRWA) gave the go-ahead to examine about one-half of Maine Yankee nuclear powerplant's 740-acre site in Wiscasset for a possible low-level radioactive waste (LLRW) site. The nuclear powerplant was the first "volunteer" to offer its compound as a

TABLE 1
NONFUEL MINERAL PRODUCTION IN MAINE[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$150	NA	W	NA	W
Sand and gravel	thousand short tons	10,183	33,007	e8,600	e$30,100	7,865	$29,349
Stone:							
Crushed	do.	e1,400	e5,300	1,591	8,801	e1,700	e8,700
Dimension	short tons	e7,512	e5,924	W	W	W	W
Combined value of cement, clays (common), garnet (abrasive 1988), peat, and values indicated by symbol W		XX	23,379	XX	25,753	XX	24,495
Total		XX	67,760	XX	64,654	XX	62,544

eEstimated. 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).

disposal site for the State's low-level radioactive waste. The majority of the radioactive waste in the State is generated by Maine Yankee. The MLLRWA was also considering a site in Aroostook County. In September, the Maple Mountain Manganese Co. offered its 500-acre site west of Bridgewater in Aroostook County as another possible disposal site. The company purchased Maple Mountain in 1987 to mine manganese, but after feasibility studies indicated that mining was neither possible nor profitable, offered the site to the waste authority. However, in November, voters in the community overwhelmingly voted to reject the mining company's offer. The MLLRWA, in turn, also rejected the proposal because before any site can be used as a LLRW dump, it must be approved by 60% of the voters in the community, according to Maine law. The MLLRWA must find a low-level radioactive waste disposal site in Maine in the event the State is unable to negotiate a contract with an out-of-State disposal facility.

EMPLOYMENT

In 1990, the average number of workers[5] employed in the mineral extractive industries in 1990 was 1,058. This included 449 workers in the sand and gravel industry, 300 in the stone industry, and 7 at other nonmetal operations. In addition, 302 workers were employed at mineral-related mills and preparation plants in the State.

LEGISLATION AND GOVERNMENT PROGRAMS

Legislation to rewrite Maine's nonferrous metal mining regulations was signed into law (Public Law 1990, Chapter 874) in April. Chapter 874 established upfront fees to process nonferrous metal mining applications and an annual licensing fee of $10,000. The nonferrous metal mining applications are distinguished from other mining applications such as those for sand and gravel pits and stone quarries. The law also required the Maine Department of Environmental Protection and the Maine Land Use Regulation Commission to jointly adopt or amend rules for this activity by February 1, 1991.

Several bills concerning environmental issues were signed into law in 1990. Some of the bills addressed the disposal of dredged material, air and water quality improvement, and amending the State's existing hazardous and solid waste laws.

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 minerals industry, planning and regulatory agencies, and the general public. During the year, the MGS continued on an aggregate assessment of the offshore sand and gravel resources, including an evaluation of the heavy-mineral content of the sands. The study was in response to the continuing pressure on land-based aggregate resources.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Cement.—Maine remained the only New England State that produced cement. Dragon Products Co., a subsidiary of CDN Cementos del Norte, produced portland and masonry cement at a plant in Thomaston, Knox County. The company also operated 16 ready-mixed concrete plants throughout the State. In 1990, both production and value of portland and masonry cement declined from 1989 levels. The primary reason for the decline was the continuing depressed construction market in the Northeast.

A new $9.4 million scrubbing system began operating at the Thomaston plant in 1990. The new system recycles waste cement kiln dust (CKD) and reduces sulfur dioxide (SO_2) emissions. The process, named the Passamaquoddy Technology Recovery Scrubber, uses 90% of the SO_2 and a portion of the carbon dioxide (CO_2) in the kiln exhaust gas to recycle all of the plant's CKD into kiln feed, potassium fertilizer, and distilled water. The system can also be used to reclaim landfilled CKD. One-half of the cost of constructing the new scrubber was funded through the U.S. Department of Energy's Innovative Clean-Coal Technology Programs.

During the year, Dragon submitted a proposal to the Wiscasset planning board to build a railroad-to-barge transfer station at the city's waterfront. The company plans to ship the cement by rail to the terminal from its Thomaston plant and then barge it to Boston and New Hampshire. Although the proposal received unanimous approval by the town planning board, construction of the transfer station is contingent on a number of conditions. These conditions include meeting State Department of Environmental Protection standards for dust emission, monitoring noise levels, alerting lobstermen of barge traffic schedules, and that there be no stockpiles of materials at the station.

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. After almost 4 years of seeking approval, the company received State Department of Environmental Protection (DEP) approval to mine clay on an 89-acre parcel of land near Auburn, Androscoggin County. The area to be mined is adjacent to the area currently being worked by the company. In order to mine the parcel, Morin must abide by DEP regulations concerning truck traffic movement, air quality, streamwater runoff, establishment of buffer zones, and noise control.

Gemstones.—Semiprecious and gem-quality mineral specimens continued to attract rockhounds and mineral specimen collectors to the State. Many fine specimens of amethyst, aquamarine, citrine, heliodor, morganite, topaz, and tourmaline, to name a few, have been collected in the State. Popular collecting localities include quarries in

Androscoggin, Oxford, and Sagadahoc Counties.

In late 1989, the world's largest gem morganite crystal was unearthed at the Buckfield Quarry in Buckfield. The crystal, dubbed the "Rose of Maine," was 115,000 carats and weighed 50 pounds. Shortly thereafter, following a dispute over whether to form a company to sell the gem and market the site as a tourist attraction, the owners split the crystal into at least three pieces to increase its marketability.[6] A separate, large morganite crystal, which came from the same rock cavity, was donated to the Maine State Museum for display.

The Plumbago Mining Co. continued to mine a significant commercial amethyst deposit near the town of Sweden. The company began mining gem-quality amethyst from the deposit in 1989.

Graphite (Synthetic).—Synthetic graphite was produced by Fiber Materials Inc. at its plant in Biddeford, York County.

Peat.—Peat was mined by two companies in Maine. Dear Hill Farms Inc. mined peat for horticultural purposes in Waldo County, and Down East Peat LP hired a private contractor to mine peat for use as fuel at a 22.8-megawatt, peat-fired electric powerplant near Deblois, Washington County. Fuel for the plant was harvested from the adjacent 1,200 acre Denbo Heath Bog.

Perlite (Expanded).—Crude perlite shipped in from New Mexico was expanded by the Chemrock Corp. at a plant in Rockland, Knox County. Both quantity and value increased over 1989 levels. The expanded perlite was sold primarily as a filter aid.

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 1988 and 1990 and estimates for 1989.

Construction sand and gravel was the State's leading mineral commodity produced and accounted for almost one-half of the State's total value. In 1990, output declined about 9% from the estimated output of 1989; value remained essentially the same, the result of higher average unit values. The average unit value in 1990 was $3.73. A total of 80 companies or towns mined construction sand and gravel from 103 operations at 344 pits in 16 counties. Leading counties, in order of output, were York, Cumberland, Androscoggin, Penobscot, and Somerset. Major uses were for construction and roadbuilding.

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 1988 and 1990 and actual data for 1989.

Crushed.—Crushed stone was the State's third leading mineral commodity after construction sand and gravel and portland cement. The estimated crushed stone production of 1.7 million short tons was 7% higher than that of 1989. Leading counties, in order of output, were Cumberland, Knox, and Penobscot. Limestone, sandstone, traprock, and marl were quarried primarily for cement manufacture, concrete aggregate, and railroad ballast.

In response to citizens' complaints concerning blasting at a crushed stone quarry in Topsham, the township enacted a blasting ordinance. The ordinance, the first of its kind in Maine, set limits for ground vibration and shock waves from blasting in quarries, at construction sites, and in other areas where explosives are used. Town officials used ordinances developed in Huntsville, AL, to write the ordinance, which requires blasters to get town permits and notify nearby residents of expected blasts. The ordinance also requires testing of nearby wells following blasts and seismographic recordkeeping.

Dimension.—New England Stone Industries Inc. quarried dimension granite at Crotch Island, Hancock County. In 1990, estimated output and value increased over 1989 levels. 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 17 years of mineral-related experience and has covered the mineral activities in Maine for 6 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]Rock Products. Aggregate: Fearful but Cautiously Optimistic in 1991. V. 93, No. 11, Dec. 1990, p. 39.

[5]"Average number of workers" is summary of the average number of workers at individual mining establishments during periods (not necessarily continuous) of active operations.

[6]Portland Herald Press. "Ross of Maine" Morganite Spilt by Mining Brothers. Jan. 9. 1990, p. 1.

TABLE 2

MAINE: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	$775	$3,942	$5.09
Plaster and gunite sands	2	9	4.50
Concrete products (blocks, bricks, pipe, decorative, etc.)	W	W	7.73
Asphaltic concrete aggregates and other bituminous mixtures	405	2,791	6.89
Road base and coverings[1]	1,676	4,848	2.90
Fill	987	2,976	3.02
Snow and ice control	757	1,846	
Other[2]	105	742	7.07
Unspecified:[3]			
Actual	267	472	1.77
Estimated	2,892	11,723	4.05
Total or average	[4]7,865	29,349	3.73

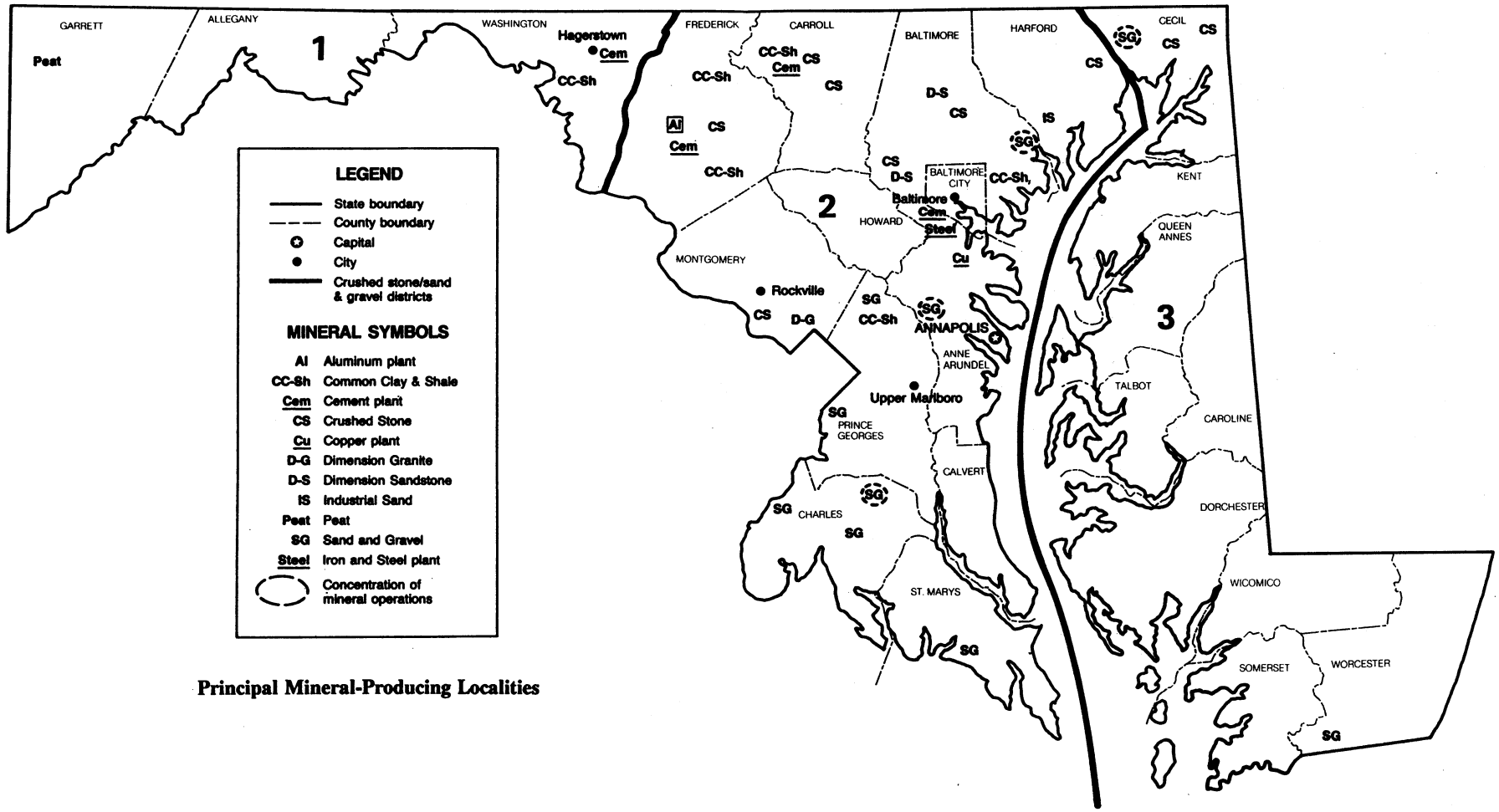
W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes road and other stabilization (cement and lime.)
[2]Includes filtration.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data do not add to total shown because of independent rounding.

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):			
W. E. Cloutier Co. Inc.	Box 1849 Lewiston, ME 04240	Pit	Androscoggin.
Harry C. Crooker & Sons Inc.	Old Bath Rd. Brunswick, ME 04011	Pits and plants	Androscoggin, Lincoln, Sagadahoc.
Dragon Products Co.	Box 191 Thomaston, ME 04861	do.	Androscoggin, Hancock, Oxford, Somerset.
R. J. Grondin & Son	Rural Route 4 Gorham, ME 04038	Pits	Cumberland and York.
Lane Construction Corp.	Box 103 Bangor, ME 04401	do.	Aroostook, Penobscot, Waldo, Washington.
Maine Department of Transportation	State House Station 16 Augusta, ME 04333	Pits and plants	Androscoggin, Kennebec, Knox, Oxford, Penobscot, Waldo.
Portland Sand & Gravel	94 Walnut St. Portland, ME 04091	Pit	Cumberland.
Tilcon Inc.	Box 209 Fairfield, ME 04937	Pits	Penobscot and York.
Stone (1989):			
Crushed:			
Blue Rock Industries	58 Main St. Westbrook, ME 04092	Quarries and mill	Cumberland and Kennebec.
The Cook Concrete Co.	960 Ocean Ave. Portland, ME 04103	Quarry and mill	Cumberland.
Dragon Products Co.	Box 191 Thomaston, ME 04861	Quarries	Aroostook and Knox.
Lane Construction Corp.	Box 103 Bangor, ME 04401	do.	Aroostook and Penobscot.
Dimension:			
New England Stone Industries Inc.	Providence Pike Smithfield, RI 02917	Quarry	Hancock.

[1]Also sand and gravel and stone.

MARYLAND



Principal Mineral-Producing Localities

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 increased to a State record of about $369 million in 1990. Demand for construction aggregates remained at near record-high levels. An increase in price and production of sand and gravel and a higher price for crushed stone contributed to the State's gain in total value.

State and local legislation to increase regulation of the mining industry was proposed with mixed results. Land use issues and decisions were expected to have a major effect on Maryland's mining industry during the 1990's.

TRENDS AND DEVELOPMENTS

Mineral consumption in Maryland began to slow down in 1990. Production of construction aggregates (sand and gravel and crushed stone), the raw materials used in building, reached an alltime high in Maryland in 1988 at 52 million short tons. High interest and inflation rates in the early 1980's had adversely affected the home and highway construction markets. In 1982, only about 25 million tons of construction aggregates was produced Statewide. Once these rates became lower, the demand for minerals resurfaced.

In 1990, output of construction aggregates totaled about 49 million tons. However, other mineral commodities shipped into Maryland through the Port of Baltimore showed a sharper decline. Cement, iron ore, and manganese ores dropped significantly according to data compiled by the Maryland Port Administration.[2] Iron ore imports dropped from 6.7 million tons in 1989 to 3.9 million tons in 1990; cement declined from 420,000 tons in 1989 to 162,000 tons in 1990; and manganese ores, from 76,000 tons to 12,000 tons.

LEGISLATION AND GOVERNMENT PROGRAMS

In 1990, State and local legislation was proposed to increase regulation of the mining industry. In the State General Assembly, House bill 1430 was proposed requiring public information meetings and hearings to be conducted by the Department of Natural Resources (DNR) on all completed applications for a surface mining permit. House bill 428 required the DNR to adopt regulations relating to permit conditions for dewatering surface mining operations. In Maryland, this bill would primarily affect stone quarry operators. This legislation would make a quarry operator liable for

TABLE 1
NONFUEL MINERAL PRODUCTION IN MARYLAND[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland)	thousand short tons	1,808	$89,083	1,871	$94,002	1,798	$91,172
Clays	metric tons	357,833	2,016	351,464	1,882	338,775	1,712
Gemstones		NA	5	NA	3	NA	3
Lime	thousand short tons	6	329	—	—	—	—
Peat	do.	7	W	3	W	3	W
Sand and gravel (construction)	do.	19,266	95,169	e16,900	e84,500	18,271	104,023
Stone:							
Crushed	do.	e32,700	e167,000	30,841	153,375	e30,500	e163,900
Dimension	short tons	e20,729	e1,515	27,529	2,072	e24,102	e1,751
Combined value of other industrial minerals and values indicated by symbol W		XX	7,804	XX	6,216	XX	6,053
Total		XX	362,921	XX	342,050	XX	368,614

eEstimated. 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).

"special exceptions" for mining operations. The ban prevented the opening or expanding of sand and gravel operations at least until 1991, when new regulations were expected to be adopted.

The Maryland Geological Survey (MGS) is responsible for mineral and energy resources investigations, which are directed through its facilities in Baltimore. Mineral resource maps for eight of nine counties on the State's Eastern Shore were completed during the year. These maps were prepared for use in land use planning.

The MGS also continued work with the Minerals Management Service of the Department of the Interior. In this project, cores from Maryland's inner continental shelf were logged, photographed, and split into samples for analysis of heavy minerals.

The Energy Information Administration published a State Coal Profile for Maryland.[3] The State produced about 3 million short tons of coal in 1989 from 29 mines in Allegany and Garrett Counties.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Portland cement, construction sand and gravel, and crushed stone accounted for $359 million or almost 97% of Maryland's nonfuel mineral production. Land use issues involving the question of mine development versus conservation continued to be a major concern of the industries producing these mineral commodities.

Other industrial minerals produced in Maryland included masonry cement, clays, peat, dimension stone, and industrial sand. For the most part, these industries were small, long-established, and stable operations; for these commodities, land use conflicts were less significant.

Cement.—Production of portland cement remained at about the 1.8-million- short-ton level for the fourth consecutive year. The State's three cement plants again operated at almost 90% of capacity compared with the U.S. average of about 76%. About three-fourths of the cement was used in ready-mixed concrete by the construction industry. Two of the portland cement producers also manufactured masonry cement.

Lehigh Portland Cement Co. received approval to open a new limestone quarry near New Windsor for use in cement manufacture at its Union Bridge plant. Design plans showed a 66-acre quarry to be mined to a depth of 195 feet. The State's DNR, Water Resources Administration, approved the permit.

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 1988 and 1990 and estimates for 1989.

Maryland 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 1990, sand and gravel production of 18.3 million tons was the third highest total reported in State history. District 2, which accounted for about three-fourths of the output, encompassed the greatest geographic area and population concentrations.

In 1990, sand and gravel was produced by 42 companies at 69 pits in 12 of Maryland's 23 counties. Charles County led the State in output, followed by Prince Georges and Anne Arundel Counties. Sand and gravel used for concrete aggregates accounted for about one-half of the total sales. Since 1988, the price of sand and gravel has increased by about 15% to $5.69 per ton.

In Prince Georges County, Circuit Court dismissed an appeal of an exemption to county zoning regulations that allowed Southern Maryland Sand & Gravel Co. to mine a 360-acre site near Piscataway.

Genstar Stone Products Co. announced plans to donate a 120-acre mine site to the Anne Arundel County Department of Recreation and Parks. Mining of sand and gravel at the mine in Davidsonville was projected to be completed in 3 years followed by 2 years of reclamation. The county was expected to own the land in February of 1995.

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 1988 and 1990 and actual data for 1989.

Production of crushed stone exceeded 30 million tons for the fourth successive year. Crushed stone remained the State's leading mineral commodity, accounting for 44% of the State's value of nonfuel mineral production. Nationally, Maryland ranked 17th in crushed stone output and 15th in value.

Metals

No metallic ores were mined in Maryland. Metals discussed in this section were processed from materials received from both foreign and domestic sources. 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 in 1990.[4] Iron ore and magnanese ore shipments decreased in 1990 and are discussed under Trends and Developments. Imports of ferroalloys also dropped, from 193,000 tons to 177,000 tons. Shipments of bauxite from overseas decreased from 369,000 tons to 364,000 tons.

Aluminum.—Eastalco Aluminum Co., a subsidiary of Alumax Inc., continued to produce aluminum at its smelter near Frederick.

Copper.—Mitsubishi Materials America Corp., a subsidiary of Mitsubishi Metal Corp. of Japan, acquired an 80% interest in Cox Creek Refining Co. Southwire Co. of Carrollton, GA, owned the other

20% of the company. Cox Creek manufactured copper cathode and wire rod at a facility in Baltimore. In 1989, the firm produced 60,000 metric tons of copper cathode and 30,000 tons of wire rod.[5]

Iron and Steel.—Bethlehem Steel Corp. operated an integrated steel plant at a 3,500-acre complex in Sparrows Point. During 1990, the company completed relining of a large blast furnace and continued modernization of a 68-inch, hot strip mill. As a result of capital expenditures of more than $1.1 billion in the past 10 years, the Sparrows Point plant has one of the largest blast furnaces in the Western Hemisphere and a slab caster with an annual capacity approaching 3.6 million tons.[6]

[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related industry and government experience and has covered the mineral activities in Maryland for 6 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Maryland Port Administration. Foreign Commerce Statistical Report 1990. July 1991, p. 279.

[3]Weekly Coal Production, State Coal Profile: Maryland. DOE/EIA-0218(90-38), Sept. 15, 1990, pp. 3-5.

[4]Work cited in footnote 2.

[5]American Metal Market. Mitsubishi To Acquire Majority Share of Cox Creek. V. 98, No. 142, July 23, 1990, p. 8.

[6]Bethlehem Steel Corp. 1990 Annual Report, p. 3.

TABLE 2
MARYLAND: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	$9,144	$53,559	$5.86
Plaster and gunite sands	230	1,031	4.48
Concrete products (blocks, bricks, pipe, decorative, etc.)	61	228	3.74
Asphaltic concrete aggregates and other bituminous mixtures	1,134	5,939	5.24
Road base and coverings	1,638	5,187	3.17
Fill	700	1,495	2.14
Snow and ice control	W	W	5.95
Other[1]	477	2,398	5.03
Unspecified:[2]			
Actual	4,887	34,186	7.00
Total or average	18,271	104,023	5.69

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes filtration.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 3
MARYLAND SAND & GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	W	W	6,179	37,698	W	W
Plaster and gunite sands	—	—	W	W	W	W
Concrete products (blocks, bricks, etc.)	—	—	—	—	61	228
Asphaltic concrete aggregates and other bituminous mixtures	—	—	1,111	5,861	24	78
Road base and coverings	W	W	1,408	3,878	W	W
Fill	—	—	351	901	349	594
Snow and ice control	—	—	W	W	W	W
Other miscellaneous[1]	38	330	144	383	3,720	19,886
Unspecified:[2]						
Actual	—	—	4887	34,186	—	—
Total	38	330	[3]14,079	82,907	4,154	20,786

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[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.

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:			
Coplay Cement Co., (Societe des Ciments Francais)	4120 Buckeystown Pike Lime Kiln, Box D Frederick, MD 21701	Quarry and plant	Do.
Portland and masonry:			
Independent Cement Corp. (St. Lawrence Cement Inc.	Box 650 Hagerstown, MD 21740	do.	Washington.
Lehigh Portland Cement Co.[1] (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.
Maryland Clay Products Inc. (Boren Brick & Tile Co.)	7100 Muirkirk Rd. Beltsville, MD 20705	Pit and plant	Prince Georges.
Victor Cushwa & Sons 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.[2]	3901 Glidden Rd. Baltimore, MD 21226	Plant	Baltimore.
Calcined:			
National Gypsum Co., Gold Bond Building Products Div.	2301 South Newkirk St. Baltimore, MD 21224	Plant	Baltimore.
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.
Peat:			
Garrett County Peat Products	R.F.D. 1, Box 91 Accident, MD 21520	Bog and plant	Garrett.
Sand and gravel:			
Construction:			
Charles County Sand & Gravel Co.	Box 322 Waldorf, MD 20601	Pits and plant	Anne Arundel, Charles, St. Marys.

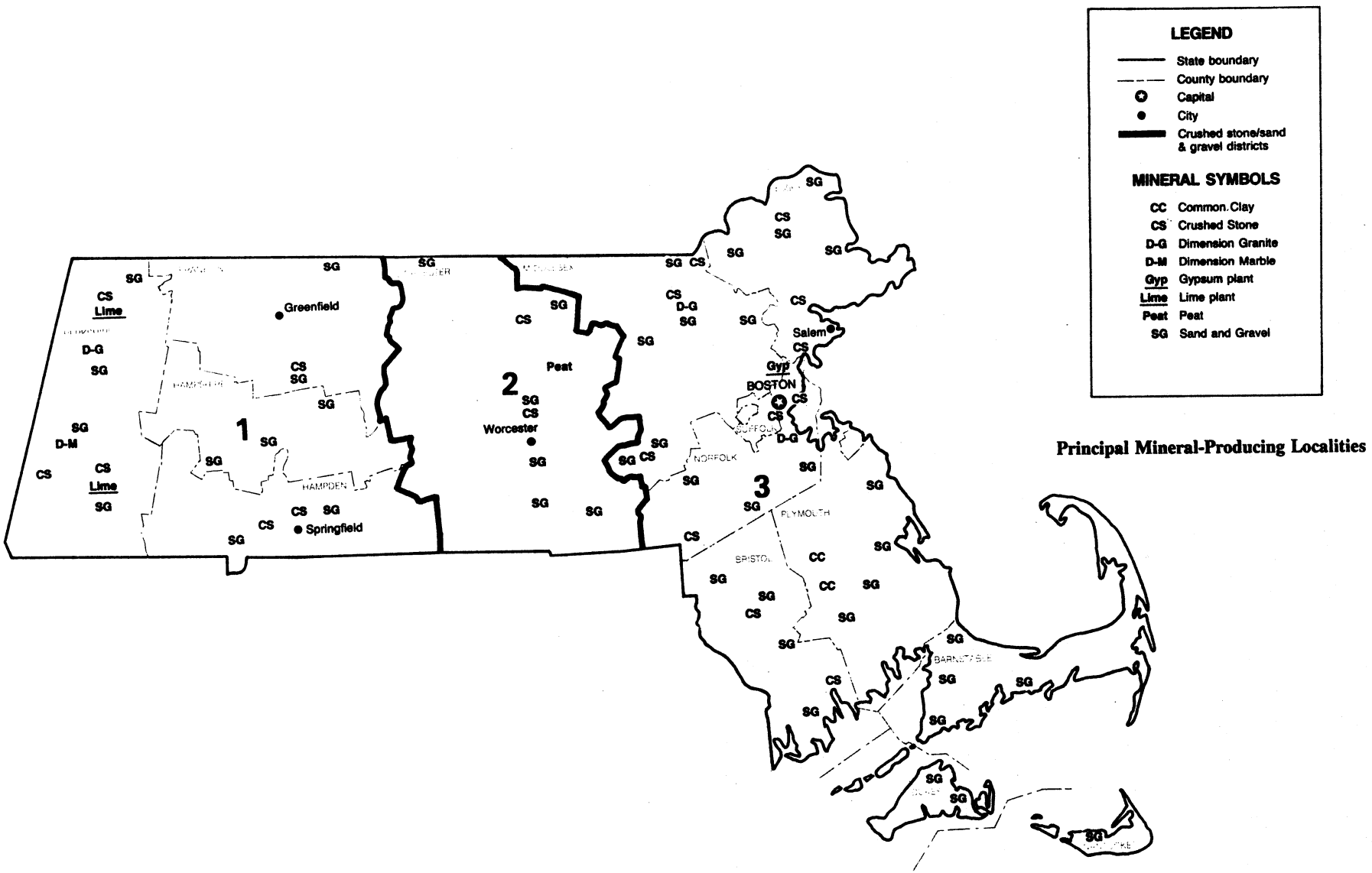
See footnotes at end of table.

TABLE 4—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Construction—Continued			
Laurel Sand & Gravel Inc.[1]	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.	4714 Barnabas Rd. Temple Hills, MD 20748	Pits and plant	Prince Georges.
Southern Maryland Sand & Gravel Corp.	8700 Ashwood Dr. Capital Heights, MD 20743	Pit	Charles.
York Building Products Co. Inc.	Box 1708 York, PA 17405	Pits and plant	Cecil.
Industrial:			
Harford Sands Inc.	Box 25 40 Fort Hoyle Rd. Joppa, MD 21085	Pits	Harford.
Stone:			
Crushed:			
The Arundel Corp.[3]	110 West Rd. Baltimore, MD 21204	Quarries and plants	Baltimore, Frederick, Harford.
Genstar Stone Products Co.[3]	Executive Plaza 4 11350 McCormick Rd. Hunt Valley, MD 21031	do.	Baltimore, Carroll, Frederick, Harford.
Martin Marietta Aggregates Corp.[3]	Box 30013 Raleigh, NC 27612	Quarries	Washington.
Maryland Materials Inc.	Box W North East, MD 21901	Quarry and plant	Cecil.
Phoenix Inc.	Box 676 Frederick, MD 21701	Quarry	Frederick.
Rockville Crushed Stone Inc.	Box 407 133900 Piney Meetinghouse Rd. Rockville, MD 20850	do.	Montgomery.
D. M. Stoltzfus & Son Inc.	Box 11 Talmage, PA 17580	do.	Cecil.
Dimension:			
Patapsco Natural Stone Quarry Inc.	Marriottsville Rd. Marriottsville, MD 21104	do.	Baltimore.
Stoneyhurst Quarries	Box 34463 8101 River Rd. Bethesda, MD 20817	do.	Montgomery.
Weaver Stone Co.	15027 Falls Rd. Butler, MD 21023	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 titanium dioxide (pigments).
[3]Also sand and gravel.

MASSACHUSETTS



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] and Joseph A. Sinnott[2]

The value of nonfuel mineral production in 1990 was $127.5 million, a decrease of $16.6 million compared with the 1989 value. The combined value of crushed stone and construction sand and gravel, the State's two leading mineral commodities, accounted for 83% of the value. In 1990, the State ranked eighth among 34 States that produced dimension stone. Other commodities produced included common clay, industrial sand, lime, and peat. Industrial minerals processed or manufactured in the State included abrasives, graphite, gypsum, perlite, and vermiculite.

TRENDS AND DEVELOPMENTS

One leading indicator of the health of the State's aggregate industry was the number of construction contracts awarded. In 1990, the total value of construction contracts was down 23% from 1989 after declining 15% from 1988 to 1989. Overbuilding in the mid-1980's had led to a collapse of the residential, commercial, and industrial construction markets. Although the value of nonbuilding construction contracts rose 14% in 1990, this was offset by declines in the value of nonresidential contracts (down 26%) and residential construction contracts (down 34%). Normally, highway construction was also a large consumer of aggregates. Because of State budgetary cuts, however, an estimated $300 million worth of road and bridgework in the State was put on hold. As a result of fewer construction contracts and highway construction projects, output of the State's two leading mineral commodities (crushed stone and construction sand and gravel) were lower in 1990.

The long-term outlook for aggregate producers does appear brighter however, once the combined $10 billion Boston Harbor Cleanup and the Boston Central Artery Projects get into full swing. It was estimated that 3.8 million cubic yards of concrete would be required in the construction of the $5 billion Central Artery-Tunnel Project. Structural steel needed would amount to 25,000 short tons, and almost 2 million square feet of ceramic tile would be needed to finish tunnel interiors.[3] The State passed an additional 10-cent-per-gallon gasoline tax in the spring of 1990, which should provide additional funds for highway projects.

EMPLOYMENT

In 1990, the average number of workers[4] employed in the mineral extractive industries in Massachusetts was 1,058. This included 449 workers in the sand and gravel industry, 300 in the stone industry, and 302 working in mills and preparation plants.

TABLE 1
NONFUEL MINERAL PRODUCTION IN MASSACHUSETTS[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$1	NA	$3	NA	$1
Sand and gravel:							
Construction	thousand short tons	22,168	79,364	e13,900	e57,000	12,774	51,466
Industrial	do.	W	W	34	601	30	401
Stone:							
Crushed	do.	e17,500	e91,900	11,880	67,768	e9,200	e54,500
Dimension	short tons	W	W	67,533	10,302	e56,254	e10,992
Combined value of clays (common), lime, peat, and values indicated by symbol W		XX	20,973	XX	8,452	XX	10,138
Total		XX	192,238	XX	144,126	XX	127,498

eEstimated. 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).

LEGISLATION AND GOVERNMENT PROGRAMS

Under the State Mining and Mineral Resources Research Institute Program Act (Public Law 98-409), the U.S. Bureau of Mines awarded a basic allotment grant of $145,000 to the Massachusetts Institute of Technology (MIT) to conduct research and training in the mineral-related disciplines. In addition to the allotment grant, $125,745 was provided for studies of respirable dust for a total of $270,745. Under stipulations of the act, the State of Massachusetts was required to match this grant on a 2:1 basis.

Engineers at the University of Massachusetts were planning to construct a large-scale solar energy system near the school's Amherst campus utilizing a large clay deposit as a heat storage medium. The technique, which could overcome the difficulty of storing solar energy, was explored by the U.S. Department of Energy in the 1970's as a way to heat homes, but heat leaked out of the relatively small system too fast. The Amherst system's much larger, 100,000-cubic-meter clay deposit is expected to retain and give back 85% of its stored heat. As planned, heat from the sun will be captured during the summer utilizing 6 acres of solar collectors. The heated water would then be pumped through underground pipes that interlace the clay. In the winter, the warm clay would heat water pumped into the system to 140° F. The heated water would then be pumped to a new convention center on the campus, providing 80% of the center's heating requirements. The estimated cost of the project is $3.5 million.

Vitrifix of North America Inc., Alexandria, VA, sought approval to open a plant near Grafton to process waste asbestos by vitrifying asbestos into glass. If approved, the plant, which would be the first of its kind in the world, will convert asbestos and glass waste into a hard, reportedly nonhazardous glass product, using a 2,200° F furnace. Carcinogenic asbestos fibers are reportedly destroyed at 1,700° F. In addition to receiving local approval for construction of the plant, the company must file an environmental notification form with the Massachusetts Environmental Policy Act (MEPA) unit.

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.

Graphite (Manufactured).—Two companies, both 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 continued to produce lime in Berkshire County from locally quarried limestone. Primary markets for the lime included western New York and New England, with the majority shipped by truck.

In July, groundbreaking began on a $13 million upgrading and expansion at Pfizer Inc.'s lime plant in Adams. Upgrading will include removing existing inadequate structures at the plant and constructing a new office building and main quality control assurance laboratory, which will house a totally computerized control system. Obsolete equipment at the plant will be replaced, and a new carbonator will be built. The new equipment will enable the Adams plant to double its production of precipitated calcium carbonate, a high-grade synthetic product used primarily in the paper industry. Environmental concerns that will be addressed include increasing restoration of mined-out lands, adding muffling equipment, enclosing other machinery to reduce noise and dust emissions, and an asbestos abatement program at the plant.

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 1988 and 1990 and estimates for 1989.

Massachusetts construction sand and gravel statistics are compiled by geographical districts as depicted by the State map. Table 3 presents end-use data for the State's three districts.

The value of construction sand and gravel accounted for the second largest portion (40%) of the State's total mineral value. In 1990, production and value of construction sand and gravel decreased 8% and 10%, respectively, from 1989 levels. The 1990 output also represented a decrease of 42% from the alltime high output of 22.2 million tons produced in 1988. These decreases were largely

attributable to fewer construction starts and a decrease in highway construction projects.

In 1990, more than 100 companies mined construction sand and gravel in 13 counties. Leading counties, in order of output, were Middlesex, Worcester, and Norfolk. The material was used mainly for concrete aggregate, fill, and road base and coverings.

Boston Sand & Gravel Co. was awarded a 10-year contract by the Massachusetts Water Resources Authority to supply the concrete for the massive $5 billion Boston Harbor Project. The provisions in the $87.8 million contract state that Boston Sand & Gravel will transport by barge all raw materials to a Deer Island central mixing facility it will build. The contract also required that the company have access to, or own, an onshore location to load barges and store materials. The Boston Harbor Project includes building the second largest primary and secondary wastewater treatment facility in the Nation--an almost 6-mile-long, 11-foot-diameter, cross-harbor tunnel to transport sewage from Nut Island to Deer Island and a 9.5-mile, 24-foot-diameter ocean discharge tunnel to carry treated wastewater from Deer Island to deep-ocean waters.

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 1988 and 1990 and actual data for 1989.

Crushed.—Crushed stone was the State's leading mineral commodity, accounting for almost 43% of the State's total value. Estimated stone production in 1990 was 23% lower than that in 1989. The 1990 estimated output of 9.2 million tons was also 47% lower than he alltime high output of 17.5 million ons produced in 1988. Traprock (basalt) accounted for the majority of the stone produced, followed by granite and limestone. Major uses included road base and concrete aggregates.

Dimension.—Massachusetts ranked eighth of the 34 States that reported dimension stone production. Dimension granite, used primarily for curbing, was quarried by six companies in Berkshire, Middlesex, and Plymouth Counties. Dimension marble was quarried by one company in Berkshire County and sold as rough blocks.

Vermiculite (Exfoliated).—W. R. Grace & Co. exfoliated imported vermiculite at its Easthampton plant in Hampshire County. Major uses were for insulation and fireproofing.

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[1]State Mineral Officer, U.S Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related experience and had covered the mineral activities in Massachusetts for 5 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistance.

[2]State geologist, Executive Office of Environmental Affairs, Boston, MA.

[3]Albee, R. The Big Dig, Boston's Central Artery Project. ConnStruction, Summer 1991, v. 30, No. 2, pp. 10-11.

[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.

TABLE 2

MASSACHUSETTS: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,484	$18,404	$5.28
Plaster and gunite sands	72	633	8.79
Concrete products (blocks, bricks, pipe, decorative, etc.)	205	1,842	8.99
Asphaltic concrete aggregates and other bituminous mixtures	889	4,283	4.82
Road base and coverings[1]	1,345	3,814	2.84
Fill	1,164	3,308	2.84
Snow and ice control	322	1,483	4.61
Railroad ballast	W	W	5.83
Other[2]	868	4,067	4.69
Unspecified:[3]			
Actual	576	2,369	4.11
Estimated	3,848	11,262	2.93
Total[4] or average	12,774	51,466	4.03

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes road and other stabilization (cement).
[2]Includes roofing granules and 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.

TABLE 3

MASSACHUSETTS: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	764	$3,708	552	$2,863	2,168	$11,833
Plaster and gunite sands	—	—	W	W	W	W
Concrete products (blocks, bricks, etc.)	W	W	—	—	W	W
Asphaltic concrete aggregates and other bituminous mixtures	W	W	W	W	657	3,423
Road base and coverings[1]	129	709	936	1,539	280	1,566
Fill	155	406	360	1,334	649	1,569
Snow and ice control	38	191	116	414	168	879
Railroad ballast	—	—	W	W	—	—
Other miscellaneous[2]	396	954	122	896	859	5,552
Unspecified:[3]						
Actual	270	539	25	150	281	1,680
Estimated	788	1,594	263	855	2,797	8,813
Total[4]	2,540	8,100	2,374	8,051	7,859	35,315.00

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes road and other stabilization (cement).
[2]Includes roofing granules and 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.

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Clays:			
Stiles & Hart Brick Co.	Box 367 Bridgewater, MA 02324	Pit	Plymouth.
Graphite (synthetic):			
The Stackpole Fibers Co., Inc.	Foundry Industrial Park Lowell, MA 01852	Pit	Middlesex.
Textron Corp., Avco Specialty Materials Div.	1275 King St. Box 9000 Greenwich, CT 06836	Plant	Do.
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.
Sand and gravel:			
Construction:			
Berkshire Concrete Co.	465 Chesire Rd. Pittsfield, MA 01201	Pits	Berkshire.
Emaral Corp.	Box 173 Millbury, MA 01527	Pit	Middlesex and Worcester.
Heffron Materials	Box 176, 68 Winter St. Reading, MA 08164	Pit	Middlesex.
P. A. Landers Inc.	Box FF Hanover, MA 02339	Pit	Plymouth.
S. M. Lorusso & Sons Inc.	230 West St. Walpole, MA 02081	Pit	Norfolk.
Industrial:			
Whitehead Bros. Co. Inc.	Box 259, River Rd. Leesburg, NJ 08327	Pit	Do.
Stone:			
Crushed (1989):			
Keating Materials Corp.	2140 Bridge St. Dracut, MA 01826	Pit	Middlesex and Worcester.
John S. Lane & Son Inc.	730 East Mountain Rd. Westfield, MA 01085	Quarries	Berkshire, Hampden, Hampshire.
S. M. Lorusso & Sons Inc.	331 West St. Walpole, MA 02081	do.	Middlesex, Norfolk, Suffolk.
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.
Dimension:			
Fletcher Granite Co.	West Chelmsford, MA 01863	Quarry	Middlesex.
Williams Stone Co. Inc.	Box 278 East Otis, MA 01029	do.	Berkshire.

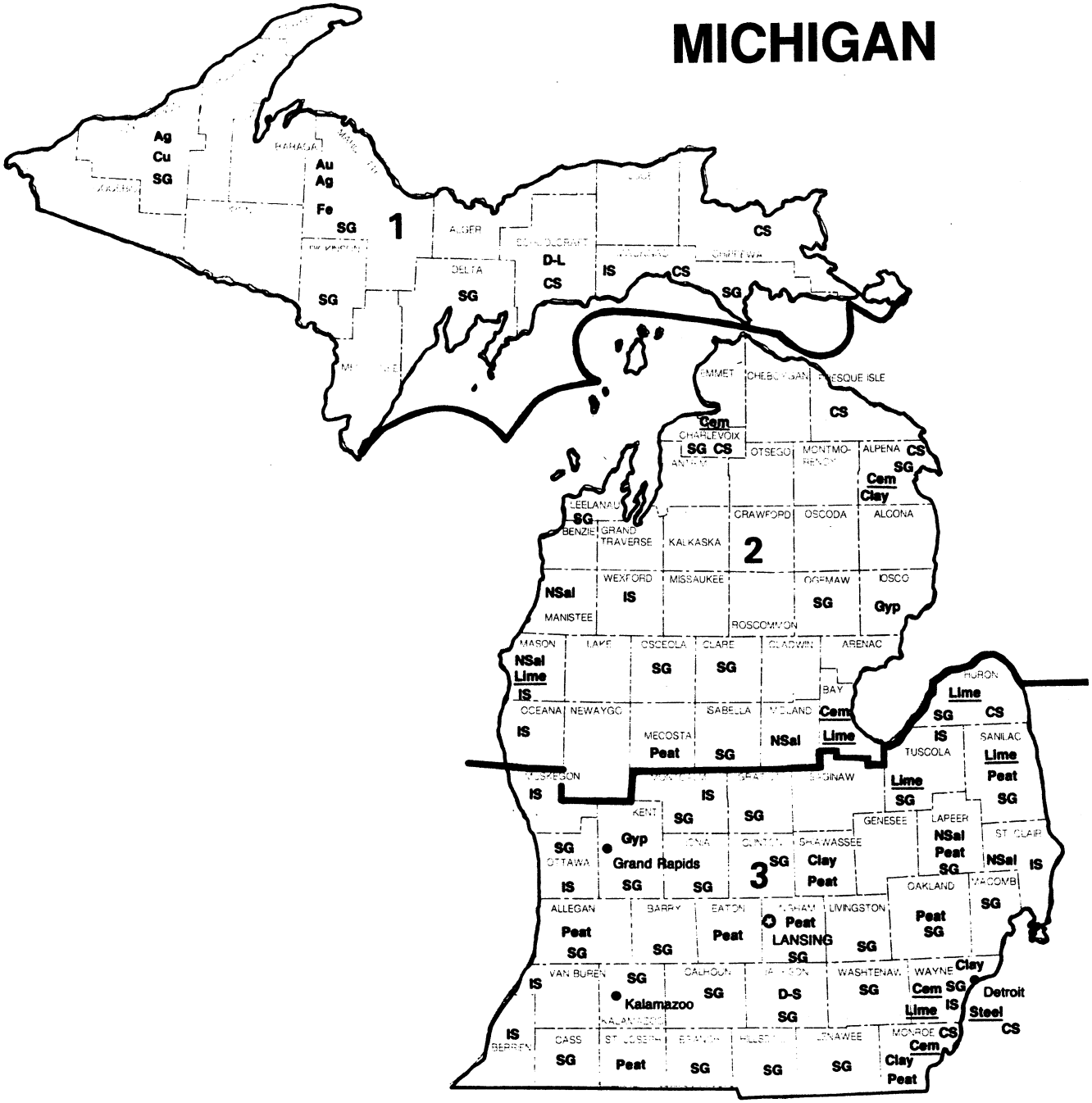
See footnotes at end of table.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Vermiculite (exfoliated):			
W. R. Grace & Co.	62 Whittemore Ave. Cambridge, MA 02140	Plant	Hampshire.

[1]Also stone.

MICHIGAN



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
D-L	Dimension Limestone
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

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 Wanda J. West[1] and Milton A. Gere, Jr.[2]

Michigan's 1990 nonfuel mineral production was valued at $1.4 billion. The 10% decline from the record-high value established in 1989 was attributed mainly to a 4-month strike by members of the United Steel Workers of America Union, which resulted in a drop of almost one-third in the value of iron ore shipments. Value decreases also were reported for the sales of calcium chloride, clays, gypsum, iron oxide pigments, lime, magnesium compounds, industrial sand, silver, and dimension stone. Gains were registered for some of the principal mineral commodities used in construction, including cement, construction sand and gravel, and crushed stone, and also for copper, gem stones, peat, potash, and salt. Despite a slumping auto market, raw steel production was at nearly the same level as that in 1989.

The diversity and strength of Michigan's mineral industry enabled it to rank eighth, nationally, in value of nonfuel mineral production in spite of a lengthy work stoppage in the iron ore industry, the largest contributor to the State's nonfuel mineral value. The State accounted for about 4% of the Nation's nonfuel mineral value in 1990. It was the leading producer of calcium chloride, crude iron oxide pigments, magnesium compounds, and peat; it ranked second in production of iron ore and construction sand and gravel and third in portland cement, gypsum, and industrial sand. Industrial minerals provided about two-thirds of the State's nonfuel mineral value.

Michigan's vigorous highway improvement program created a 24% rise in the value of State road contract awards

TABLE 1
NONFUEL MINERAL PRODUCTION IN MICHIGAN[1]

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
Cement:							
Masonry	thousand short tons	265	$22,915	255	$22,286	272	$23,880
Portland	do.	5,253	231,141	5,449	253,324	5,906	263,607
Clays	metric tons	1,248,121	4,432	1,249,198	4,599	1,201,542	4,094
Gemstones		NA	25	NA	10	NA	11
Gypsum (crude)	thousand short tons	1,958	11,630	2,089	15,589	2,000	11,511
Iron ore	thousand metric tons	14,623	W	15,045	W	10,034	W
Lime	thousand short tons	714	36,088	621	32,479	622	30,898
Peat	do.	322	6,256	286	6,082	280	6,264
Sand and gravel:							
Construction	do.	53,508	138,171	e48,000	e132,000	53,729	153,057
Industrial	do.	3,045	27,150	2,865	24,577	2,310	19,285
Stone (crushed)	do.	e38,800	e120,300	40,905	123,678	e43,100	e129,000
Combined value of bromine (1988), calcium chloride (natural), copper, gold (1988-89), iron oxide pigments (crude), magnesium compounds, potash (1989-90), salt, silver, stone (dimension), and values indicated by symbol W		XX	989,453	XX	984,347	XX	796,516
Total		XX	1,587,561	XX	1,598,971	XX	1,438,123

[e]Estimated. 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).

in 1990 (to $606 million)[3] and was the main factor in sustained or increased production of cement and aggregate materials. The increased demand offset declines that existed most of the year in the commercial construction and homebuilding markets. According to the U.S. Department of Commerce, Bureau of the Census, 38,871 private and public residential units were authorized in 1990, 6,816 fewer than in 1989; value of nonresidential construction totaled $2.3 billion, about 8% less than in the previous year.

EMPLOYMENT

The Michigan Employment Security Commission, Bureau of Research & Statistics, reported that Michigan's labor force totaled 4.58 million, basically unchanged from that of 1989. The State's unemployment rate rose from 7.1% to 7.5%. A rate of 8.9%, compared with 8.2% in 1989, was posted in the Upper Peninsula where completion of major construction projects and the 4-month mine workers' strike contributed to the accelerated rate.

Statewide, 9,000 persons were engaged in mining, 10% fewer than those in 1989. Mining employment in the Upper Peninsula totaled 2,900 persons, 24% fewer than the 3,800 employed in 1989. Iron mining activities were brought to a standstill on August 1 when 1,800 members of the United Steel Workers Union went on strike with the expiration of their contract. By the time a December 1 settlement was reached, the shutdown had resulted in temporary layoffs of several hundred employees at companies serving the iron ore industry, such as power companies, railroads, and Great Lakes ore carriers.

Average annual pay for Michigan miners, including all sectors of the industry, was $31,029 compared with an annual wage of $25,376 for all industries in the State.[4]

REGULATORY ISSUES

Amendments to the Federal Clean Air Act, enacted on November 15, 1990, as Public Law 101-549, imposed stricter environmental control standards, including tougher regulations on toxic emissions from coke ovens. Steel companies operating integrated mills expected to make large expenditures to comply with the law's curb on toxic air pollutants. Late in the year, National Steel Corp. announced plans to build a $300 million coke battery and byproducts plant at its Great Lakes Division at Ecorse, which was expected to meet or exceed all of the new requirements.

In August, the U.S. Environmental Protection Agency (EPA) released preliminary findings of studies done at the Torch Lake Superfund site on the Keweenaw Peninsula in Houghton County. The report indicated there was no ground water contamination in private wells around the town of Lake Linden. In addition to testing well water, the EPA, with assistance from the State Department of Natural Resources (DNR) and the U.S. Bureau of Mines, had collected and examined air and soil samples from various locations in the area. It also studied shore tailings for the possibility of metals being released into the environment and the contents of drums found in the tailings disposal area. Analysis of the tailings, soil, and air samples suggested the presence of metals such as arsenic, chromium, copper, and lead and organic compounds.[5] A remedial investigation report with EPA's final conclusions was expected to be released within a few months. Torch Lake was added to the Superfund list in 1986 after unusually large numbers of fish from the lake reportedly had abnormal tumorous growths. Researchers had not agreed on whether elevated levels of arsenic, chromium, copper, lead, nickel, and zinc were caused by the copper industry or if they were naturally occurring. Studies failed to prove conclusively any link between the fish abnormalities and the copper mining wastes, which for years had been dumped into the Lake and the Keweenaw Waterway.

EXPLORATION ACTIVITIES

In May, the DNR, through its Real Estate Division, conducted a metallic minerals lease sale, offering 14,229 acres of State-owned land in five counties. The three successful bidders were Callahan Mining Corp. (3,478 acres), Crystal Exploration Inc. (640 acres), and Alex Fagotti of Crystal Falls (720 acres). Bonus bids totaled $9,063.58. The highest bid per acre was $5.27 and the lowest was $1.01, with an average bid of $1.87 per acre. Combination of the bonuses bid and the first year rental payments ($3 per acre) were expected to produce $23,577.58 in revenue for the Michigan Natural Resources Trust Fund. Most of the 4,838 acres covered by the bids were in Marquette County (2,518 acres); other counties involved were Dickinson (840 acres), Gogebic (120 acres), and Iron (1,360 acres). None of the Menominee County acreage offered in the sale was leased. Statewide, lease sale results were down considerably from those of 1989, when there were 8 successful bidders, 7,643 acres leased, bonuses of $29,599, and first year revenues of $52,528.38. As of fiscal year 1989-90, Michigan had 16,277 acres of State-owned land under lease for metallic minerals.

Exploration activity in the Upper Peninsula focused mainly on base and precious metals and diamonds. The DNR reported that 9 companies performed exploratory drilling of 92 holes on State and private mineral leases in the Upper Peninsula, totaling approximately 18,400 feet. Also, four exploration drill holes for limestone-dolomite were drilled in the Lower Peninsula.

Although Callahan Mining Corp.'s Ropes gold mine in Marquette County remained closed throughout the year, the company continued to pursue an exploration program for gold and other minerals in the Upper Peninsula through two joint ventures funded by Western Mining Corp. (U.S.A.). Western, a subsidiary of Western Mining Corporation Holdings Ltd. of Australia, can earn up to 50% of Callahan's interest

in the properties included under each of these ventures that were managed by Callahan. The company planned to do exploration drilling at the venture sites, involving the greenstone belt and other areas, during 1991.

Crystal Exploration Inc. continued its diamond exploration program in the vicinities of Iron Mountain and Crystal Falls in Iron and Dickinson Counties, respectively, throughout 1990. Nineteen holes were drilled, resulting in the discovery of two kimberlite pipes. Eleven of the holes intersected kimberlite. In mid-1990, Crystal contracted Airmag Surveys of Philadelphia to fly a fixed-wing aeromagnetic survey of 9,200 line-kilometers. Later, Digem Inc. was utilized to fly precision low-level rotary-wing surveys over 40 geophysical targets generated from the fixed-wing survey. A total of 840 line-kilometers was flown. Most of the work was carried on in the Upper Peninsula of Michigan; however, a minor portion did extend into Wisconsin. Crystal, a wholly owned subsidiary of the Australian company Crystal Mining NL, maintained a field office in Crystal Falls.

Great Lakes Minerals launched a $1 million exploration and development drilling program on a copper deposit in Keweenaw County near Gratiot Lake. The project was a joint venture with Michigan Mining and Manufacturing. Earlier drilling reportedly had identified a 3-million-short-ton deposit, designated the 543-S, grading 2.9% copper. Late in the year, the company reported that drilling results from several holes indicated high-grade intersections within wider, lower-grade zones, confirming the continuity of the previously outlined reserves. Great Lakes planned also to examine two additional deposits as part of the project.

Several other mineral exploration firms continued various stages of exploration in the Upper Peninsula. Projects varied from the extension of a known limestone-dolomite deposit to precious-metals exploration to studying the rock supporting an electric power dam.

Exploration for oil and gas continued in the Michigan Basin in the Lower Peninsula. There were 1,314 drilling permits issued for oil and gas wells. By yearend, 950 holes were drilled, resulting in 767 gas wells, 39 oil wells, and 144 dry holes. The Antrim gas play accounted for 737 of the gas wells drilled.

LEGISLATION AND GOVERNMENT PROGRAMS

No legislation specifically related to nonfuel minerals was enacted into law during the 1990 session of Michigan's 85th legislature.

Writing of rules for Act 188, Public Acts of 1988, the Forest and Mineral Resource Development Fund Act, continued during 1990. The Michigan Geological Survey Division (GSD) of the DNR led the effort, with assistance from the Forest and Mineral Resource Development Fund Board. Public hearings were held and paperwork was prepared for the final approval of the rules. When the rules are approved and the money is appropriated, this act will allow for grants and loans to be made for projects involving new technologies, products, etc., that will aid the State's forest and mineral resource industries.

The GSD's primary activity in the Lower Peninsula is the regulation of the oil and gas industry. Duties include issuing drilling permits, monitoring production, and plugging oil and gas wells. There are, however, numerous nonfuel mineral-and geological-related activities performed by the GSD staff. These duties include regulating mine reclamation at open pit mines and quarries, as well as at any potential coal mines; permitting and regulating mining and reclamation at industrial sand operations in protected sand dune areas; assisting with the taxation of metallic mine operations; serving as a cooperator in the Statewide Groundwater Data Base effort; and assisting DNR's Real Estate Division in the metallic and nonmetallic mineral leasing programs. The staff also maintains geological information data bases; provides ground water and geological data to requestors; assists DNR divisions with evaluation of State-owned mineral deposits, ground water supplies, etc.; and issues permits for, and regulates, mineral wells, which include deep disposal wells, mineral brine production wells, geotechnical and test wells, and mineral exploration drill holes.

The GSD maintained its Geological Core and Sample Repository at Marquette. This "rock library" contains drill core and cuttings from throughout most of the State, with the greater part of the collection originating from mineral exploration drilling in the western part of the Upper Peninsula. The materials are open to public use, by appointment, for geological research by industry, government, and academia. Additions during 1990 included 60 drill holes consisting of 446 boxes of core representing about 5,188 feet of drilling from 7 counties. Two additional cuttings libraries are maintained by the GSD. Cuttings from hundreds of selected oil and gas wells are maintained by the Subsurface and Petroleum Geology Unit in Lansing. Water well cuttings from selected Upper Peninsula water wells are maintained by the GSD at the DNR's Escanaba District Office. Records for thousands of oil and gas wells and logs for water wells in Michigan are maintained in the GSD's Lansing office. Copies of all Upper Peninsula water well logs also are maintained at the Escanaba District Office.

A current catalog of material published by GSD, entitled "Publications, Microfilm Documents, Open Files & Maps" (PL-1), is available from its Lansing office.

The Gerald E. Eddy Geology Center, in the Waterloo State Recreation Area in Washtenaw County, continued to be a cooperative effort of the DNR's Geological Survey and Parks Divisions. The center has interpretative displays featuring the geology and mineral resources of the State and hiking trails that offer an explanation of the geology in the immediate area.

Construction of Michigan Technological University's (MTU) Minerals and Materials Engineering building at Houghton was nearing completion at yearend. The $47.7 million

facility will house undergraduate and graduate academic and research programs in metallurgy, materials processing, and mining, as well as the Institute of Materials Processing. Multifaceted research in those program areas was conducted in 1990. The Mineral Technology Research Group completed a study on ways to improve the vitality of Michigan's limestone industry. Study areas included: (1) applied research on new technologies to identify new uses for limestone, (2) seeking ways to broaden markets and develop new markets for limestone and limestone products, and (3) investigating ways to lower costs associated with the production, processing, and transportation of limestone and limestone products. A report of research findings was published in February.[6]

MTU's Department of Mining Engineering personnel, in cooperation with the GSD, continued research on economic development of the graphitic rock resources of the western Upper Peninsula. Earlier research had established that the rock had the proper chemical and physical characteristics to be used as kiln feed material, substituting for shale, in portland cement manufacture. Several cement companies were interested in these findings, and additional work was done on exploration for reserves, including core drilling and a transportation cost assessment. Higher than desired pyrite levels in some of the slate rock led to research on ways to remove the sulfur. Crushing-screening and bioextraction methods were being investigated.

A multiyear geologic mapping project of the Ishpeming greenstone belt, which has a potential for gold deposits, was completed by MTU's Department of Geological Engineering, Geology, and Geophysics. The area is a few miles north of the inactive Ropes gold mine and several gold prospects that were explored years ago. Funding was provided by the GSD (which published two related reports in 1990) and the U.S. Geological Survey.

In fiscal year 1990, MTU received research and allotment grants totaling $338,697 from the U.S. Bureau of Mines under provisions of Public Laws 98-409 and 100-483, the State Mining and Mineral Resources Research Institute Program. The basic allotment grant of $145,000 was supplemented by additional funds for respirable dust research. Funds provided under the act support basic research in the mineral sciences and engineering, and they are matched by State funds on a 2:1 basis. Since designated a participant in the Mineral Institute Program in 1979, Michigan Tech has received more than $3 million in Federal funds through provisions of the program.

FUELS

According to the U.S. Department of Energy, Michigan ranked 15th in crude oil production and in natural gas production in 1990. The State produced 19,675,000 barrels of oil (42 gallons each) and 139,955 million cubic feet of gas.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Calcium Chloride.—Michigan again led the Nation in calcium chloride production, outranking California, the only other producing State, by a considerable margin. Dow Chemical Co. produced calcium chloride pellets and flake at its well brine operation near Ludington in Mason County, and Wilkinson Chemical Corp. sold calcium chloride solution from its operation near Mayville in Lapeer County. Output and value declined slightly from 1989 levels. 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.

Martin Marietta Corp., Magnesia Specialties Div., marketed some byproduct calcium chloride from its brine operations in Manistee County.

Cement.—Portland and masonry cement sales rose about 8% and 7%, respectively, over those of 1989 and were the highest since 1979. Michigan ranked third among the 38 States producing portland cement and fourth among the 36 masonry-cement-producing States. The value of portland cement increased 4% to a record $263.6 million. Among the nonfuel minerals produced in Michigan in 1990, only iron ore contributed more to the total State value of mineral production. The average price of Michigan's portland cement was $44.64 per ton ($1.85 less than that in 1989) compared with the U.S. average of $48.72. Masonry cement sales averaged $87.82 per ton ($0.32 more than that in 1989), considerably higher than the national average of $68.84.

Michigan's five cement plants operated at 93% of their 6.1-million-short-ton finish grinding capacity compared with an 86% utilization rate in 1989. The plants operated at almost 99% of their clinker capacity. Lafarge Corp. and Medusa Cement Co. operated dry-process plants; Holnam Inc. and St. Mary's Peerless Cement Co. operated wet-process plants; and Essroc Materials Inc. (formerly known as Aetna Cement Corp.) operated a grinding plant only. Gray portland cement was produced at each of the plants. Holnam was the only company not producing masonry cement; however, the company was the only producer of portland pozzolan cement. About 75% of the portland cement sales were to ready-mixed concrete companies; other customers included concrete product manufacturers (11%), highway contractors (9%), building material dealers (4%), and other miscellaneous customers. Most of the cement was trucked in bulk form to consumers.

Raw materials consumed in the manufacturing process included 7.1 million short tons of limestone, 1.6 million short tons of clay and shale, 669,000 short tons of clinker, 295,000 short tons of gypsum, and smaller amounts of anhydrite, fly ash, iron ore, sand, and slag.

Cement shipments to and within Michigan from all domestic sources

included 2.7 million short tons of portland cement and 135,000 short tons of masonry cement, only slight declines from 1989 shipments.

In March, Dundee Cement Co. and Ideal Basic Industries of Denver, both subsidiaries of Holderbank Financiere Glaris Ltd. of Switzerland, merged and began operating under the name Holnam Inc., a publicly traded holding company. Installation of a new $17 million baghouse facility at the Dundee plant was completed in 1990. The new unit was part of a plan to bring emissions from the kiln stack into conformance with State standards.

Lafarge substantially completed the first phase of a modernization and expansion program at its Alpena plant. Project costs included approximately $55 million for equipment and related support systems and between $10 million and $15 million in facility upgrades. The second phase of the program, scheduled for completion in 1992, will involve additional improvements to the plant's raw materials handling facilities and refinements to existing kiln systems. The upgrade and modernization program will cut operating costs and increase the plant's rated annual cement production capacity by about 25%, to 2.5 million short tons.[7]

Medusa installed state-of-the-art, high-efficiency separators on finish mills at the Charlevoix plant, lowering electrical power consumption and improving product quality. Also, according to the company's annual report, it converted an oil tanker to a self-unloading, 8,500-short-ton capacity cement-carrying barge that will transport cement from the Charlevoix plant to Medusa's network of terminals on the Great Lakes.

Clays.—Five companies produced common clay and shale from five pits in four counties. Production and attendant value decreased about 4% and 11%, respectively, compared with 1989 figures. Michigan ranked seventh in common clay output among the 43 producing States. Most of the tonnage was captive production by cement companies; the remainder was for use in pottery and brick manufacture.

Gemstones.—The value of gem stones and mineral specimens collected by mineral dealers, rockhounds, and other hobbyists was estimated to have increased 10% in 1990. Gem stones common to Michigan include: small, colorful, richly banded agates; ankerite; chlorastrolite; domeykite; jasper; laumontite; native copper; Petoskey stones (fossilized coral); and prehnite. Lake Superior beaches, old mine dumps, and gravel pits are often the sources of materials collected.

Crystal Exploration Inc. continued its diamond exploration program. Work, focused on several Upper Peninsula areas, included sampling of glacial sediments, geophysical surveys, and drilling.

Gypsum.—Output of crude gypsum decreased by 4%, and a $1.71 per ton decline in the average price resulted in a 26% drop in total value. Nevertheless, Michigan again ranked third among the 20 producing States. The State has two important gypsum-producing areas. Domtar Gypsum Inc. and Georgia Pacific Corp. operated underground mines near Grand Rapids in Kent County, and Michigan Gypsum Co., National Gypsum Co., and USG Corp. operated open pit mines in Iosco County. USG's Alabaster Mine and National Gypsum's Tawas Mine ranked third and seventh, respectively, among the 58 U.S. mines active in 1990.

Domtar Gypsum, Georgia-Pacific, and National Gypsum 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; also, some was shipped to other States for processing. Calcined production from the 4 plants totaled 637,000 short tons valued at about $11.8 million, placing Michigan 11th among the 28 States where calcining plants were operated. Gypsum is commonly used in wallboard and other building products but also is used as an agricultural fertilizer, in dental castings and toothpaste, and as a filler in food products, glass, and plastics.

Lime.—Michigan ranked 10th of 32 States in lime production. Output registered a slight rise over that of 1989, but total value decreased about 5%. The average price per short ton was $49.68 compared with a national average of $51.77. Five companies reported production of quicklime from eight plants in seven counties; some hydrated lime also was produced at one of the plants. The product was sold for a variety of uses, including steelmaking, sugar refining, and water treatment.

Lime shipments to and within Michigan, from all domestic sources, totaled 1 million short tons of quicklime and 41,000 short tons of hydrated lime compared with 1.1 million tons of quicklime and 40,000 tons of hydrated lime in 1989.

Late in the year, Koch Minerals Co., Wichita, KS, sought approval to build a lime plant at Escanaba, Delta County. The facility would use a rotary kiln to process limestone into quicklime. If approved, the 15-month construction project was expected to begin in mid-1991. About 15 to 20 fulltime jobs would be created by the plant when it becomes operational.[8] No action had been taken on the permit application as of yearend. Earlier in the year, Western Lime & Cement Co., Green Bay, WI, requested permission to build a similar plant at Gladstone, also in Delta County. The company planned to produce approximately 350 short tons of lime pellets daily at the proposed plant using limestone from the Gulliver Quarry of Pfizer Specialty Minerals Inc. Pellets produced at the $6 million to $10 million plant would be sold primarily to the paper industry and for pollution control. Citing environmental concerns, Gladstone residents intensely protested the plan, and at yearend, the proposal was still being disputed.[9]

Magnesium Compounds.—Three companies produced magnesium compounds from natural well brines at operations in Manistee and Mason

Counties in west- central Michigan. Total output declined slightly from that of 1989, but the State continued as the leader among six producing States and, in 1990, provided most of the Nation's output. Compounds produced included caustic-calcined magnesia, magnesium carbonate, magnesium hydroxide, and refractory magnesia. Dow Chemical Co. also produced small amounts of unpurified bromine as a byproduct of magnesium production at its Ludington plant in Mason County. The material was shipped to Arkansas and reprocessed for consumption.

Peat.—Michigan continued to lead the Nation in peat sales, ranking first among 22 producing States in 1990 and supplying one-third of the U.S. total. Eleven companies sold 280,000 short tons of peat from bogs in 10 counties. Although sales declined about 2% from the 1989 level, a $1.10 per ton increase resulted in a 3% growth in total sales value.

Reed sedge was the predominant type produced, with smaller quantities of humus and sphagnum also reported. About 89% of the sales was for general soil improvement. The rest was used as an ingredient in potting soils; for mushroom beds; on golf courses; by nurseries; for vegetable growing; packing lowers, plants, shrubs, etc.; and as an earthworm culture. Two-thirds of the product was sold in packaged form; the remainder, in bulk.

Perlite (Expanded).—Crude perlite from Harborlite Corp.'s mine in Arizona was expanded at the company's Vicksburg plant in Kalamazoo County. Sales and value approximated those of 1989. The expanded product was marketed for use in filter aids and fillers.

Potassium Salts.—Kalium Chemicals Ltd. completed the first full year of operation at its pilot plant facility in Hersey Township in southwestern Osceola County. The company produced potash by solution mining of an ore body, which was 2,400 meters deep. No specific plans were announced by Kalium for further expansion of the 36,000-metric-ton-per-year test facility that was constructed to demonstrate a technical ability to extract and refine potash from the Michigan Basin.

Salt.—Salt was solution-mined by Akzo Salt Inc. in Manistee and St. Clair Counties and by Morton International Inc. in Manistee County. The vacuum pan process was used at each of the operations to obtain the salt from the brine. Michigan ranked eighth among 14 producing States. Sales increased about 5% in quantity and 9% in value. Salt was sold for a variety of uses, including animal feed, chemical-industrial processing, highway deicing, human consumption, and water treatment.

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 1988 and 1990 and estimates for 1989.

A record-high output of construction sand and gravel was reported in 1990, with tonnage and value increasing 12% and 16%, respectively, over 1989 estimated figures. It accounted for 11% of the State's nonfuel mineral value; only iron ore and portland cement contributed more. Michigan again ranked second, behind California, among the producing States. In 1990, 240 companies and government agencies reported production from 314 operations in 72 of the State's 83 counties. Table 3 provides production and end-use data for construction sand and gravel from each of the State's three districts depicted in the State map.

Industrial.—Compared with 1989 figures, industrial sand production fell 19% in quantity and 22% in value to its lowest level in many years. Michigan ranked third among 38 producing States, yielding to California the second place ranking it had held for 10 years. Illinois continued as the number one producer. Seven companies reported output from 14 operations in 11 counties, mainly from coastal dunes along Lake Michigan. Each of the companies sold sand for foundry applications, a use which consumed about 92% of the production. The remainder was sold for glassmaking, fiberglass manufacture, sandblasting, refractories, traction sand, and other miscellaneous uses.

Slag, Iron and Steel.—Michigan ranked fourth among 28 States processing iron and steel slag in 1990. Only Ohio, Indiana, and Pennsylvania, respectively, reported greater sales. Two companies processed iron and steel slag from steel mills in Wayne County and 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. Sales increased 7% in quantity and 9% in value.

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 1988 and 1990 and actual data for 1989.

Crushed.—Sales of crushed stone by Michigan producers were estimated at 43.1 million short tons, about 5% above 1989 sales and the highest since 1974 when sales neared 47.5 million short tons. Attendant value increased about 4% to $129 million, a record high. Limestone-dolomite constituted more than 90% of the crushed stone sales, with marl, sandstone, traprock, and quartzite accounting for virtually all of the remainder. Although Michigan ranked only 12th among the 49 States producing crushed stone, it is the site of some of the Nation's largest quarries. Based on 1989 data, the average output of the State's 30 active limestone-dolomite quarries was 1.3 million short tons, compared with a national average of 322,000 short tons. Michigan Limestone Operations' Calcite Quarry and Presque Isle Corp.'s Stoneport Quarry, both in Presque Isle

County, ranked second and fourth, respectively, in production among the Nation's 3,416 active crushed stone operations.

In September, Inland Steel Co. sold its Inland Lime & Stone Co. quarry at Gulliver to Pfizer Specialty Minerals Inc., a subsidiary of Pfizer Inc. The Schoolcraft County limestone quarry was closed in December 1989 after almost 60 years of operation when union workers refused to vote on a contract proposal from St. Mary's Cement Co. of Ontario who wanted to buy the operation. That sale had hinged on the labor agreement, which called for a cut in pensions in the event of a plant closure. Pfizer hoped to reopen the quarry in the spring of 1992, following a major renovation of the operation. Limestone from the Gulliver quarry will be used by Pfizer to manufacture precipitated calcium carbonate for use as a paper filler or coating pigment for the whitening of paper.[10] Also, as part of the sales agreement, Inland Steel agreed to purchase 1 million short tons of stone from Pfizer for 11 years commencing in 1992 for use at its East Chicago, IN, steel mill.[11]

As in a growing trend nationwide, Michigan aggregate producers desiring to expand existing operations or to develop new ones frequently encountered obstacles because of zoning regulations, land use conflicts, or opposition by the general public for environmental or aesthetic reasons. One of the most publicized such cases in Michigan during 1990 was France Stone Co.'s request for the rezoning of 200 acres in Monroe Township from agricultural to heavy industrial as a preliminary step in opening a new limestone quarry. The operation was to replace a nearby, nearly depleted quarry from which the company produced about 1 million to 1.25 million short tons of crushed stone annually.[12] After several months of heated public debate over the issue, the Monroe Township Board unanimously rejected the rezoning request, contending that it would conflict with the township's future land use plan and that France Stone failed to prove that the quarry would not adversely affect "the health, safety, and public welfare" of area residents. Late in the year, France Stone filed a 15-page lawsuit against Monroe Township in the U.S. District Court in Detroit for denying the company's rezoning application. The matter was unresolved at yearend, and the court battle was expected to be a lengthy one.

Dimension.—Production of dimension stone was estimated to have declined sharply from that of 1989. Two companies were active during 1990. 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.

Sulfur (Recovered).—Two companies recovered byproduct sulfur at petroleum refineries in Manistee and Wayne Counties. Sales increased 15% in quantity and 8% in value over those reported for 1989.

Vermiculite (Exfoliated).—Vermiculite from out-of-State sources was exfoliated by W. R. Grace & Co., Construction Products Div., at its Dearborn plant in Wayne County. Most sales were for block and loose-fill insulation and fireproofing. Other uses included concrete and plaster aggregates and agricultural purposes. The plant was permanently closed on September 1, resulting in a sharp decline in 1990 output compared with that of 1989. Increased competition from other materials, particularly in the building products market, and a reduced level of construction activity contributed to the closure.

Metals

Copper, Gold, and Silver.—Nationally, Michigan ranked fifth among 12 States in copper production and ninth among 19 States in silver production. Virtually all of the output was from Copper Range Co.'s White Pine Mine, smelter, and refinery complex in Ontonagon County. Copper Range Co. is owned by Metall Mining Co., a Canadian-based subsidiary of Metallgesellschaft A.G. of the Federal Republic of Germany. Production of copper, in terms of recoverable metal, was about 8% higher than that in 1989, and silver production gained about 6%. Total value of production did not register equal gains because of lower base metal prices. Copper prices averaged $1.23 per pound in 1990 compared with $1.31 per pound in 1989. Silver prices dropped for the third consecutive year to $4.82 per troy ounce compared with the 1989 average of $5.50.

In January, Metall Mining Co. announced a capital investment program aimed at modernizing its Copper Range facility and lowering production costs. The company planned to spend about $30 million over the next 4 years to replace antiquated equipment with larger, more efficient machinery, making changes that would nearly double the annual copper production to about 65,000 short tons. As part of the production increase program, Metall Mining purchased mill equipment for its concentrator from Round Mountain Gold Corp., a subsidiary of Echo Bay Inc. (owner of the Copper Range operation from January to November 1985), for $4 million. The mill section, already in the Copper Range concentrator, had been idle since 1977. Addition of this equipment was expected to boost Copper Range's capacity by about one-third, to a total of 23,000 short tons per day. Ore production in 1990 averaged 14,300 short tons per day compared with 12,900 tons per day in 1989. This resulted in the production of 94.4 million pounds of cathode equivalent compared with 87.4 million pounds in 1989.[13] Approximately 1,100 people were employed at the facility. As of December 31, 1989, proven and probable reserves at the White Pine Mine were 180.7 million short tons containing 4.5 billion pounds of extractable copper, sufficient for more than 30 years of production.[14]

Red Metal Explorations Inc. mined a small amount of ore in conjunction with development work at the Caledonia Mine in Ontonagon County. Activities included building a new entrance, establishing an emergency exit route, and working

approximately one-half mile into the horizontal mine. Ore was stockpiled for future smelting at Copper Range's White Pine smelter. Some native copper specimens encountered during development work were sold on the world market. Company plans for the operation included mine cleanup, limited production, and ore body exploration, with long-range plans for setting up a modular mining system. The Caledonia Mine was last operated by Calumet & Hecla Inc. in 1959.

Peninsula Copper Industries Inc. (PCI) produced copper oxide and other copper compounds at its Hubbell plant for use in manufacturing wood preservatives and for other uses. Circuit boards and other copper scrap materials served as the company's source for copper in 1990; however, progress was made during the year toward securing raw material from a native copper mine in Houghton County. In September, PCI announced its purchase by Chemetals Inc., a wholly owned subsidiary of Sadachem S.A., a Belgian company. The sale was contingent on the completion of rehabilitation and startup of the Centennial No. 6 copper mine, which was last operated in 1976. The mine would supply PCI with 5 million pounds of copper over a 5-year period. Dewatering of the mine was completed in November, and production was expected to begin in the spring of 1991. Mine operations were conducted by MICHCAN Copper Co. Ltd., a joint venture of PCI, Keweenaw Copper Co., and Torch Lake Holdings Co., who acquired the mine in 1989. When fully operational, the Centennial was expected to employ almost 100 people.

Callahan Mining Corp.'s Ropes gold mine in Marquette County was inactive the entire year. The mine was closed indefinitely on September 29, 1989, because of ground control problems near the main production shaft and low gold prices at that time. The mine and mill remained on indefinite shutdown after milling of stockpiled leach residues was completed in the first quarter. Flooding of the mine was begun. Because complete flooding was expected to take 7 to 8 years, company officials said pumps could be reinstalled and the mine reactivated if gold prices showed significant improvement. Resumption of operations to bring to the surface broken ore remaining at the Ropes would depend on sustained higher gold prices sufficient to justify expenditures that would be required to make the shaft usable and for additional ventilation and escapeway facilities. As of yearend, mineralized material at the mine was estimated at 483,355 short tons, grading 0.093 ounce of gold per ton, sufficient for less than 1 year of operations.[15]

Iron Ore.—A 122-day strike by the State's iron miners resulted in iron ore shipments falling to their lowest level since the recession-plagued year of 1982. The State continued to rank second, behind Minnesota, of the nine States shipping iron ore, and iron ore remained the chief contributor to Michigan's nonfuel mineral value. However, shipments and value dropped approximately one-third below the 1989 levels, and the State furnished only 18% of the Nation's total compared with 26% in 1989.

The strike began on August 1 when about 1,800 members of the United Steel Workers Union walked off their jobs at Cleveland-Cliffs Iron Co.'s (CCI) Empire and Tilden Mines in Marquette County, the State's only active iron ore operations. A settlement was reached on December 1, with workers agreeing to a new 3-year contract that would increase wages $1.25 per hour immediately, with an additional $0.25 per hour on January 1, 1992. The pact also included a $2,000 signing bonus in 1990, three annual cost-of-living supplements, and 50 shares of CCI common stock. The shutdown caused peripheral layoffs at companies providing goods and services to the iron ore industry, such as power companies, railroads, and Great Lakes ore carriers. The last strike by western Marquette County miners was a 113-day work stoppage in 1977.

Cleveland-Cliffs Inc. reported in its 1990 annual report to stockholders that 5.3 million long tons (5.4 million metric tons) of pellets was produced during the year at the Empire Mine, which had a rated annual capacity of 8 million long tons (8.1 million metric tons). Owners of the Empire Iron Mining Partnership were Inland Steel Co. (40%), LTV Steel Co. (25%), Wheeling-Pittsburgh Steel Corp. (10%), and CCI (25%).

In the same report, CCI stated that 3.9 million long tons (4.0 million metric tons) of pellets was produced at the Tilden Mine, which had a rated annual capacity of 6.7 million long tons (6.8 million metric tons). About 53% of the pellets was from hematite ore, and the remainder was from magnetite. Company goals for the first full year of dual magnetite and hematite pellet production were not attained because of the steelworkers' strike. Owners of the Tilden Magnetite Partnership were The Algoma Steel Corp. Ltd. (50%), Stelco Inc. (16.7%), and CCI (33.3%). Entitlement holders in the Tilden Hematite Partnership were Algoma Steel (25%), Stelco (8.3%), and CCI (66.7%). In June, Algoma Steel announced that it would seek to sell its U. S. coal and iron ore interests, including its Tilden Mine interest. Algoma was expected to continue to use Tilden pellets after any ownership change; however, no sale was announced as of yearend. New production equipment added to the Tilden production fleet in 1990 included a 12-cubic-yard (9-cubic-meter) diesel-powered shovel, the first to be used in the iron ore industry.

About 98% of the Michigan ore was hauled by rail to Escanaba or Marquette ports and then transported by lake vessels to lower lake ports for delivery to blast and steel furnaces. The remainder was shipped entirely by rail to consumers, mostly to USX Corp.'s Fairfield steelworks near Bessemer, AL. First ore cargoes of the 1990 navigation season left the Lake Superior & Ishpeming Railroad Co. Presque Isle dock in Marquette on March 21, and the Chicago & Northwestern Railroad (C&NW) dock in Escanaba on March 22. Approximately 5 million long tons of ore was shipped from each of the ports before their closings on January 1, 1991, and January 31, 1991, respectively.

Michigan ranked first among the five States reporting shipments of crude iron oxide pigments. All shipments were by CCI from a stockpile at its Mather Mine in Marquette County.

In December, CCI formed a joint venture with North Star Steel Co., Minneapolis, MN, to evaluate the production of iron carbide pellets to compete with premium-quality scrap in the production of steel by electric arc furnaces. The process, developed by Iron Holdings Ltd., Lakewood, CO, involves treating the ore in a fluidized bed reactor that substitutes carbon for oxygen in the iron to make the iron carbide pellets. According to the American Iron and Steel Institute (AISI), electric furnaces' share of U.S. steel production has grown from less than 10% to 34%-37% in the past 20 years.[16] These electric "minimills" cannot use the type of iron pellets currently produced in the Lake Superior District, and the new technology could provide an access for producers such as CCI to this expanding potential market.

Iron and Steel.—Michigan mills produced 8.1 million short tons of raw steel in 1990, about 1% less than in 1989, according to the AISI. Its three Detroit-area steel mills provided about 8% of the 98.9 million tons produced nationwide. The State ranked fourth in production, following Indiana, Ohio, and Pennsylvania. Most of the steel produced at Michigan mills was used by the automobile industry.

In November, National Steel Corp. announced plans to build a new coke battery and byproducts plant at its Great Lakes Division at Ecorse. The 85-oven battery was scheduled for completion late in 1992 at a cost of $300 million. It will produce approximately 890,000 short tons of coke annually. The facility was expected to meet or exceed all requirements of stricter environmental regulations on toxic emissions from coke ovens, as contained in clean air legislation that the U.S. Congress passed in 1990. Coke, a byproduct of coal burning, is used to fuel steelmaking blast furnaces. In February, National began operating a new $70 million vacuum degassing facility at the Great Lakes Division. The degasser is a quality-enhancing process that removes carbon and oxygen from molten steel, yielding a low-carbon steel used primarily by automakers. The steel is reportedly stronger at a thinner gauge, thereby providing stronger and lighter weight autobody outer panels. Annual production capacity was expected to be about 2 million short tons. In June, National Intergroup Inc. sold an additional 20% of its share in National Steel to NKK Corp. of Japan for $146.6 million. The transaction resulted in NKK owning 70% of National Steel.

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[1]Former editorial assistant, U.S. Bureau of Mines, Minneapolis, MN. She has 36 years of experience in mineral-related work with the U.S. Bureau of Mines and has covered the mineral activities in Michigan for 1 year.

[2]Regional geologist, Geological Survey Division, Michigan Department of Natural Resources, Marquette, MI.

[3]Highway and Heavy Construction. Market Update: Highway Construction Booming to New Heights. V. 133, No. 6, Apr. 1990, pp. 34-37.

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[13]Southwestern Pay Dirt. Copper Range Has Loss, but Better Times Coming, Says Metall. Mar. 1991, p. 13A.

[14]Ontonagon Herald. Copper Range Buys Mill Section. May 23, 1990.

[15]Callahan Mining Corp. (Phoenix, AZ). 1990 Form 10-K Report, p. 9.

[16]The Mining Journal (Marquette). Cliffs Looks at New Form of Iron Pellet. Dec. 15, 1990.

TABLE 2

MICHIGAN: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	7,461	$22,015	$2.95
Plaster and gunite sands	75	286	3.81
Concrete products (blocks, bricks, pipe, decorative, etc.)	310	1,189	3.84
Asphaltic concrete aggregates and other bituminous mixtures	4,007	11,788	2.94
Road base and coverings[1]	6,574	16,216	2.47
Fill	3,381	7,604	2.25
Snow and ice control	365	877	2.40
Railroad ballast	15	38	2.53
Other[2]	204	700	3.44
Unspecified:[3]			
Actual	17,800	59,309	3.33
Estimated	13,537	33,034	2.44
Total or average	53,729	[4]153,057	2.85

[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.

TABLE 3

MICHIGAN SAND & GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	231	$1,191	1,870	$4,219	5,360	$16,605
Plaster and gunite sands	W	W	W	W	65	227
Concrete products (blocks, bricks, etc.)	16	78	141	540	153	572
Asphaltic concrete aggregates and other bituminous mixtures	125	425	381	1,697	3,501	9,666
Road base and coverings[1]	887	1,983	1,251	2,959	4,436	11,274
Fill	436	508	383	1,482	2,562	5,614
Snow and ice control	80	155	121	246	164	476
Railroad ballast	—	—	W	W	W	W
Other miscellaneous[2]	118	389	21	80	89	328
Unspecified:[3]						
Actual	7	42	389	1,110	17,404	58,158
Estimated	1,039	2,964	2,356	4,878	10,143	25,192
Total[4]	2,938	7,736	6,914	17,210	43,876	128,111

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[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.

TABLE 4

MICHIGAN: USABLE IRON ORE[1] PRODUCED (DIRECT SHIPPING ALL 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[2]	Iron content	
1854-1984	561,172	[3]321,307	[4]253,631	1,136,109	N/A	N/A
1985	12,679	0	0	12,679	8,181	64.52
1986	10,727	0	0	10,727	6,911	64.43
1987	12,491	0	0	12,491	7,956	63.69
1988	14,589	0	0	14,589	9,063	62.12
1989	15,611	0	0	15,611	9,778	62.64
1990	9,468	0	0	9,468	5,881	62.12
Total[2]	627,270	[5]321,307	[5]253,631	1,202,207	N/A	N/A

NA Not available.

[1]Exclusive after 1905 of iron ore containing 5% or more manganese.

[2]Data may not add to totals shown because of independent rounding.

[3]No production after 1981.

[4]No production after 1979.

[5]Distribution by range partly estimated before 1906.

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]	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 Range Co.[3]	Box 100 White Pine, MI 49971	Underground mine, concentrator, smelter, refinery.	Ontonagon.
Gypsum:			
Domtar Gypsum Inc.	Box 1670 Grand Rapids, MI 49504	Underground mine and plant	Kent.
Georgia-Pacific Corp.	133 Peachtree St., NE Atlanta, GA 30303	do.	Do.
Michigan Gypsum Co.	2840 Bay Rd. Saginaw, MI 48603	Open pit mine	Iosco.
National Gypsum Co.	2001 Rexford Rd. Charlotte, NC 28211	Open pit mine and plant	Do.
USG Corp.	101 South Wacker Dr. Chicago, IL 60606	Open pit mine	Do.
Iron ore:			
Cleveland-Cliffs Iron Co.[4]	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	Plant	Wayne.
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.

See footnotes at end of table.

TABLE 5-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
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.
Fletcher & Rickard	25800 Haas Rd. New Hudson, MI 48165	do.	Oakland.
Hyponex Corp.	14111 Scottslawn Rd. Marysville, OH 43031	Bogs and plants	Lapeer and Shiawassee.
Michigan Peat Co.	Box 980129 Houston, TX 77006	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.[5,6]	2020 Dow Center Midland, MI 48640	Brine wells and plant	Mason.
Martin Marietta Corp., Magnesia Specialties Div.[6]	Executive Plaza II Hunt Valley, MD 21030	do.	Manistee.
Morton International Inc.[6]	110 North Wacker Dr. Chicago, IL 60606	do.	Do.
Wilkinson Chemical Corp.[5]	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.	67500 Mound Rd. Romeo, MI 48065	Pits and plants	Kalamazoo, Livingston, Macomb, Oakland.
Grand Rapids Gravel Co.	2700 28th St., SW 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 48804	do.	Clare, Gogebic, Gratiot, Isabella.
Edward C. Levy Co. Lyon Sand & Gravel Co.	4780 South Hill New Hudson, MI 48165	Pit and plant	Oakland.
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.	3931 East Holt Rd. Holt, MI 48842	do.	Ingham and Tuscola.
Tri-City Aggregates Inc.	1401 Souter Blvd. Holly, MI 48442	do.	Oakland.
Whitaker & Gooding Co.	5800 Cherry Hill Rd. Ypsilanti, MI 48197	do.	Lapeer, Oakland, Washtenaw.

See footnotes at end of table.

TABLE 5-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Industrial:			
Cheyenne Sand Corp., a subsidiary of Construction Aggregates Corp.	Box 6 Ferrysburg, MI 49409	do.	Ottawa.
Manley Bros. of Indiana Inc.	Box 538 Chesterton, IN 46304	do.	Berrien and Van Buren.
Nugent Sand Co. Inc.	Box 1209 Muskegon, MI 49443	do.	Muskegon.
Sargent Sand Co.	Box 6280 Saginaw, MI 48603	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 (1989):			
Crushed:			
Limestone-dolomite:			
Beazer USA	1850 Koppers Bldg. Pittsburgh, PA 15219	Quarry and plant	Monroe.
Holloway Sand & Gravel Co. Inc.	29250 Wixom Rd. Wixom, MI 48096	Quarries and plants	Do.
Inland Lime & Stone Co., a division of Inland Steel Co.	Gulliver, MI 49840	Quarries and plants	Mackinac and Schoolcraft.
Michigan Mineral Associates	Rogers City, MI 49779	do.	Mackinac and Presque Isle.
Presque Isle Corp.	Box 426 Alpena, MI 49707	Quarry and plant	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	Quarry and plant	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.

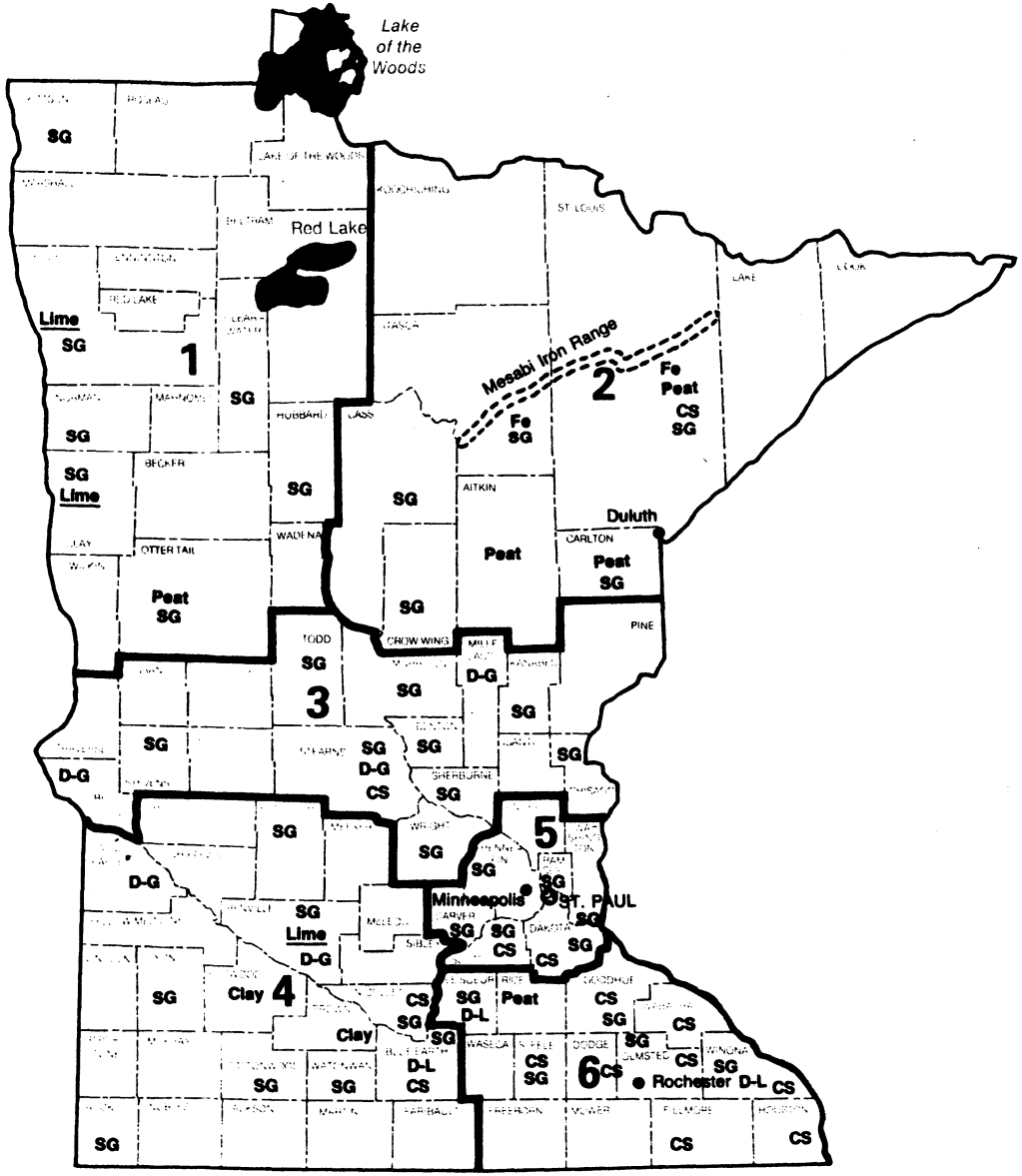
See footnotes at end of table.

TABLE 5-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Vermiculite (exfoliated):			
W. R. Grace & Co.	62 Whittemore Ave. Cambridge, MA 02140	Plant.	Wayne.

[1]Also clays.
[2]Also crushed limestone.
[3]Also silver.
[4]Also crude iron oxide pigments.
[5]Calcium chloride.
[6]Magnesium compounds.

MINNESOTA



LEGEND

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

MINERAL SYMBOLS

Clay	Clay
CS	Crushed Stone
D-G	Dimension Granite
D-L	Dimension Limestone
Fe	Iron
Lime	Lime plant
Peat	Peat
SG	Sand and Gravel

Concentration of mineral operations

Principal Mineral-Producing Localities

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 James H. Aase[1]

Nonfuel mineral production in Minnesota was valued at almost $1.5 billion in 1990, a 7% increase over that of the previous year and less than 1% above the average for the decade of the 1980's. Advances in both quantity and value were recorded for more than one-half of the commodities produced compared with 1989 figures.

Production came from sites in 80 of the State's 87 counties. St. Louis County was the leading county in terms of value for nonfuel mineral production, contributing about 84% of the State's total.

The State ranked sixth nationwide in value of nonfuel mineral production, contributing 4.4% of the U.S. total.

Iron ore, the principal commodity produced in the metallic sector, accounted for almost $9 out of every $10 of the State's total nonfuel mineral value and was credited for 91% of the $94 million increase over that of the previous year. Leading the nonmetallic commodities in value was construction sand and gravel, followed by crushed stone. Collectively, these two commodities contributed about 7% of the State's total nonfuel mineral production value.

Among the mineral commodities produced in Minnesota during the year, the quantity of iron ore produced ranked 1st among 9 States reporting production; peat, 3d of 22; construction sand and gravel, 6th of 50; dimension stone, 7th of 34; industrial sand, 10th of 38; lime, 24th of 32; crushed stone, 30th of 49; and clay, 32d of 44.

TRENDS AND DEVELOPMENTS

Inland Steel Mining Co. began construction on a $20 million project to develop an open pit taconite mine near Gilbert, St. Louis County. Crude ore from the new Laurentian Taconite Mine will be transported by truck over a 6-mile haul road to the company's Minorca taconite processing plant in Virginia. Initial production from the new mine was targeted for early 1991, and the mine was to be phased in with the crude ore currently being produced at Inland's Minorca pit. Ore reserves at Minorca are expected to be exhausted by 1995. The Laurentian Mine and adjoining properties in the area were estimated to contain a 40-year supply of crude taconite for the company's Minorca processing plant.

Less than 6 months after finalizing its purchase of the taconite operations of the former Reserve Mining Co., Cyprus Northshore Mining Corp. restarted idle operations at Babbitt and Silver Bay. The first shipment of taconite pellets was made in mid-April. Reserve closed its mine and processing plant in 1986. Cyprus bought the operation in bankruptcy court for $52 million in mid-1989. The company reportedly spent an

TABLE 1
NONFUEL MINERAL PRODUCTION IN MINNESOTA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$40	NA	$42	NA	$46
Iron ore	thousand metric tons	40,735	1,134,539	41,044	r1,223,909	45,139	1,308,920
Peat	thousand short tons	29	1,414	r33	1,415	48	2,972
Sand and gravel (construction)	do.	33,769	72,678	e33,700	e82,600	33,869	77,502
Stone:							
Crushed	do.	e8,300	e28,200	8,760	30,218	e9,100	e31,900
Dimension	short tons	e45,000	e13,000	44,605	16,031	e60,195	e20,836
Combined value of clays (common, kaolin), lime, and sand and gravel (industrial)		XX	18,015	XX	22,022	XX	27,746
Total		XX	1,267,886	XX	1,376,237	XX	1,469,922

e Estimated. r Revised NA Not available. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

additional $30 million renovating the Silver Bay processing plant and repairing mining equipment and the 47-mile railroad linking the Babbitt Mine and the Silver Bay plant.

EMPLOYMENT

Employment in the State's mining industry averaged 8,200 workers during the year, an increase of 6.5% compared with the 1989 work force. The metal mining sector accounted for 6,400 of these workers, an 8.5% increase in number compared with that of 1989. The average hourly wage for all mine workers was $14.40, a 5% increase over that of the previous year. Metal mine workers had average hourly wages of $14.96, a 6% increase. The average number of hours worked per week was reported at 43.8 hours for all workers and 43.5 hours for those in metal mining.[2]

In 1990, two fatalities occurred at surface mining operations in the State. During the 7.5 million employee-hours worked at surface mining operations during the year, there were 182 injuries resulting in lost workdays and 78 injuries with no workdays lost. At mills and preparation plants associated with surface mining operations, a reported 169 injuries occurred to workers resulting in lost workdays and 75 injuries occurred with no lost workdays. A total of 6.7 million employee-hours was worked at the mills and plants during the year.[3]

REGULATORY ISSUES

The Minnesota Pollution Control Agency (MPCA) levied a fine on Eveleth Taconite Co. for violating State hazardous waste rules. Specifically, the company was found to have accumulated a large quantity of potentially hazardous waste on-site at its taconite operation. As a result of facility maintenance and iron ore testing, the company generated waste petroleum naphtha, polychlorinated biphenyl (PCB) waste, solvent and paint waste, corrosive laboratory waste, and large quantities of grease and oil. In addition to the fine, the company was required by MPCA to implement a hazardous waste management plan that outlines steps to prevent similar violations in the future. The plan also must document hazardous waste training for pertinent employees, include a hazardous waste shipping schedule, designate exact locations of on-site hazardous waste storage, and describe how the company intends to manage properly waste oils and greases. The company also was required to submit a remedial action plan for investigation, excavation, and disposal of contaminated soil.

EXPLORATION ACTIVITIES

The slowdown in exploration for base and precious metals was evident in Minnesota in 1990. The acreage of State-owned mineral rights under lease for nonferrous metals decreased. The State did, however, issue 84 new metallic mineral leases during the year covering 33,299 acres. An additional 12 leases covering 5,023 acres from an October 1990 lease sale was to be issued after yearend. By the end of 1990, the State had a total of 93,540 acres of mineral rights covered in 257 leases held by 27 lessees. Additionally, the State had 117 iron ore and taconite leases held by seven lessees.[4]

The search for nonferrous base and precious metals was confined primarily to the ancient greenstone terrains of the northern part of the State. This accounted for 24,473 feet of drilling in 51 drill holes.[5]

Iron ore expansion drilling in St. Louis and Itasca Counties amounted to 3,988 feet in 33 drill holes.[6]

In the central Minnesota River Valley region, 56 drill holes totaling 5,705 feet of drilling was conducted to evaluate kaolin clay resources. The clay material was being evaluated in an effort to meet the needs of the regional paper industry.[7]

A total of 140 exploration holes amounting to 34,168 feet were drilled during 1990 in Minnesota. The holes were drilled in 11 counties by 13 companies. The samples and data were to be turned over to the Department of Natural Resources (DNR) upon termination of the lease, as provided by State law.[8]

LEGISLATION AND GOVERNMENT PROGRAMS

During the 1990 session of the Minnesota Legislature, a bill was enacted into law that was of particular interest to the State's iron ore industry. The legislation, Omnibus Tax Bill--Chapter 604, froze for 1 year the production tax rate for iron ore and taconite concentrates produced in 1990. Additionally, for tax law purposes, the definition of real property was amended to include iron ore and taconite minerals not otherwise exempt, and to exclude mine shafts, tunnels, and other underground openings to extract ores and minerals. It also provided for a deduction of certain reclamation costs from the net proceeds tax. The bill added all clays to the list of minerals excluded from the net proceeds tax on mining.

In an attempt to stimulate additional mineral development in Minnesota, the State's legislature established a Minerals Coordinating Committee (MCC). The committee was composed of personnel from the DNR's Division of Minerals, Minnesota Geological Survey (MGS), the Natural Resources Research Institute, and the Mineral Resources Research Center. Among the MCC-sponsored projects were the following:

1. Bedrock mapping and drilling of key mineral potential areas as a followup to recently completed aeromagnetic surveys conducted by MGS. Evaluation of the mineral potential of selected areas using geochemistry of the glacial drift through overburdened drilling continued.
2. The platinum-group mineral potential of the Basal Zone of the Duluth Complex and the base and precious-metal potential of Archean greenstone were studied through sampling and analysis of drill core in the Hibbing DNR Drill Core Repository.
3. A seminar was organized and the proceedings published on the application of recent concepts of ore deposit model

for base and precious-metal sulfides for the State. Information on the mineral potential was distributed through the publication series of the respective agencies.

4. Legal research was conducted to improve the quality and accessibility of mineral ownership information. This activity was designed to promote mineral leasing in the State.

5. An investigation was started to determine suitable technologies for processing Minnesota's ilmenite resources.

6. In the iron ore area, MCC was engaged in efforts to improve taconite pellet characteristics and quality, to assess mining and crushing methods, and to evaluate opportunities for added value products.

The DNR conducted a wide range of projects designed to enhance knowledge of the State's mineral resources. Included among the projects were the following:

1. A dimension stone inventory, begun in 1989, was continued through 1990. Rock outcroppings in northeastern and north-central Minnesota were investigated. Through 1990, 10 prospects were identified within the survey area. Open file information and samples from these sites are available for examination at DNR offices in St. Paul and Hibbing.

2. An inventory of aggregate resources in Wright County was completed. The results were portrayed on a resource map available from the St. Paul DNR Minerals office.

3. A two-volume directory of the State's present and past industrial minerals industry, exclusive of sand and gravel, entitled "Inventory of Industrial Mineral Pits and Quarries in Minnesota" was prepared and made available from the Hibbing DNR Minerals office.

4. A study got underway to review and consolidate all available geological and geophysical information on the Lake of the Woods County Archean greenstone belt, known for its potential for base metals. The information was from new DNR projects covering till geochemistry, aeromagnetic interpretation, and bedrock drill core lithochemistry in cooperation with the United States Geological Survey. Preliminary findings indicated the presence of chemical sediments and several types of alteration. From high-quality overburdened cores, glacial drift stratigraphy and underlying saprolite were evaluated. A framework was established for the use of till or saprolite geochemistry as exploration tools.

The MGS continued basic research projects designed to further expand geological knowledge that, in part, related to the mineral and water resources of the State. Among the various projects underway in 1990 were the following:

1. Bedrock geological mapping in the Cook area of west-central St. Louis County continued. This is an area of Archean bedrock with a very complex structure, metamorphic, and intrusive history.

2. Drilling continued in St. Louis and Cook Counties to test geophysical models and augment mapping in an area where little is known about the bedrock geology.

3. Trace elements in insoluble residues of carbonate rock were under study as a possible tool for evaluating mineral potential.

4. Geological atlases were completed for Dakota, Hennepin, Olmsted, Scott, Washington, and Winona Counties.

Under provision of title III of the Surface Mining Control and Reclamation Act of 1977, Public Law 95-87, as revised, the Minnesota Mining and Mineral Resources Research Institute (MMRRI), University of Minnesota, received grants totaling $392,000 from the U.S. Bureau of Mines in Federal fiscal year 1990. MMRRI has as part of its mission conducting generic research projects and assisting in efforts to train engineers and scientists in mineral-related disciplines.

The U.S. Bureau of Mines Twin Cities Research Center (TCRC) conducted research on a wide range of mining and mineral-related projects that come under the broad categories of advance mining, health, safety, environment, and minerals-materials. During the year, researchers studied ways to upgrade low-grade manganese resources found in the State. The Cuyuna Range of central Minnesota contains a minimum of 176 million long tons of marginal-grade manganese material. If economically feasible upgrading could be developed, the country could be supplied with this strategic metal from domestic sources in future years.

Other activity at TCRC included a cooperative research program with the State aimed at making the dimension stone industry more competitive with foreign sources. Sophisticated geophysical methods were evaluated for the detection of fractures and flaws at potential and operating quarry sites. The detection and avoidance of damaged rock would afford a considerable cost saving for the State and domestic stone industry.

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Leading the Nation in iron ore production, Minnesota accounted for 79% of the total U.S. shipments in 1990. Shipments of iron ore rose almost 10% in quantity and 7% in value compared with 1989 figures, marking the fourth year in a row that shipments have exceeded that of the year earlier. Approximately 99% of the shipments were in the form of taconite pellets from the seven taconite plants on the Mesabi Range in St. Louis and Itasca Counties. The remainder of the shipments were mostly concentrates and some beneficiated natural ore.

According to figures released by the Lake Superior Industrial Bureau, an association of taconite companies, Minnesota's seven taconite operations generated well over $800 million in economic activity during 1990. Taconite companies met payroll costs of $270 million and purchased goods and services totaling more than $575 million. In addition, the industry paid in excess of $87 million in State and local taxes during 1990, bringing total industry expenditures to more than $900 million.

Workers at Eveleth Taconite Co. approved a 39-month contract in May. The 665 members of the United Steel Workers of America Local 6860 approved the agreement that called for an immediate $1 per hour pay raise, followed by a 25-cent-per-hour increase for each of the following two contract years. The contract will expire at the same time as four other taconite plant contracts on the Iron Range. Prior to winning the agreement, workers staged a 48-hour strike after the previous contract expired.

On October 15, United Steel Workers Union officials and representatives from USX Corp. began early negotiations on a contract due to expire February 1, 1991. The union represented 18,000 workers in 7 States. About 1,300 of these workers were employed at the USX Minntac taconite operations at Mountain Iron.

National Steel Pellet Co. and the Hanna Research Center experimented with crushing of taconite ore instead of the traditional grinding methods. Preliminary results indicated that the procedure could be cost effective, improve productivity, and reduce energy consumption. Testing was to extend into 1991, and a decision on whether to convert all 10 of National's primary grinding mills to the new method would follow. Should the change be implemented, the company estimated it would cost about $20 million and take 3 years to complete.

The Minnesota Sportfishing Congress announced that it would sue LTV Steel Mining Co. for allegedly discharging high levels of toxic metals into waterways that drain into the Boundary Waters Canoe Area wilderness near Babbitt. The congress is an umbrella group representing individual anglers and angling clubs. The group alleged that discharges from waste rock stockpiles at LTV's Dunka open pit iron ore mine violated the Clean Water Act. In 1989, the MPCA issued a notice of violation to LTV charging that toxic metals seeping from its rock stockpiles exceeded water quality standards. LTV disputed the MPCA claim and stated it was in compliance with its water quality permit. During 1990, the company, MPCA, and others sought a solution to improve the quality of water emanating from stockpiles. The essence of one solution was to deacidify the water with limestone, pass it through an organic filtration system to capture the metals, and then discharge the cleaned water.

Industrial Minerals

Clays.—The quantity and value of clay produced in the State during 1990 fell slightly below the levels attained in 1989. The entire output for the year was credited to two firms operating pits in the southern part of the State. Ochs Brick & Tile Co. mined common clay in Brown County and low-grade kaolin clay in Redwood County for use in brick manufacturing. Northwestern States Portland Cement Co. mined a low-grade kaolin clay in Redwood County for use in cement manufacturing at its Mason City, Iowa, plant.

Gemstones.—No commercial gem stone mining operations were reported in Minnesota in 1990. The value for gem stones indicated in table 1 is an estimated amount as no precise value is known for gem material that rock hounds, mineral collectors, and other hobbyists collected.

Lime.—Lime produced in the State during 1990 decreased 34% in quantity, but rose 6% in value compared with that of the previous year. All of the production was from two sugar-beet processing companies that consumed their own lime output. Limestone used to manufacture the lime was obtained from out-of-State sources. The consumption of lime in Minnesota during the year, from all domestic sources, totaled 262,000 short tons.

Peat.—Peat sales rose 45% in quantity and 110% in value compared with 1989 figures. The average unit value for all types of peat produced in the State was about $62 per short ton, an increase of $19 per short ton over the previous year's average. Nine companies harvested peat from bogs in seven counties. Approximately 70% of the peat produced was the sphagnum type, with the remainder principally reed-sedge and a small amount of hypnum. Carlton County, with two producers, accounted for more than one-half of the State's output during the year. Approximately 60% of the peat produced was marketed in packaged form, the remainder in bulk. The largest use of packaged peat was as a general soil improvement. Bulk peat was used most extensively by nurseries.

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 annual report contains actual data for 1988 and 1990 and estimates for 1989.

Construction sand and gravel production remained at nearly the same level as that of the previous year. The value of the year's output was reported to have dropped about 6% compared with that of 1989. Production during the year was obtained from 478 pits in 77 counties by 206 firms and government agencies. The average unit value of the material mined in the State during the year was reported at $2.29 per short ton. The largest specified use of the sand and gravel consumed during the year was in road bases and coverings, accounting for 20% of the production. Construction sand and gravel statistics are compiled by geographical districts as shown on the State map. Table 5 presents end-use data for the six districts covering the State. The leader in terms of value of sand and gravel output was Dakota County, followed by Hennepin County and Washington County, respectively.

Industrial.—Industrial sand was produced by two companies with operations in Le Sueur, Scott, and Washington Counties. Production increased 24% in quantity and 37% in value compared with that of 1989. The largest use of the sand produced during the year was for hydraulic fracturing. Approximately two-thirds of the year's output was marketed

utilizing railroad transportation; the remainder was shipped by truck.

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 annual report contains estimates for 1988 and 1990 and actual data for 1989.

Crushed.—Crushed stone output was estimated to have increased 4% in quantity and 6% in value over that reported in 1989. The average unit value of the mined material was estimated at $3.51 per short ton, an increase of about 2% compared with that of 1989.

Dimension.—Dimension stone production was estimated to have increased 35% in quantity and 30% in value compared with that reported for the previous year. Granite and limestone were the principal types of dimension stone quarried.

Other Industrial Minerals.—Perlite obtained from out-of-State sources was expanded at the USG Acoustical Products Co. plant near Cloquet. The quantity and value of the expanded material produced remained at the same level as that in the previous year. Sulfur was recovered at two of the State's petroleum refineries. The recovered material increased 7% in quantity and decreased 1% in value compared with 1989 figures.

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[1]Former State Mineral Officer. The author has 33 years of experience in mineral-related work in private industry and government. Assistance in the preparation of the report was given by Wanda J. West, editorial assistant.

[2]Minnesota Department of Jobs and Training, Research and Statistics Office. Employment, Hours, and Earnings, 1981-1990. May 1991. 37 pp.

[3]U.S. Department of Labor. Mine Injuries and Worktime, Quarterly. 1990. p. 11.

[4]Mining Engineering, Annual Review 1990. V. 43, No. 5, May 1991, pp. 500-501.

[5]Work cited in footnote 4.

[6]Work cited in footnote 4.

[7]Work cited in footnote 4.

[8]Work cited in footnote 4.

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)
1985	1,485	33,985	35,470	64.20	1,481	34,057	35,538	95.83
1986	1,179	26,297	27,476	64.07	1,367	27,875	29,242	95.33
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	.64	498	44,642	45,140	98.90

'Revised.

[1]Exclusive of ore containing 5% or more manganese.

[2]Data may not add to totals shown because of independent rounding.

TABLE 3

SALIENT STATISTICS FOR PORTS SHIPPING MINNESOTA IRON ORE

Year, port, and dock	Date of first shipment	Date of last shipment	Number of shipments	Total shipments (gross tons)	Average shipment (gross tons)	Largest shipment (gross tons)
1989:						
Duluth, MN: DM&IR	Apr. 1	Dec. 19	260	7,291,267	28,043	60,244
Superior, WI: Burlington-Northern	Mar. 25	Dec. 22	275	10,877,547	39,554	60,402
Taconite Harbor, MN: LTV Steel	Mar. 26	Dec. 19	177	8,086,808	45,688	60,483
Two Harbors, MN: DM&IR	Mar. 14	Dec. 25	217	9,352,595	43,100	60,193
Total or average			929	35,608,217	38,330	60,483
1990:						
Duluth, MN: DM&IR	Apr. 4	Jan. 1	269	7,605,933	28,275	58,311
Silver Bay, MN: Cyprus Northshore	Apr. 19	Jan. 7	89	2,199,039	24,708	57,420
Superior, WI: Burlington-Northern	Mar. 24	Jan. 2	285	11,052,629	38,781	58,798
Taconite Harbor, MN: LTV Steel	Mar. 26	Jan. 2	217	8,656,570	39,864	58,698
Two Harbors, MN: DM&IR	Mar. 20	Jan. 13	288	11,483,533	39,873	58,971
Total or average			1,148	40,977,704	35,695	58,971

Source: Annual Reports of the Lake Carriers' Association, 1989 and 1990.

TABLE 4

MINNESOTA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	4,604	$14,944	$3.25
Plaster and gunite sands	161	668	4.15
Concrete products (blocks, bricks, pipe, decorative, etc.)	502	1,208	2.41
Asphaltic concrete aggregates and other bituminous mixtures	3,755	9,909	2.64
Road base and coverings[1]	6,689	11,796	1.77
Fill	986	1,407	1.43
Snow and ice control	330	854	2.59
Railroad ballast	10	70	7.00
Other[2]	2,339	4,878	2.09
Unspecified:[3]			
Actual	9,301	20,365	2.19
Estimated	5,193	11,403	2.20
Total or average	[4]33,869	77,502	2.29

[1]Includes road and other stabilization (cement).
[2]Includes roofing granules and 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.

TABLE 5

MINNESOTA: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	579	2,218	404	1,746	465	1,090
Plaster and gunite sands	7	65	32	227	W	W
Concrete products (blocks, bricks, etc.)	W	W	14	47	—	—
Asphaltic concrete aggregates and other bituminous mixtures	1,100	3,830	237	416	927	2,382
Road base and coverings[1]	1,238	2,572	1,415	2,421	2,026	2,878
Fill	66	115	209	285	54	64
Snow and ice control	88	295	108	233	W	W
Railroad ballast	—	—	10	70	—	—
Other miscellaneous[2]	51	226	79	316	46	146
Unspecified:[3]						
Actual	745	1,240	200	450	23	37
Estimated	1,559	3,467	121	187	1,424	2,740
Total[4]	5,434	14,027	2,831	6,398	4,965	9,338

	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	325	1,231	2,539	7,327	293	1,332
Plaster and gunite sands	6	27	W	W	W	W
Concrete products (blocks, bricks, etc.)	W	W	W	W	W	W
Asphaltic concrete aggregates and other bituminous mixtures	679	1,429	583	1,210	228	641
Road base and coverings[1]	1,225	2,374	515	983	269	568
Fill	48	67	443	605	165	271
Snow and ice control	15	35	W	W	36	100
Railroad ballast	—	—	—	—	—	—
Other miscellaneous[2]	17	102	2,798	4,227	33	149
Unspecified:[3]						
Actual	493	998	7,018	14,516	822	3,125
Estimated	290	698	1,058	2,847	741	1,465
Total[4]	3,098	6,960	14,954	33,128	2,588	7,651

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes road and other stabilization (cement).
[2]Includes roofing granules and 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.

TABLE 6
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.	Silver Bay, MN 55614	Mine and primary crusher	St. Louis.
Do.	do.	Concentrator and agglomerator	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.	do.	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.
Michigan Peat Co.	Box 980129 Houston, TX 77098	Bog and plant	Carlton.
Minnesota Sphagnum Inc.	Box 58 Goodhart, MI 49737	do.	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.

TABLE 6—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and Gravel—Continued			
Construction—Continued			
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.
C. S. McCrossan Inc.	7865 Jefferson Hwy. Maple Grove, MN 55369	do.	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 (1989):			
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.
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):			
Arrowhead Blacktop Co.	Box 6568 Duluth, MN 55806	Quarry and plant	St. Louis.
Dimension:			
Granite:			
Cold Spring Granite Co.	Cold Spring, MN 56320	Quarries	Big Stone, Mille Lacs, Renville.
Do.	do.	Quarries and plant	Stearns.
Field Financial Inc.	3434 Heritage Dr. Edina, MN 55435	Quarry and plant	Lac Qui Parle.
Limestone:			
Biesanz Stone Co. Inc.	Box 768 Winona, MN 55987	do.	Winona.
Minnesota Quarries Inc.	Box 1358 Mankato, MN 56002	do.	Blue Earth.

TABLE 6—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Limestone—Continued			
Vetter Stone Co.	Route 5, Box 41 Mankato, MN 56001	Quarries and plant	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.
Koch Refining Co., a division of Koch Industries Inc.	Box 2302 Wichita, KS 67201	do.	Dakota.

MISSISSIPPI

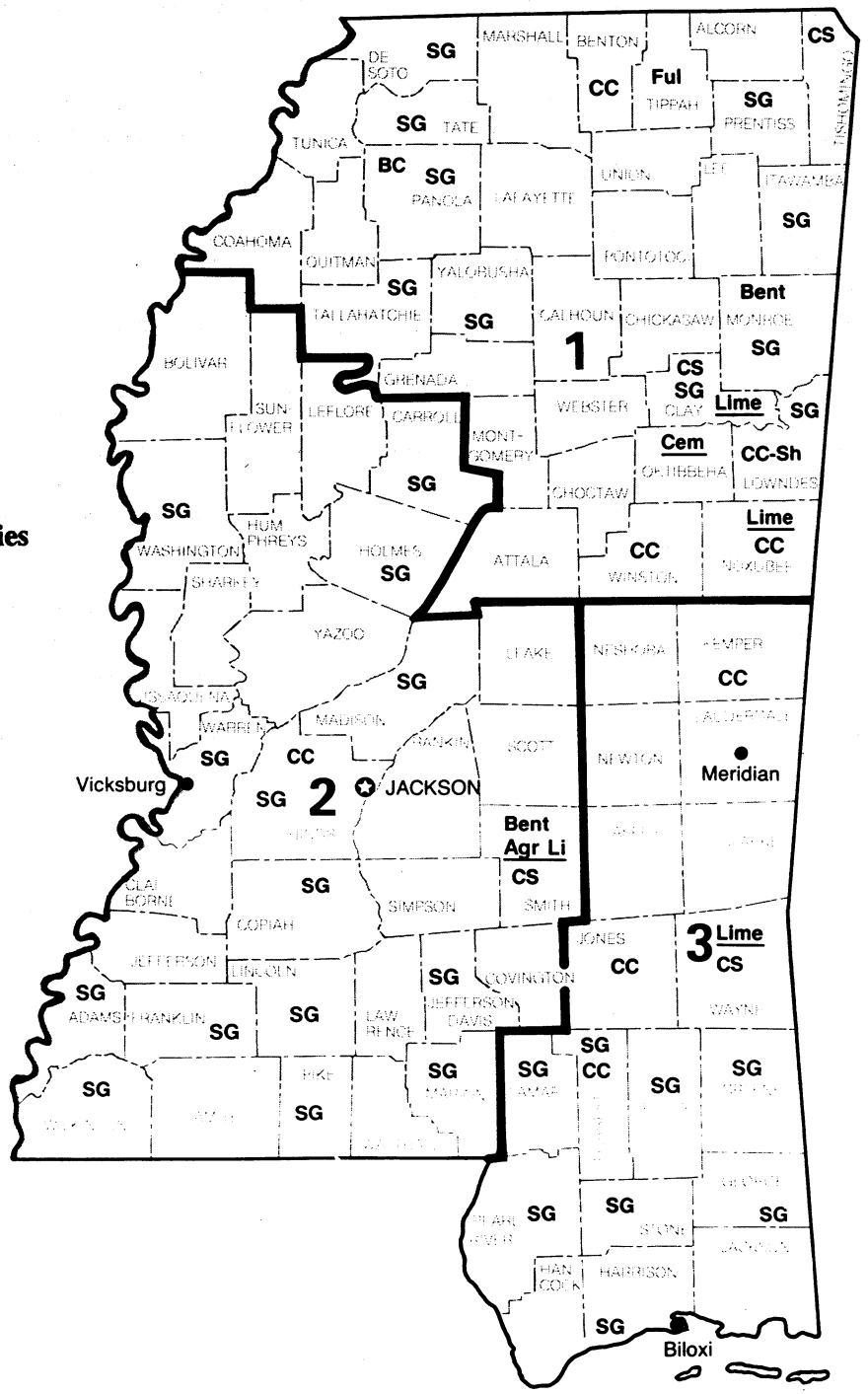
LEGEND

- State boundary
- County boundary
- Capital
- City
- Waterway
- 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
Lime	Lime plant
SG	Sand and Gravel

Principal Mineral-Producing Localities



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 and Energy Resources, 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 Mississippi's nonfuel mineral production in 1990 totaled $112 million, according to data supplied to the U.S. Bureau of Mines by the State's mineral producers. The 1990 value exceeded that reported by industry in 1989 by $4.7 million and exceeded the record of $110.1 million established in 1987. Increased sales of portland cement, specialty clays, and crushed stone accounted for the 4% increase. While Mississippi's national ranking in mineral value slipped from 41st to 42d, the State was an important producer of ball clay, bentonite, common clay, and fuller's earth. Two of the four acid-activated bentonite plants in North and Central America are in Mississippi.

TRENDS AND DEVELOPMENTS

Mississippi is an agricultural and manufacturing State; mineral sales are a small but important part of the State's economy. During the decade of the 1980's, mineral sales totaled almost $1 billion, and over 60% of the value was from sales of construction mineral commodities. In July, the U.S. economy entered a recession following several years of economic prosperity. The recession, however, appeared to have little effect on Mississippi's mineral industry, other than the clay sector.

Developments in the mineral sector in 1990 included: (1) the sale of the State's only cement plant to a Swiss firm, (2) opening of a ball clay mine in northwestern Mississippi by an English firm, (3) negotiations on the sale of a closed Pascagoula fertilizer complex, and (4) completion of the expansion of a titanium dioxide pigment plant in Hamilton. A De Lisle titanium dioxide pigment producer announced plans for a 1995 expansion, and expansion plans were announced for a Flowood steel plant.

EXPLORATION ACTIVITIES

During 1990, Federal prospecting permits were active for 1,200 acres in Mississippi's Bienville National Forest. The prospecting permits were for bentonite, and several shallow test holes were drilled.

LEGISLATION AND GOVERNMENT PROGRAMS

No bills were passed by the 1990 Mississippi Legislature that affected the State's mineral producers. On the county level, however, the Copiah County supervisors, legislators, and gravel company personnel drafted legislation that would place a $0.50 per cubic yard severance tax on gravel mined in the county and sold in other counties. The tax, which would be used to improve county roads and bridges, was expected to raise about $100,000 per year. A review of the draft tax proposal was scheduled early in 1991. Copiah County

TABLE 1
NONFUEL MINERAL PRODUCTION IN MISSISSIPPI[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2]	short tons	1,093,316	$24,564	899,373	$23,573	817,828	$16,196
Gemstones		NA	1	NA	5	NA	1
Sand and gravel (construction)	thousand short tons	13,314	38,806	e15,600	e51,500	13,032	45,817
Stone (crushed)	do.	e1,500	e9,000	1,069	3,994	e1,400	e5,500
Combined value of cement, clays (ball, fuller's earth, [1990]), sand and gravel (industrial)		XX	31,029	XX	28,539	XX	44,799
Total		XX	103,400	XX	107,611	XX	112,313

eEstimated. 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.

was one of Mississippi's major sand and gravel producers.

The Marine Minerals Technology Center (MMTC) at the University of Mississippi (UM) received a $1.2 million grant from the U.S. Department of the Interior for offshore mineral and environmental research. The grant, administered by the U.S. Bureau of Mines, was divided between the Continental Shelf Division at UM and the Ocean Basins Division at the University of Hawaii. The two divisions, administered by UM, were involved in minerals research within the 200-mile exclusive economic zone adjacent to the U.S. coastlines. MMTC personnel were investigating a broad spectrum of undersea mineral resources ranging from gold and chromite off the Northwestern U.S. coast to phosphate and aggregate off the southeastern coast and shell off the gulf coast.[3]

The Mississippi Mineral Resources Institute (MMRI) at UM, funded by the U.S. Bureau of Mines, made several grants available to further mineral resources investigations in the State. Universities and laboratories that participated during 1990 included Mississippi State University, the University of Southern Mississippi, the Gulf Coast Research Laboratory, Jackson State University/Millsaps College, and the University of Mississippi.

The grants covered research into (1) hydrocarbon-ground water reservoirs; (2) selected clay, sand and gravel, heavy mineral, and associated deposits; (3) boracite group minerals in subsurface evaporite formations; (4) ash removal from lignite; (5) coalbed methane; (6) oil production; (7) upgrading Mississippi lignite; (8) mineral resource potential of the Jackson Dome; and (9) projects on Mississippi clay and heavy- mineral occurrence and utilization.[4]

The Mississippi Office of Geology, established in 1850 and previously called the Mississippi Geological Survey, consisted of an Administrative Division, Environmental Geology Division, Surface Geology Division, Energy and Coastal Geology Division, and Mining and Reclamation Division. During fiscal year 1990 (which ended June 30, 1990), the Environmental Geology Division logged approximately 89 water wells and test holes, and the data were entered into the office's water well data base. The division provided support for other sections by drilling 11 test holes in support of a clay research study and surface mapping. The division also assisted the Office of Pollution Control by performing technical reviews of several geologic-hydrologic reports associated with permit applications to build and operate sanitary landfills.

The Surface Geology Division worked on a new State geologic map by remapping selected formation boundaries and, in conjunction with Millsaps College and Jackson State University, participated in an investigation of economic clays along the Midway-Wilcox boundary.

The Energy and Coastal Geology Division maintained the State's sample and core library and administered most of the mineral leasing activities on State-owned lands and offshore waters. Studies ongoing included the Cambro-Ordovician stratigraphy of northern Mississippi, a report on the State's salt domes, and a study of the framework of the Cretaceous and Miocene sediments of offshore Mississippi.

The Mining and Reclamation Division performed 622 mine site inspections. The staff evaluated and revised the Mississippi Coal Mining and Reclamation Regulations to meet the Office of Surface Mining (OSM) regulations. The regulations, updated as of January 1, 1990, were submitted to OSM for informal review.[5]

The Mississippi Department of Economic Development's Energy and Transportation Division awarded MMRI $62,254 to help the Municipal Gas Authority of Mississippi (MGAM) develop and manage low-cost natural gas systems for smaller municipalities throughout the State. The MMRI staff will provide MGAM with a data base of technical and economic information that will enable the authority to ensure low-cost natural gas supplies.

The U.S. Geological Survey (USGS) awarded the Office of Geology's Coastal Processes Section $217,000 in the first year of a 5-year coastal erosion study. USGS Groundwater Division personnel continued to monitor the State's waterways to determine flow quantity and water quality.

The Appalachian Regional Commission issued a $150,000 grant to improve a road that services Mississippi's only hardrock limestone quarry. The matching-funds grant will provide $300,000 to rebuild two bridges and approach routes on the road to the Vulcan Materials Inc. stone quarry. The stone company and a local trucking firm built a temporary bypass around one collapsed bridge to keep the road passable. The quarry furnished the material, and the trucking firm hauled the stone at no charge.[6]

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

In 1990, there were 261 permitted mineral operations covering 7,330 acres in Mississippi. Excluded from permitting requirements are operations disturbing less than 4 acres. Mississippi mineral producers mined, manufactured, or recovered as a byproduct eight industrial minerals. Several other industrial mineral commodities were shipped into the State and manufactured into a higher value product.

Cement.—Sales of cement ranked second in value among the industrial minerals produced in-State. Mississippi ranked 29th among the 38 States producing portland cement. The State's lone cement plant was Artesia in Lowndes County. Both output and value increased 12% over the 1989 level.

During the year, the Artesia cement plant operated by United Cement, a Texas Industries Inc. subsidiary, was sold to Holnam Inc., a holding company for Holderbank, the world's largest cement manufacturer. In August, Holnam

announced it had completed the $61 million purchase.[7]

The Artesia cement wet-process complex, first operated in 1973, features a 14- by 500-foot, coal-fired kiln. Cretaceous chalk mined in Lowndes County was blended with a sand obtained from local sources and mill scale from Alabama and slurried into the kiln. The material was converted into clinker and, after exiting the kiln, mixed with Spanish gypsum and ground to produce a grey portland cement. The market area included nine southeastern States. Gypsum and coal were received by barge at the Lowndes County Port on the Tennessee-Tombigbee Waterway.

Clays.—Mississippi ranked 12th among the 36 States with clay production. Clay sales ranked third among the State's industrial mineral commodities and accounted for almost 30% of the total mineral value.

The clay industry in Mississippi produced 818,000 short tons (ball clay and fuller's earth excluded) valued at $16.2 million, a decrease of 81,600 short tons and $7.4 million below that reported in 1989.

Ball Clay.—Mississippi ranked third among the five States reporting the production of ball clay, a highly plastic, fine-grained sediment. The Kentucky-Tennessee Clay Co. mined and processed ball clay in northwestern Mississippi near the community of Sledge. A second firm, United Clay of Gleason, TN, opened a $2.5 million mine and processing facility in the Sledge area in August.[8] United Clay, owned by Watts, Blake, and Bearne of Newton Abbot, England, purchased the Mississippi ball clay reserves from Cyprus Industrial Minerals Co. The Newton Abbot company was the world's largest producer of ball clay.

Kentucky-Tennessee dried, ground, and bagged the clay for sales to the tile and asphalt filler markets. United Clay used a similar processing method to produce a product for the fiberglass and ceramic fixtures markets. A portion of United's production was shipped to the company's operation in Gleason, TN.

Bentonite.—The State ranked 2d among the 11 States with bentonite production. Production was 289,000 short tons valued at approximately $13.6 million.

High-absorbency and green strength properties characterize bentonite, a clay mined by three companies. The three, Applied Industrial Minerals Corp. (AIMCOR), American Colloid Co., and Engelhard Corp., operated surface mines in the east-central part of the State.

AIMCOR operated a calcium-bentonite mine and processing plant near Aberdeen in Monroe County. Crude ore was trucked from the mine to the processing plant where it was air dried, shredded, sized, and bagged. Principal sales were to the foundry industry, where the bentonite was used as a binder in moldmaking and to the animal feed industries for use in pelletizing food products.

American Colloid Co., Aberdeen, mined bentonite that was processed by both conventional and acid treatment methods. The former consisted of air drying, crushing, screening, and bagging for sales to the foundry industry. With the latter, bentonite was treated with sulfuric acid, washed, dried, sized, and bagged to produce a clay for specialty sales. Both Mississippi and Arizona bentonites were used in the acidizing process; the in-State bentonite was sold to the vegetable oil industry as a filter to remove impurities, and the Arizona bentonite was sold to the desiccant industry.

Engelhard Corp. operated surface mines in Monroe and Smith Counties and a processing plant in Jackson. Both conventional and acid activation methods were used in processing Mississippi and Arizona bentonites. Sales were to the desiccant, vegetable oil, and petrochemical industries.

Common Clay.—The State ranked 18th among the 43 States reporting common clay and/or shale production. Eight firms operated 14 mines in the eastern part of Mississippi to produce 582,000 short tons of clay valued at $2.6 million. The tonnage was approximately 46% of the clay produced in-State in 1990. Production increased 42,000 short tons above that reported by the industry in 1989, while the value remained the same.

Much of the common clay mined in-State was used in the manufacture of brick. Six of the State's 7 brick companies operated 12 mines; the seventhth purchased clay from another firm. Two of the Mississippi brick companies opened mines in Alabama, and one company purchased shale from western Alabama.

One company, Boydston Lumber Co. in Louisville, mined and sold clay in Mississippi, Alabama, Louisiana, and South Carolina. A Jackson firm, Jackson Ready Mix Concrete Co., mined clay for the manufacture of lightweight aggregate; both the mine and the kiln were in the Jackson metropolitan area.

Fuller's Earth.—Mississippi ranked 4th among the 10 States reporting the production of fuller's earth, a high-absorbency clay. Oil Dri Production Co. Inc and AIMCOR mined and processed fuller's earth in north-central Mississippi.

Oil Dri operated a mine and processing plant north of Ripley. The raw clay was shredded, air dried, calcined, sized, and bagged to produce industrial waste absorbents and pesticide carriers. The company operated a second mine and plant south of the community of Blue Mountain to produce a pet waste absorbent. Crude clay was shredded, ground, calcined, screened, and bagged at the Blue Mountain operation.

The AIMCOR plant north of Blue Mountain produced pet and industrial waste absorbents and pesticide carriers. Raw clay was shredded, ground, and calcined to produce a marketable product.

Sand and Gravel.—Mississippi ranked 27th among the 50 sand and gravel-producing States. Sand and gravel sales ranked first among the State's eight industrial mineral commodities, accounting for almost 41% of the 1990 mineral value. The production of sand

and gravel was reported by 66 companies operating 118 mines in 36 of Mississippi's 82 counties. Both construction and industrial sand and gravel were produced. The 1990 output and value fell below that estimated for 1989 by 2.6 million tons and $5.7 million.

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 1988 and 1990 and estimates for 1989.

Mississippi construction sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 3 presents end-use data for the State's three districts.

Construction sand and gravel production was reported by 68 firms operating 117 mines in 36 counties. Output was 282,000 short tons lower than that reported in 1988, the last year with a full-year industry canvass; value, however, rose $7 million. The industry operated 45 stationary and 35 portable processing plants. Three counties, Copiah, DeSoto, and Itawamba, produced over 1 million tons. The major end uses reported were (1) concrete aggregate, (2) asphaltic concrete, and (3) road base and cover.

Copiah County officials and sand and gravel personnel worked together to develop a sand and gravel tax for sand and/or gravel sold out of the county. The tax was to be voted on in 1991.

Industrial.—The production of industrial sand was reported by Tri-Sands Inc. from a mine in Tishomingo County and by Huey Stockstill Inc. in Pearl River County. Sales were to the foundry industry for use in mold and core forming and for 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 1988 and 1990 and actual data for 1989.

Excluding the northeastern corner of the State, Mississippi is covered with coastal plain sediments, sands, marls, clays, and chalk. The older, precoastal plain sediments are exposed only in Tishomingo County, and the only "hard-rock" surface limestone resources crop out in the county.

Vulcan Materials Inc. has a limestone quarry near the community of Iuka in Tishomingo County. This was the only "hard" limestone quarry in Mississippi. A few operations produce a "soft" limestone, predominately chalk or marl sold for agricultural applications. The estimated production and value of Mississippi stone for 1990 rose from 1,060,000 short tons in 1989 to 1,400,000 in 1990. Value increased from $3,994,000 in 1989 to an estimated $5,500,000 in 1990.

Sulfur (Recovered).—Mississippi again ranked third among the byproduct sulfur-producing States. Output totaled 726,000 metric tons valued at $48.6 million. This was an increase in production of 23,000 metric tons; value, however, fell $16.2 million.

Five companies reported sulfur recovery from five refineries in Clarke, Jackson, Lamar, and Rankin Counties.

Other Industrial Minerals.—In addition to the mineral commodities listed in table 1, a number of minerals were shipped into Mississippi from other States or foreign countries and processed into higher value products. Anhydrous ammonia, produced from natural gas feedstock, was manufactured by Mississippi Chemical Corp. The chemical company's plant was at Yazoo City.

Ilmenite and rutile, titanium minerals, were shipped into the State by E.I. du Pont de Nemours & Co. and Kerr-McGee Chemical Corp. to manufacture a titanium dioxide pigment.

Brick companies shipped in cobalt and manganese oxide and iron oxide pigments from Georgia and Texas for use as a coloring agent. Georgia barite was also purchased by several companies for use in the brickmaking process.

Du Pont completed a $10 million expansion at its titanium dioxide pigment plant at De Lisle and announced an expansion to increase output by 100,000 short tons per year. The expansion is scheduled to begin in 1995.[9] The De Lisle facility imported ilmenite from Australia.

Kerr-McGee operated a 106,000-short-ton-per-year titanium dioxide plant at Hamilton. The chloride process facility obtains its primary feedstock from the company's synthetic rutile plant in Mobile, AL.

Lime was shipped into Vicksburg for the Falco Lime Inc. company. A Missouri firm, Mississippi Lime Co., supplied the lime. Falco marketed quick and hydrated lime as well as calcium carbonate and kiln dust. Sales were to soil stabilization contractors, pulp and paper mills, and water treatment plants. The kiln dust was used to solidify and neutralize toxic chemicals at hazardous waste disposal sites.

Perlite, a volcanic rock that expands significantly when heated, was expanded by Manville Products Corp., Natchez, and USG Interiors Inc. in Greenville. Output from the two firms was sufficient to rank Mississippi first among the 33 States with perlite expanding facilities. Sales were to the formed products, roof, and insulation board industries.

Phosphate rock imported from Morocco could be in the State's future as negotiations began between Mississippi Chemical Corp. (MCC), Pascagoula, and the Moroccan owned OCP, the phosphate company of Morocco. The MCC fertilizer complex in Pascagoula was closed in 1989.

Rock salt was purchased by KemaNord Inc. in Columbus. The salt, obtained from Louisiana, was used at KemaNord's sodium chlorate manufacturing plant. Sodium chlorate was sold to paper mills for use in bleaching pulp.

Stone (dimension), primarily granite and marble, was shipped into Mississippi from several other States and sold for cemetery monument and architectural applications.

Metals

Both metal scrap and metal ore were shipped into Mississippi as feedstock for several of the State's metal production firms.

Iron and Steel.—Flowood, near Jackson, was the site of Birmingham Steel Corp.'s 210,000-short-ton melting capacity minimill. The Flowood mill had a rolling capacity of 300,000 tons. In June, the company announced a $45 million expansion that would add about 60,000 square feet to the plant. The expansion will add a new melt shop and boost steel production to 500,000 short tons per year. Rolled steel output will increase to 400,000 short tons annually.[10]

Manganese.—Kerr-McGee Chemical Corp. imported manganese ore from West Africa for its electrolytic manganese metal plant in Hamilton. Output was sold primarily to the aluminum industry. The Hamilton plant was one of two in the United States producing electrolytic manganese metal.

[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 30 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]Oxford Eagle. UM Center Receives Funds. Dec. 6, 1990.

[5]Mississippi Bureau of Geology. MMRI Research Grants, in Mississippi Geology. V. 10, No. 4, June 1990, p. 11.

[6]Written communication from M. B. E. Bograd, Senior Geologist, MS Bureau of Geology, to the author. Nov. 9, 1990.

[7]Daily Corinthian (Corinth). Grant Will Improve Roads to State Limestone Quarry. Sept. 11, 1990.

[8]Denver Post. Holnam Completes United Cement Buy. Aug. 29, 1990.

[9]Metro Jackson Business News. Clay Mine Opens in Sledge; Contract Hauling Planned for Site. Sept. 1990.

[10]Mining Magazine. North American Plant Expansions. May, 1990.

[11]Jackson Clarion-Ledger. Birmingham Steel to Invest $45 Million in Flowood Plant. June 29, 1990.

TABLE 2
MISSISSIPPI: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	4,259	$17,503	$4.11
Plaster and gunite sands	58	276	4.76
Concrete products (blocks, bricks, pipe, decorative, etc.)	41	156	3.80
Asphaltic concrete aggregates and other bituminous mixtures	1,546	6,226	4.03
Road base and coverings[1]	1,442	4,134	2.87
Fill	231	329	1.42
Other[2]	225	519	2.31
Unspecified:[3]			
Actual	2,777	10,211	3.68
Estimated	2,452	6,463	2.64
Total[4] or average	[4]13,032	45,817	3.52

[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules.
[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.

TABLE 3
MISSISSIPPI: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

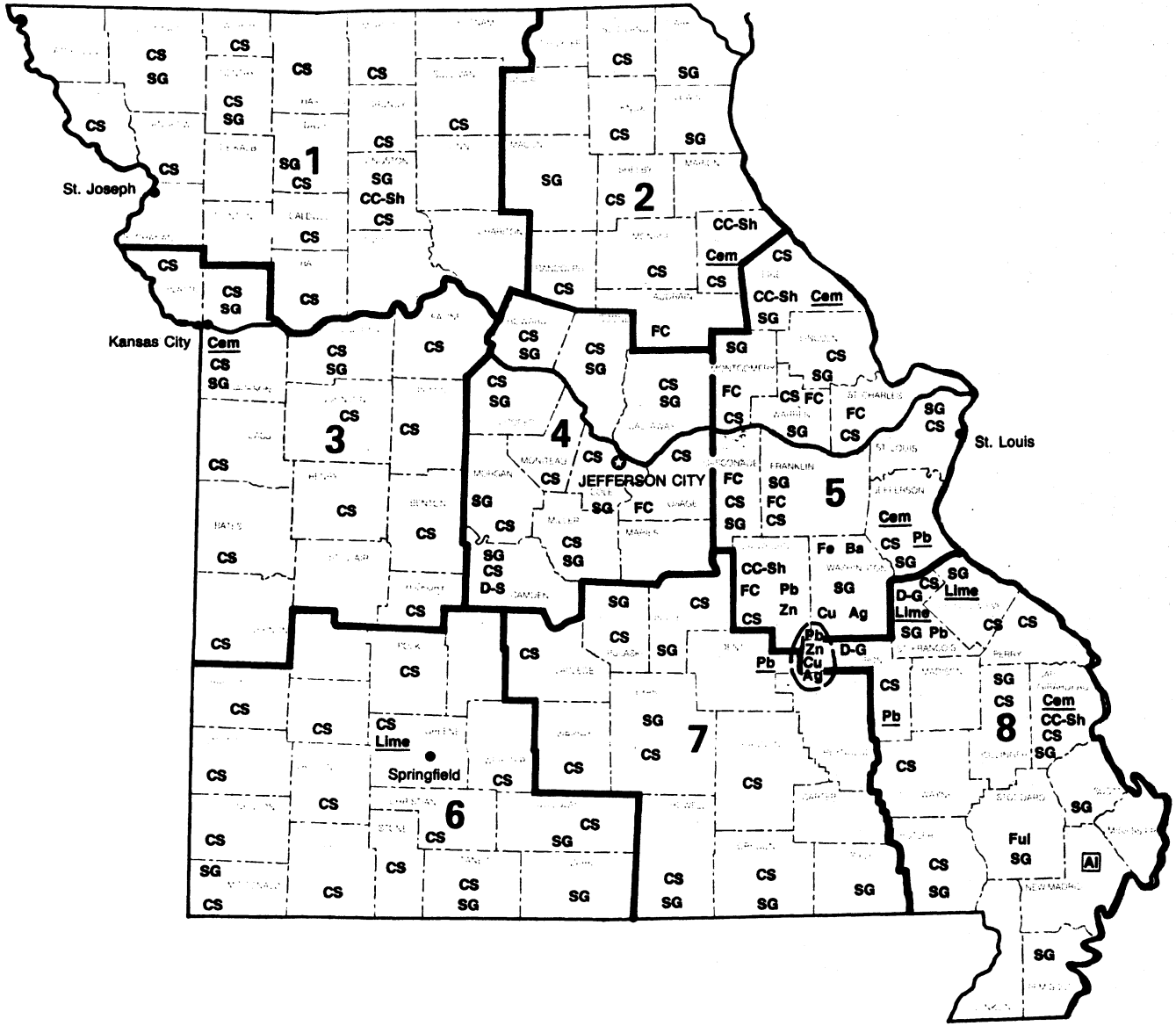
Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	1,707	5,951	1,554	7,747	997	3,806
Plaster and gunite sands	W	W	W	W	W	W
Concrete products (blocks, bricks, etc.)	W	W	W	W	2	9
Asphaltic concrete aggregates and other bituminous mixtures	490	1,551	700	3,674	357	1,002
Road base and coverings[1]	360	1,066	763	2,319	320	749
Fill	76	131	55	97	100	100
Other miscellaneous[2]	54	197	206	536	62	210
Unspecified:[3]						
Actual	2,316	7,991	211	1,419	251	801
Estimated	848	2,264	1,002	2,645	601	1,554
Total[4]	5,851	19,150	4,490	18,438	2,690	8,229

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules.
[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.

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:			
Boydston Lumber Co.	Box 207 Louisville, MS 39339	Mine	Winston.
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:			
American Sand & Gravel Co.	Box 272 Hattiesburg, MS 39401	Mines and plant	Forrest, Jones, Lamar, Pearl River, Perry.
Blain Sand & Gravel Co.	Box 278 Mount Olive, MS 39119	Mines and plants	Various.
J. J. Ferguson S & G Co.	Box 660 Greenwood, MS 38930	do.	Carroll and Holmes.
Industrial:			
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	Tishomingo.
Limeco Inc.	Route 1, Box 431 West Point, MS 39773	Quarry and plant	Clay.
United Cement Co.	Box 185 Artesia, MS 39736	do.	Lowndes.

MISSOURI



LEGEND

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

MINERAL SYMBOLS

Ag	Silver
Al	Aluminum plant
Ba	Barite
CC-Sh	Common Clay & Shale
Cem	Cement plant
CS	Crushed Stone
Cu	Copper
D-G	Dimension Granite
D-S	Dimension Sandstone
FC	Fire Clay
Fe	Iron
Ful	Fuller's earth
Lime	Lime plant
Pb	Lead
Pb	Lead smelter
SG	Sand and Gravel
Zn	Zinc
	Concentration of mineral operations

Principal Mineral-Producing Localities

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 Division of Geology and Land Surveys, Missouri Department of Natural Resources, Division of Geology and Land Survey, for collecting information on all nonfuel minerals.

By James R. Boyle[1] and Ardel Rueff[2]

Missouri's nonfuel mineral industry produced almost $1.1 billion of mineral commodities in 1990. This was an increase of about $44 million over that reported in 1989 and the second highest value ever reached by the State's nonfuel mineral producers. In 1979, the record year, Missouri nonfuel mineral producers recorded sales of $1.16 billion. The value of the three leading mineral commodities, lead, crushed stone, and portland cement, increased almost $77 million over the 1989 level and more than accounted for the increase in value in 1990.

During the decade of the 1980's, mineral sales totaled $8.5 billion; in 1990, Missouri was one of 12 States with nonfuel mineral output valued at more than $1 billion. Missouri continued to rank 11th among the 50 States in total nonfuel mineral value and ranked in the top 10 nationally in 9 industrial minerals and 8 metallic minerals.

TRENDS AND DEVELOPMENTS

During the decade of the 1980's, the relative combined value of metal and construction minerals accounted for between 75% to 90% of the State's nonfuel mineral value. Metal values exceeded 50% at the beginning of the decade, declined at mid-decade, and then rose to about 50% again by 1990. The value range of construction minerals contrasted with metal values; they were

TABLE 1
NONFUEL MINERAL PRODUCTION IN MISSOURI[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite	thousand metric tons	24	$1,930	W	W	W	W
Cement:							
Masonry	thousand short tons	153	6,310	W	W	W	W
Portland	do.	4,679	184,755	4,922	$182,005	4,481	$180,090
Clays[2]	metric tons	1,435,045	12,171	1,479,898	14,665	1,347,558	12,864
Iron ore	thousand metric tons	816	W	1,060	W	1,002	W
Lead[3]	metric tons	353,194	289,194	366,931	318,320	372,383	377,824
Sand and gravel:							
Construction	thousand short tons	11,217	32,941	e10,000	e32,500	9,243	25,097
Industrial	do.	744	9,876	750	9,972	W	W
Silver[3]	metric tons	45	9,550	53	9,456	35	5,462
Stone:							
Crushed	thousand short tons	e52,100	e183,000	51,754	171,848	e53,100	e190,900
Dimension	short tons	e3,644	e547	W	W	W	W
Zinc[3]	metric tons	41,322	54,842	50,790	91,885	48,864	80,355
Combined value of clays (fuller's earth), copper, gem stones, iron oxide pigments (crude), lime, and values indicated by symbol W		XX	182,833	XX	r219,236	XX	221,026
Total		XX	967,949	XX	1,049,887	XX	1,093,618

e Estimated. r Revised. 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] Recoverable content of ores, etc.

lowest at the beginning of the decade, increased at mid-decade, and decreased again at the decade's end.

The relative contrast between output of metals and construction minerals produced a healthy mineral industry. Over the decade, with the two sectors complementing each other, a relatively stable industry resulted. Withstanding a major drop in output in the metals industry, the outlook for the minerals industry in the State is positive.

Developments during 1990 included the sale of two of the State's major metal producers and a major safety award for another. Fluor Corp., the parent company of Missouri's Pea Ridge Iron Ore Co., announced in July the sale of Pea Ridge to Big River Minerals Corp., St. Louis, MO. In May, Fluor Corp. and Homestake Mining Co. announced an agreement to dissolve their partnership in The Doe Run Co., which allowed Fluor Corp. to purchase all of Doe Run. Doe Run's Buick Mine and mill was awarded the 1989 Sentinels of Safety award in the Underground Metals Division. Doe Run's two preference-right lease applications for lead exploration in the Mark Twain National Forest were delayed. A decision was expected in 1991.

The State's three lead producers could profit from a test underway by the National Association of Homebuilders. Two homes have been constructed with a sheet lead membrane or liner under the foundation to shield residents from radon gas.

EMPLOYMENT

Missouri's total employment rose slightly as did the unemployment rate. Employment in the civilian labor force increased 0.77% from 2,614,000 to 2,634,000. The unemployment rate increased from 5.5% to 5.7%. Total mining employment showed no change from the 5,200 reported in 1989.[3]

REGULATORY ISSUES

Early in 1990, the National Park Service (NPS) requested that the U.S. Environmental Protection Agency designate a 967-square-mile area in south-central Missouri as a sole source aquifer. The designation would be authorized under the Federal Safe Drinking Water Act. Included was a part of the Current River-Ozark National Scenic Riverway north of Van Buren administered by the NPS.

The Scenic Riverway was north of the Mark Twain National Forest property where The Doe Run Co. has been trying to win preference-right leases from the U.S. Forest Service (USFS) and the U.S. Bureau of Land Management (BLM) to continue exploratory drilling for lead and zinc. After applying for two preference right leases in the mid-1980's, Doe Run was informed in late 1988 that the USFS had recommended that the BLM grant the leases. The leases were opposed by environmental groups, and in March 1989, the USFS determined that available environmental information was insufficient to issue the leases. Concern existed that an exploration lease would have permitted development. Doe Run was required to submit a mine plan prior to the completion of USFS deliberations on the lease application. Such a plan would require extensive geological information, and in late July, USFS began an environmental analysis on a Doe Run proposal to drill up to 20 additional exploration holes to collect information to prepare the mine plan. The drilling was to be authorized under an exploration license-special use permit. Opponents to the drilling were concerned with aquifer pollution, which, they claimed, was sufficient grounds to deny the company the leases. At yearend, drilling had not begun.

EXPLORATION ACTIVITIES

Although interest among the State's metal producers in the geologic model of the Olympic Dam deposit in Australia and its similarity to the Pea Ridge iron deposit remained strong, information on in-State geochemical-geophysical or drilling exploration was sparse.

Cominco Ltd.'s surface drilling at the Magmont Mine yielded two minor extensions to previously known lead mineralization. The company was evaluating the Boss-Bixby copper-iron deposit at yearend. Cominco abandoned its exploratory drilling project on two Dent County farms, and all leases were dropped.[4]

Doe Run completed a second exploration hole in the excluded portion of the Irish Wilderness area. The State's third metal producer, ASARCO Inc., expressed interest in the Olympic Dam-type model; however, the extent of the company's exploration activity was unknown.

LEGISLATION AND GOVERNMENT PROGRAMS

The 1990 Missouri Legislature adjourned May 18 after considering almost 1,400 bills and passing slightly less than 15% of them. Among those passed were two that had a direct impact on the State's mineral producers. House bill 1240, signed into law by the Governor, created a nine-member coal commission to determine the effects of State and Federal laws on coal consumption and provided for a survey of transportation systems and the potential impacts of sulfur-removal and alternative combustion technologies. Nonfuel mineral producers were impacted by House bill 1584, which the Governor also signed into law. The new law revised the Missouri Mining and Land Reclamation Act and added 24 new sections. The procedures for obtaining permits and the amount of fees were also revised. Included in the new regulatory authority were minerals usable in natural form or capable of being processed into a usable form as a chemical, energy source, or raw material for manufacturing or construction material. Bills authorizing the State to join the Interstate Mining Compact, to create a Metallic Mineral Mine Land Reclamation Fund, and to designate the Department of Natural Resources as the lead technical agency for geologic hazard assessment died in committee.

Several programs by State and Federal agencies had an impact on the Missouri mineral industry. In March, the Missouri Department of Natural Resources (DNR), operating under the State's Air Conservation Law, placed the Pea Ridge Iron Ore Co. on a schedule to reduce iron oxide particulate air emissions. Under an agreement between DNR and the company, Pea Ridge had until yearend to install pollution equipment on one of its five furnaces. By the end of January 1991, emission test results were to be delivered to the DNR. If successful, multicyclone air scrubbing equipment was to be installed on one furnace each year until 1994.

The Missouri Division of Geology and Land Survey (DGLS) was reorganized and given new responsibilities as part of a department-wide, yearlong effort to develop new operating parameters for the 1990's. The Geological Survey Program was divided into four sections: (1) the Geological Mapping and Resources Section, which fulfills the traditional role of a Geological Survey by acquiring and maintaining basic geological data, was composed of a geological mapping-stratigraphy unit and a mineral resources unit, (2) the Environmental Geology Section, established to apply basic geologic and hydrologic data to environmental problems, including hazard waste sites, (3) the Wellhead Protection Section, the regulatory arm of the Geological Survey program, regulated water-well drillers and underground injection operations to protect Missouri's subsurface waters, and (4) the Geotechnical Services Section, which provided laboratory services for the program and managed the geologic map and core sample repositories.[5]

During the year, DGLS personnel began work on Missouri's new State Water Plan, authorized in 1989 and funded in 1990. DGLS personnel continued the geologic mapping of the Pea Ridge iron ore mine. The mine provided a three-dimensional view of a deposit thought to be an analog to a large copper, gold, silver, uranium, and rare-earth element deposit in southern Australia. The Missouri mapping project could lead to similar metal deposit discoveries elsewhere in the midcontinent. The DGLS was the repository for Missouri cave data, and on January 27, the State became the first in the Nation to record 5,000 caves. Other DGLS programs included the placement of several first-order land survey monuments using geodetic positioning satellite (GPS) control in the Greater Kansas City area. Work began in other areas using GPS. About one-fourth of Missouri's detailed soil maps at a 1:24,000 scale was digitized, and the dam safety program issued a manual on design procedures for dams.

The U.S. Bureau of Mines Research Center at Rolla also was involved with a study of the Pea Ridge Mine. Rolla Research Center personnel investigated processing methods to recover rare-earth elements occurring in breccia pipes at the mine. The 1990 research effort focused on single-stage gravity separation followed by flotation to remove phosphate impurities. Other mineral investigations at the Research Center involved methods to treat lead mill tailings. One phase of the work used canola oil to collect sulfide minerals rather than use more traditional, and generally toxic, methods. Pyrometallurgical waste treatment methods were investigated to recover zinc and silver from slag while producing a nonhazardous slag for environmentally safe disposal. This study was undertaken in cooperation with the Big River Zinc Corp.

The U.S. Geological Survey (USGS) funded the DGLS to enter geological data into the USGS National Coal Resources Data System. These data include information on coal occurrence in Howard, Randolph, and Boone Counties collected between 1982 and 1985.[6]

USGS and DGLS personnel continued a cooperative study of the Pea Ridge iron deposit as a variant of an Olympic Dam-type deposit. USGS scientists collected chemical and petrographic data on the deposit, and DGLS geologists completed geologic maps of the mine workings.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Missouri's industrial mineral sector accounted for more than one-half of the State's nonfuel mineral value. Cement, stone, and sand and gravel were the three leading industrial minerals, accounting for 38.3% of the 1990 total.

Barite.—Missouri ranked third out of six States producing barite, a barium sulfate mineral used in chemical manufacture, as a pigment and filler in paint and rubber manufacture, as a glass flux, and as an oil well drilling mud additive to control gas pressure. The State's barite producers accounted for approximately 5% of the tonnage produced nationally and for about 13% of the barite value. Production and value were 21% and 38.6%, respectively, above those reported in 1989. The increase ended a downward trend begun in 1985.

Missouri's barite industry, three companies operating six surface mines, was active in Washington County north of Potosi. Crude barite was mined by dragline and front-end loaders and trucked to preparation plants where a hydrogravimetric (jig) concentrate was produced.

Cement.—Portland and masonry cements constituted the leading mineral commodity produced in-State, accounting for 17.6% of Missouri's 1990 mineral value. The State retained its fifth place ranking in cement production and value among the 38 cement-producing States. Portland cement production and value, 4.5 million short tons valued at $180 million, was 400,000 short tons and $2 million below the figures reported by the cement industry in 1989. The decline was due to the recession and 14% drop in private and public housing. Masonry cement output and value decreased slightly.

The State's cement producers, five companies with plants in Cape Girardeau,

Clarksville, Festus, Hannibal, and Sugar Creek, operated two wet-process and three dry-process plants. Four produced gray portland and masonry cement, and one produced gray portland and portland pozzolan-type cements. The industry reported sales as follows: ready-mix (72.4%), concrete products (12.1%), highway contractors (9.2%), and others (6.3%).

In December, Lafarge Corp. announced it had entered into various purchasing agreements with Cementia Holding AG of Zurich and its Spanish subsidiary Ashland S.A. to purchase the Missouri Portland Cement Co. and one in Iowa. The Missouri facility, in Kansas City, had a 480,000-short-ton clinker capacity.[7]

Clays.—Missouri ranked 10th among the 44 clay-producing States. The State's clay producers mined common clay, fire clay, and fuller's earth.

The State ranked eighth of the 43 States with common clay production. Common clay output, 1,065,000 metric tons valued at $5.2 million, accounted for a major portion of the tonnage. Common clay was mined by eight companies operating nine pits in a seven-county area. The leading counties, Crawford, Pike, and Platte, accounted for almost 83% of the total.

Among the five States producing fire clay, Missouri ranked first. The 6 producers mined 282,674 metric tons valued at $7.7 million from 27 mines in 4 counties. All sales were to the refractories industry.

The State ranked seventh among the 10 with fuller's earth production. One company operated two pits in Stoddard County; sales were mainly to the absorbent industry.

Lime.—In 1990, the State ranked first among the 32 lime- producing States. Two companies, Ash Grove Cement Co., Greene County, and Mississippi Lime Co., St. Genevieve County, produced both quick and hydrated lime. In order to protect company proprietary information, the U.S. Bureau of Mines does not publish production and value data. Lime sales were to the water treatment industry, for oil refining, and for the manufacture of paper and steel. In 1990, shipments of lime to the State or sold or used by producers in the State totaled 263,000 short tons. Of this total, 74% was quicklime and 26% was hydrated lime.

Sand and Gravel.—Missouri's sand and gravel industry consisted of 71 companies operating 102 pits in 45 counties. Decreased demand and sales were reported for both construction and industrial 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 1988 and 1990 and estimates for 1989.

Missouri construction sand and gravel statistics are compiled by geographical districts as depicted in the State map. Table 3 presents end-use data for the State's eight districts.

The value of construction sand and gravel ranked 4th among the industrial minerals produced in Missouri in 1990, and the State ranked 33d out of the 50 States with construction sand and gravel production. The industry consisted of 68 companies operating 98 mines in 45 counties. The three leading counties, St. Louis, Clay, and Callaway, accounted for more than 51% of the production. The top five producing companies accounted for 55% of the State's output.

Industrial.--Missouri ranked 19th among the 38 States with industrial sand and/or gravel production. Industrial sand and/or gravel output was reported by three companies operating four mines in a two-county area. Output and value decreased below the 750,000 short tons valued at more than $9.9 million reported by industry in 1989. The largest end use, in terms of value, was in ground filler, followed by containers, flatware, and foundry molding.

Missouri industrial sand producers were faced with the loss of a major customer as the 119-year-old PPG Industries glass plant in Crystal City announced plans to close at yearend. A falling demand in both the construction and auto industries was blamed for the closing. The Missouri Department of Economic Development estimated that the closing could remove almost $14 million per year from the Jefferson County economy, including $513,000 in lost revenue for city and county governments. The plant made glass for the automotive and construction industries and Herculite, a light, hard glass used in military and commercial aircraft.[8]

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 1988 and 1990, and actual data for 1989.

Missouri's stone producers marketed both crushed and dimension stone in 1990. Stone was the leading industrial mineral produced in 1990, accounting for 17.5% of the State's total nonfuel mineral value.

Crushed.—The estimated value of crushed stone production, $190.9 million, was $19.1 million above the figure reported by industry in 1989. Output increased from the 51.8 million short tons reported in 1989 to 53 million short tons estimated for 1990.

In 1989, the last year with complete industry records, stone was produced in 87 counties by 130 operators. Production consisted of granite and limestone.

Magruder Limestone Co., Troy, purchased the assets of Galloway Limestone Co., Frankford. Included in the sale were the Frankford and Ashley operations. Galloway employees have not had a lost time accident in more than 20 years.[9]

Martin Marietta Corp. completed the purchase of McKee Quarries Inc. of Greenwood and its two limestone quarries near Kansas City.[10]

Several proposed quarries met with citizens opposition or local legislature refusal. A proposal to site a new

county-run quarry near Liberty was denied as opponents "flooded State and Federal agencies with telephone calls, circulated petitions and picketed the old courthouse building."[11] At yearend, the Lafayette County Planning and Zoning Commission heard a rezoning request from the Les Mitchell Quarries in Lafayette County to construct a concrete and asphalt plant on the quarry property. Because of citizen opposition, a decision was withheld until 1991.[12] The Franklin County Commission ruled to deny a conditional use permit for a proposed quarry in the Dundee-Newport area. The Planning and Zoning Board's review committee had urged the board not to recommend approval, stating that the applicant had failed to show that the operation would not be a nuisance to the surrounding areas.[13]

The Boone County Planning and Zoning Commission refused a conditional-use permit for a new quarry near Columbia.
"More than 100 angry residents" opposed the operation.[14] The St. Louis County Planning Commission refused Bussen Quarries Inc. request for rezoning 106 acres to expand its quarrying operation into an abandoned hospital site in the southern part of St. Louis County. More than 200 area residents turned out for planning commission meetings concerning the rezoning request.[15]

The Missouri Limestone Producers Association recognized three quarries for the best safety program in their prospective size categories: Dawson Quarry of Union; O'Fallon Quarry of Fred Weber Inc.; and Conco Quarry of Willard.[16]

Dimension.—Keystone Granite Co. was the major dimension stone producer in-State. The company, in Graniteville in Iron County, produced a stone marketed as "Missouri Red."

Other Industrial Minerals.—Several industrial minerals, shipped into Missouri or byproducts of process streams, were either sold as recovered or processed into a higher value product. The values of these do not appear on table 1.

Calcium carbonate (precipitated) was produced by Mississippi Lime Co. at its plant in St. Genevieve County. 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 Pea Ridge Iron Ore Co.'s pelletizing plant in Washington County. The olivine was used as a binder in making iron ore pellets. Slag, a byproduct of steelmaking, was processed by International Mill Service Co. and sold for use as a concrete aggregate, for fill, railroad ballast, and road base. Stone (dimension), primarily granite and marble, was shipped into the State and fabricated into monuments and used for architectural applications. Tripoli, a siliceous, microcrystalline substance, was shipped from Oklahoma and processed by American Tripoli Co. at its plant at Seneca in Newton County. Sales were for use in tooth polishing and buffing compounds and as a filter media.

Metals

The metals sector of Missouri's mineral industry accounted for about one-half of the 1990 mineral value. The State continued as the leader among the 11 lead-producing States, and output was 78.6% of the total domestic lead production. Missouri retained its third place ranking among the nine iron-producing States.

Copper, Lead, Silver and Zinc.—Three nonferrous metal producers, The Doe Run Co., ASARCO Inc., and Cominco American Inc., 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 sedimentary rocks of Cambrian age. Major deposits are found in the Cambrian Bonneterre Formation associated with strata-bound pore space fillings, in a network of vugs that transect strata, and in solution collapse breccias.

The Doe Run Co., North America's largest integrated lead producer, operated six mines, four mills, and the Buick and Herculaneum smelters in southeast Missouri. Asarco operated the West Fork and Sweetwater Mines and mills and a smelter and refinery at Glover. Cominco operated the Magmont Mine and mill complex near Bixby.

During the year, Doe Run began the conversion of the Buick smelter to a secondary recovery unit. Work proceeded with equipment installation, and construction was expected to extend through late 1991. The facility was planned to have an annual capacity of about 60,000 short tons of refined lead and will also produce sodium sulfate and polypropylene chips as coproducts.

Asarco awarded the University of Missouri-Rolla School of Mines and Metallurgy $150,000 over a 5-year period to establish the Asarco Endowment Fund. The money will be used for undergraduate scholarships and faculty support.[17]

Cominco completed ore recovery from an area of the Magmont Mine that experienced a groundfall in 1986. Capital expenditures of approximately $400,000 were made for the replacement of mining and processing equipment. Surface drilling intersected two minor extensions to lead mineralization, and the increase in ore reserves partially offset the ore tonnage mined.[18] The company, anticipating reserve depletion at the Magmont Mine, filed a mine closure plan with the Missouri Department of Natural Resources. Cominco approached several other firms to determine their interest in purchasing the mine to recover high-grade ore remaining in pillars.

Iron Ore and Iron Oxide Pigments.—Pea Ridge Iron Ore Co., the Nation's only underground iron producer, was sold by its parent company, Fluor Corp., to Big River Minerals Corp. for approximately $12 million. Included in the sale were the iron ore mine and pelletizing plant near Sullivan in Washington County. The operation produced olivine-enriched pellets made from magnetite mined and concentrated at the mine site. The

olivine, mined in Norway and shipped by water to St. Louis, increased the alkali resistance and improved high- and low-temperature properties in the blast furnace. The olivine enriched pellet also extended refractory life and reduced coke usage.

Heavy-media magnetite was also recovered as a coproduct of the Pea Ridge plant. The magnetite was sold to coal washing plants. Sales of a new product containing 69.7% iron and 0.21% silica for ferrite permanent magnet manufacture continued.[19]

Iron ore production decreased slightly with an increase in unit value. Principal sales were to the Granite City Steel Div. of National Steel Corp. at East St. Louis, IL. In late December, Pea Ridge announced that its pellet contract was terminated. Hourly employees were laid off, and salaried staff were to maintain specialty byproduct iron ore production.[20]

Pea Ridge produced both crude and finished iron oxide pigments and Columbia Chemical Co., St. Louis, produced finished pigments. Pigment sales were for use in the manufacture of paint and coatings, electronics, rubber, plastics ceramics, and polishing compounds and as a source of iron in glassmaking.

Other Metals.—Noranda Aluminum Inc. operated the State's only aluminum reduction plant in New Madrid County. The company was a subsidiary of Noranda Mines Ltd. of Toronto, Canada. The 204,000-metric-ton plant, completed in 1971, received bauxite from the Port of New Orleans via barges on the Mississippi River. The facility produced primary aluminum and bare electrical conductors.

Armco Inc. operated its Midwestern Steel Div. at Kansas City. The facility produced carbon wire rods and grinding media. Sales, including those at the company's Baltimore plant, declined 17%, from $349.1 million to $289.3 million. Carbon rod shipments were down because of production shortages at the Kansas City plant. Lower volume and higher labor costs reduced operating results for the year.[21]

[1]Former State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has over 30 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, Missouri Department of Natural Resources, Division of Geology and Land Survey, Rolla, MO.

[3]Missouri Department of Labor.

[4]The Salem News. Cominco Will Halt Drilling Plans, Leases. Nov. 30, 1990.

[5]The State Geologists Newsletter. V. 4, No. 2, Dec. 1990.

[6]Fayette Democrat-Leader. Computer to Search for Coal in County. Mar. 24, 1990.

[7]Lafarge Corp. Annual Report, 1990. Pp. 12 and I-6.

[8]St. Louis Post-Dispatch. Glass Plant to Close in Crystal City. Sept. 21, 1990.

[9]Hannibal Courier-Post. Limestone Firm Sold. Oct. 9, 1990.

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[13]New Haven Leader. County Denies Quarry Permit. Apr. 25, 1990.

[14]Columbia Daily Tribune. Quarry Request Falls Flat. Aug. 17, 1990.

[15]Oakville-Mehlville Journal. Commission Denies Quarry Zoning Plan. Apr. 4, 1990.

[16]Rock Products. Missouri Stone Group Announces Award Winners. V. 93, No. 3, Mar. 1990, p. 24.

[17]Skillings' Mining Review. ASARCO Gives $150,000 to University of Missouri-Rolla. Dec. 29, 1990, p. 26.

[18]Cominco Ltd. 1990 Annual Report. Pp. 18-19.

[19]Skillings' Mining Review. July 28, 1990, p. 26.

[20]Mining Engineering. Annual Review 1990, Missouri. V. 43, No. 5, May 1991, pp. 501-502.

[21]Armco Inc. Annual Report, 1990. P. 22.

TABLE 2

MISSOURI: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,250	$9,067	$2.79
Plaster and gunite sands	49	137	2.80
Concrete products (blocks, bricks, pipe, decorative, etc.)	333	829	2.49
Asphaltic concrete aggregates and other bituminous mixtures	803	1,312	1.63
Road base and coverings[1]	366	1,392	3.81
Fill	303	632	2.09
Snow and ice control	51	165	3.24
Railroad ballast	W	W	16.50
Other[2]	641	2,791	4.36
Unspecified:[3]			
Actual	W	W	4.19
Estimated	3,448	8,771	2.54
Total[4] or average	9,243	25,097	2.72

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes road and other stabilization (cement).
[2]Includes roofing granules and 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.

TABLE 3

MISSOURI: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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	—	—	—	—	636	1,824
Plaster and gunite sands	—	—	—	—	—	—	49	137
Concrete products (blocks, bricks, etc.)	—	—	—	—	—	—	26	78
Asphaltic concrete aggregates and other bituminous mixtures	W	W	—	—	—	—	121	356
Road base and coverings[1]	—	—	—	—	—	—	32	94
Fill	W	W	—	—	—	—	28	82
Snow and ice control	W	W	—	—	—	—	35	106
Railroad ballast	—	—	—	—	—	—	—	—
Other miscellaneous[2]	W	W	—	—	—	—	22	93
Unspecified:[3]								
Actual	—	—	W	W	—	—	—	—
Estimated	W	W	W	W	1,549	4,072	511	1,333
Total[4]	W	W	W	W	1,549	4,072	1,460	4,104

	District 5		District 6		District 7		District 8	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	2,068	5,931,519	—	—	W	W	299	836
Plaster and gunite sands	—	—	—	—	—	—	—	—
Concrete products (blocks, bricks, etc.)	287	657	W	W	—	—	W	W
Asphaltic concrete aggregates and other bituminous mixtures	638	827,843	—	—	—	—	W	W
Road base and coverings[1]	156	709,181	46	137	65	186	67	265
Fill	216	383,809	W	W	20	53	17	66
Snow and ice control	6	34,942	—	—	6	11	W	W
Railroad ballast	W	W	—	—	W	W	—	—
Other miscellaneous[2]	19	187	26	83	241	453	56	171
Unspecified:[3]								
Actual	550	2,382	—	—	—	—	—	—
Estimated	306	888	135	367	134	271	597	1,190
Total[4]	4,246	12,000	207	587	466	974	1,036	2,529

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."

[1]Includes road and other stabilization (cement).

[2]Includes roofing granules and filtration.

[3]Includes production reported with a breakdown by end use and estimates for nonrespondents.

[4]Data may not add to totals shown because of independent rounding.

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Aluminum:			
Noranda Aluminum Inc.	New Madrid, MO 63869	Plant (smelter)	New Madrid.
Barite:			
Baroid Drilling Fluids Inc.	Box 1675 Houston, TX 77251	Mine and plant	Washington.
DeSoto Mining Co.	Box 35 Richwoods, MO 63071	do.	Do.
General Barite Co.	119 West Clement St. De Soto, MO 63111	Mines and plant	Do.
Cement:			
Continental Cement Co. Inc.	120 South Central Ave. Suite 1040 St. Louis, MO 63105	Quarry, clay pit, plant	Ralls.
Dundee Cement Co., a division of Holderbank Financiere Glaris SA.	Box 67 Clarksville, MO 63336	do.	Pike.
Lone Star Industries Inc.	Box 120014 Stamford, CT 06912-0014	Quarry and plant	Cape Girardeau.
Missouri Portland Cement Co., a subsidiary of Cementia Holdings, A.G.	7711 Carondelet Ave. Clayton, MO 63105	Plant	Jackson.
River Cement Co., a subsidiary of IFI International of Italy (Instituto Finanziario Industriale S.p.A.)	12700 Southfork Rd. St. Louis, MO 63128	Quarry and plant	Jefferson.
Clays:			
Buildex Inc.	Box 15 Ottawa, KS 66067	Pit and plant	Platte.
Dillon Clay Mining Co.	Box 115 St. James, MO 66559	Pits	Crawford.
A. P. Green Industries Inc.	1018 East Breckenridge St. Mexico, MO 65265	Pits and plants	Audrain, Callaway, Crawford, Franklin, Gasconade.
Southern Clay Inc. (Lowe's Inc.)	Box 1086 Cape Girardeau, MO 63701	do.	Stoddard.
Iron ore:			
Pea Ridge Iron Ore Co., a subsidiary of Fluor Corp.[1]	Route 4 Sullivan, MO 63080	Underground mine and plant	Washington.
Iron oxide pigments (finished):			
Columbian Chemicals Co.	1600 Parkwood Circle Suite 400 Atlanta, GA 30339	Plant	St. Louis.
Lead:			
ASARCO Incorporated:[2]	Route 1, Box 202C Bunker, MO 63629		
Glover smelter		Smelter	Iron.
Sweetwater Unit		Underground mine and plant	Reynolds.
West Fork Unit		do.	Do.
Cominco American Incorporated Magmont Mine[2]	Bixby, MO 65439	do.	Iron.
The Doe Run Co.:[2]	11885 Lackland Rd. Suite 500 St. Louis, MO 63146		

See footnotes at end of table.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Lead—Continued			
Buick		Underground mine, plant, smelter	Iron.
Casteel		Underground mine and plant	Do.
Fletcher		do.	Reynolds.
Herculaneum smelter		Smelter	Jefferson.
Viburnum No. 28		Underground mine and plant	Iron.
Viburnum No. 29		do.	Washington.
Lime:			
Mississippi Lime Co.	7 Alby St. Alton, IL 62002	Plant	Ste. Genevieve.
Resco Products of Missouri Inc.	Box 1110 Clearfield, PA 16830	Quarry and plant	St. Francois.
Perlite (expanded):			
Brouk Co.	1367 South Kingshighway Blvd. St. Louis, MO 63110	Plant	St. Louis.
Georgia-Pacific Corp.	133 Peachtree St., NE. Atlanta, GA 30303	do.	Crawford.
Sand and gravel:			
Construction (1988):			
Holliday Sand & Gravel Co., a subsidiary of List & Clark Construction Co.	6811 West 63d St. Overland Park, KS 66204	Dredges and plants	Clay.
Limited Leasing Co., a subsidiary of St. Charles Sand Co.	Route 1, Box 158 Hazelwood, MO 63042	do.	St. Louis.
Winters 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.[3]	Route 1, Box 158 Hazelwood, MO 63042	Pit and plant	Do.
Masters Bros Silica Sand Co., a subsidiary of Bussen Quarries Inc.	Route 1, Box 204 Pevely, MO 63070	Dredge and plant	Jefferson.
Unimin Corp.	258 Elm St. New Canaan, CT 06840	Mine and plant	Do.
U.S. Silica Co.	Box 187 Berkeley Springs, WV 25411	Dredge and plant	St. Louis.
Slag (iron and steel):			
International Mill Service Co.	1818 Market St. Philadelphia, PA 19103	Plant	Jackson.
Stone:			
Crushed:			
Granite:			
GAF Chemicals Corp.	Box 186 Annapolis, MD 20104	Quarry and plant	Iron.
Quality Aggregate Co.	Box 307 Piedmont, MO 63957	do.	Wayne.
Limestone-dolomite:			
Bussen Quarries[4]	5000 Bussen Rd. St. Louis, MO 63129	Quarries and plants	Jefferson and St. Louis.

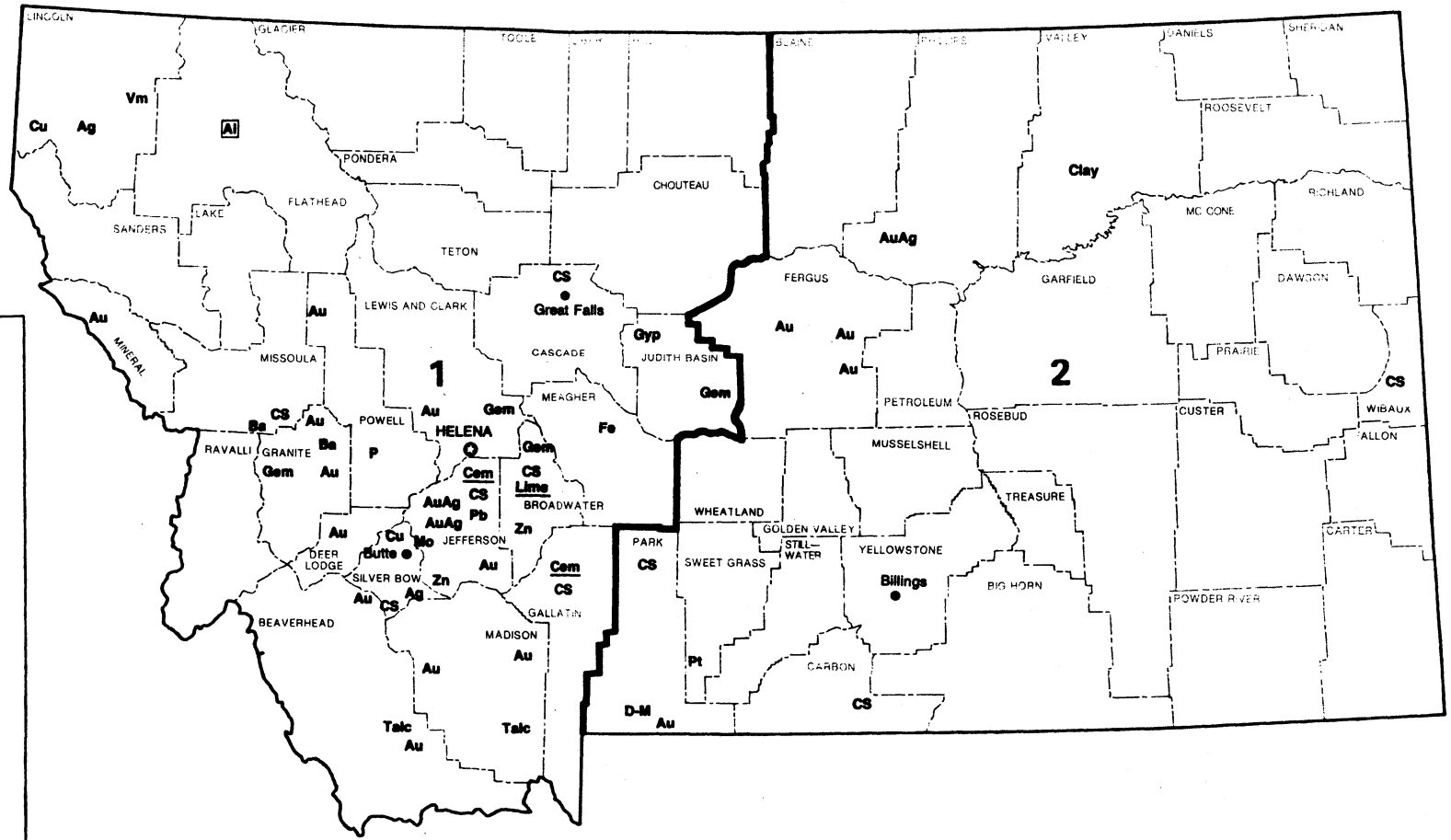
See footnotes at end of table.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Limestone-dolomite—Continued			
Martin Marietta Aggregates	Box 30013 Raleigh, NC 27622	do.	Andrews, Daviess, Gentry, Harrison, Holt, Jackson, Mercer, Nodaway, Worth.
Tower Rock Stone Co.	Box 69 Columbia, IL 62236	Quarry and plant	Ste. Genevieve.
Fred Weber Inc.	7929 Alabama Ave. St. Louis, MO 63111	Quarries and plants	Jefferson, St. Charles, St. Louis.
West Lake Quarry & Material Co.	13570 St. Charles Rock Rd. Bridgeton, MO 63044	do.	Cape Girardeau, Henry, Jefferson, St. Louis, Scott.
Dimension:			
Granite:			
Missouri Red Quarry Inc.	Box 516 Elberton, GA 30635	Quarry and plant	Iron.
Sandstone:			
Beavers Stone Co.	Box 322 Camdenton, MO 65020	do.	Camden.
Vermiculite (exfoliated):			
Brouk Co.	1367 South Kingshighway Blvd. St. Louis, MO 63110	Plant	St. Louis.
W. R. Grace & Co.	62 Whittemore Ave. Cambridge, MA 02140	do.	Do.

[1]Also crude iron oxide pigments.
[2]Also copper, silver, and zinc.
[3]Also construction sand and gravel.
[4]Also crushed sandstone.

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
Pb	Lead
Pt	Platinum group metals
Talc	Talc minerals
Vm	Vermiculite
Zn	Zinc

Principal Mineral-Producing Localities

THE MINERAL INDUSTRY OF MONTANA

This chapter has been prepared under a Memorandum of Understanding between the 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 1990 nonfuel mineral production value was $567.7 million, relatively unchanged from that of 1989. Gains in the production value of portland cement, clays, gold, crushed stone, talc, and zinc offset the decline in values of copper, molybdenum, phosphate, and vermiculite.

Metallic minerals—copper, gold, iron ore, lead, molybdenum, platinum-group metals, silver, and zinc—accounted for more than 77% of Montana's total nonfuel mineral production value. The State ranked 19th nationally in that value compared with 18th in 1989. Montana was the Nation's sole producer of platinum-group metals and ranked first for talc production; third for bentonite mined, natural gem stones, and vermiculite; fourth in the output of copper, molybdenum, and silver; and fifth in gold and lead production.

TRENDS AND DEVELOPMENTS

Although a drop in prices reduced the value of some metals, overall metal mining activity in Montana remained strong. Gold replaced copper as the leading commodity produced in terms of value. Gold was followed, in order of value, by copper, platinum-group metals, molybdenum, silver, and zinc. The construction of leach pads was undertaken

TABLE 1
NONFUEL MINERAL PRODUCTION IN MONTANA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2]	metric tons	91,802	$1,416	95,743	$1,835	29,741	$193
Gemstones		NA	1,602	NA	2,500	NA	3,692
Gold[3]	kilograms	9,175	129,291	r12,434	r152,941	13,012	161,861
Gypsum (crude)	thousand short tons	27	W	W	W	—	—
Lead[3]	metric tons	8,266	6,768	W	W	W	W
Palladium metal[4]	kilograms	r3,730	r14,750	r4,850	r22,454	5,930	21,735
Platinum metal[5]	do.	r1,240	r20,850	r1,430	r23,310	1,810	26,478
Sand and gravel (construction)	thousand short tons	7,984	20,225	e5,800	e13,900	5,114	14,319
Silver[3]	metric tons	192	40,457	194	34,367	220	34,114
Stone (crushed)	thousand short tons	e1,800	e4,500	2,846	9,718	e4,000	e15,300
Talc and pyrophyllite	metric tons	415,642	14,524	453,978	12,718	430,125	18,883
Zinc[3]	do.	18,935	25,130	W	W	W	W
Combined value of barite (1989-90), cement, clay (bentonite, [1990], fire clay, [1988-89]), copper, graphite (natural, 1988-89), iron ore, lime, molybdenum, peat, phosphate rock, sand and gravel (industrial), stone (dimension), vermiculite, and values indicated by symbol W		XX	265,008	XX	r292,394	XX	271,109
Total		XX	544,521	XX	566,137	XX	567,684

eEstimated. 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]Recoverable content of ores, etc.
[4]Palladium metal separated from platinum-group metals in 1990. 1988-89 data revised.
[5]Platinum metal separated from platinum-group metals in 1990. 1988-89 data revised.

at three gold mines, a reflection of the mineral's resurgence.

A diversity of industrial minerals continued to be produced in the State. Total production value of industrial minerals increased 9% from that reported in 1989. Construction began on a fully automated talc beneficiation plant south of Dillon. On the downside, it was announced that the State's only operating vermiculite mine near Libby would be permanently closed.

Exploration showed both signs of strength and weakness. Although many of the State and Federal agencies in Montana reported a reduction in plans and permits, exploration and development continued on three major precious-metals discoveries.

EMPLOYMENT

According to the Research and Analysis Bureau of the Montana Department of Labor and Industry, overall mining employment, including petroleum and coal industry workers, rose to 6,300, an increase of 100 from that reported for 1989. Metal mining employment totaled 2,600 workers, unchanged from that of 1989. Average weekly earnings for Montana's mineral industry workers increased to $591 from the $581 figure recorded in 1989.

REGULATORY ISSUES

After a series of public hearings and the development of a number of alternatives, work began on cleaning up the Warm Springs Ponds section of the Silver Bow Creek-Butte area of the Clark Fork Superfund (Comprehensive Environmental Response, Compensation, and Liability Act of 1980) site, one of the country's largest. After years of dumping mining, milling, and smelter waste into Silver Bow Creek in Deer Lodge County, 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, which resulted in mill tailings in the Clark Fork River. This practice is no longer allowed. Work included the removal of tailings and other associated soils from the bypass, reinforcement of the existing ponds, and the construction of a new water-treatment facility.

There was disagreement between the U.S. Environmental Protection Agency (EPA) and city officials of East Helena over EPA's plans to dig up and remove soil near ASARCO Incorporated's lead smelter. Parts of the city were declared a Superfund hazardous waste site, and the EPA planned to dig up as many as 50 residential properties and remove dirt from nearby parks, playgrounds, and ballfields. Asarco also opposed the planned action. Reportedly, EPA officials believe they have the authority to proceed with the cleanup, despite the objections, and have said that more than 200 residential yards may be dug up over the next 3 to 5 years. In related news, Asarco finished construction of its new ore handling facilities at the East Helena smelter. The $15.5 million project was built to eliminate blowing dust from concentrates stockpiled in the plant yard.

Rhone-Poulenc Basic Chemical Co. continued to install new pollution control equipment, including emission monitors and scrubbers, at its phosphate plant west of Butte. The EPA had filed a civil complaint alleging that particulate emissions from the plant violated local opacity standards under the Federal Clean Air Act.

EXPLORATION ACTIVITIES

The primary target for exploration companies was gold and other precious metals; however, interest in base metals continued to increase. The Montana Department of State Lands reported a total of 202 active exploration permits in 1990, down from 210 in 1989. The U.S. Bureau of Land Management reported the filing of 6,692 new mining claims in 1990 for a total of 73,879 active claims in the State. There were 339 plans of operation filed with the U.S. Forest Service compared with 391 reported in 1989. Deer Lodge National Forest had the most at 85, followed by Lolo, Kootenai, Helena, Beaverhead, and Gallatin. With companies trending toward smaller projects but more of them, the Montana Bureau of Mines and Geology believed that exploration expenditures in Montana for 1990 dropped from the $26 million calculated for 1989.

In the Northwest region, Asarco continued negotiation with the Forest Service over the impoundment facility at its proposed Rock Creek Project in the Cabinet Mountains. Orvana Resources continued exploration on its Libby gold project around the Lukins-Hazel Mine. The joint venture of Mines Management Inc. and Newmont Exploration drilled the Indigo gold property in Powell County. The agreement provided resources for continued exploration and evaluation. Drilling and trenching was done by Western Gold Exploration & Mining Co. (Westgold) on its Londondarry Project near Maxville and by Kennecott on its Silver King Project in Sluice Creek. Drilling also was done by Phelps Dodge on its Karger Project on Negro Mountain, on the Bullion Parks Project by Pegasus Gold Inc., by Leyman & Associates in Gold Canyon, and by Noranda Exploration Ltd. on Esmeralda Hill.

In the Helena region, Phelps Dodge and Canyon Resources Corp. announced discovery of an open-pitable gold deposit on the 7-Up Pete property. Phelps Dodge completed extensive drilling, and the companies were doing predevelopment work, including gathering baseline data necessary for permitting. North of 7-Up Pete, Phelps Dodge continued drilling in McDonald Meadows. Pegasus explored at Dreadnaught Hill northwest of Helena, and near Townsend, completed extensive drilling on Diamond Hill, Gold Hill, and the Miller Mountain properties. In search of massive sulfides near White Sulfur Springs, the partnership of Cominco American Resources Ltd. and BHP Utah Inc. drilled on its Sheep Creek Project, and Kennecott Exploration Co. drilled in the area of Geis and Sawmill Creeks.

In the Butte region, Cloverleaf Gold Co. purchased the Maltby's Mound

Project, west of Norris, from Newmont Exploration. The company prepared for permitting by doing reserve studies and an environmental assessment. Goldstream Corp. applied for permits to operate a large gold placer and a lode gold mine along California Creek, east of Sheridan in the Tobacco Root Mountains. The proposed vat leach mill for the lode mine in Beaverhead National Forest would use bromide rather than cyanide to separate gold from ore. Billiton Minerals explored the Green Campbell property and at the Garrison Mine in Alder Gulch, west of Virginia City. Drilling and trenching was done by Highland Gold in the Fish Creek drainage and by Cordex Exploration in Dry Georgia Gulch. West of Argenta, Pacific Gold Mines Inc. conducted an underground bulk sampling program at the Yellowband Mine. Swansea Gold Mines optioned and explored Sandhurst Mining's Ruby Creek Project. International Mahogany and its subsidiary Magellan Resources stepped up exploration plans at its Southern Cross gold property, a joint venture with Chevron Resources.

In the south-central region, Crown Butte Resources Inc. and Noranda Minerals Corp. continued drilling and other exploratory work at their New World Project in the Gallatin National Forest near Cooke City. The companies indicated that initial results were promising and they would begin the permitting process, including development of an environmental impact statement. The gold-silver-copper property contains two open-pitable deposits and an underground reserve. In the Stillwater Complex, Phelps Dodge Mining Co. joined Chrome Corp. of America, a subsidiary of Boulder Gold N.L., in a venture to explore and develop platinum-group metals and/or continue Chrome Corp.'s chrome mining and ferrochrome smelting project. The agreement included a drilling program at the Mountain View and Benbow Mines as well as Crescent Creek. In Park County, Mineral Hill Mining Co. drilled at its Crevasse gold project. The joint venture of Fischer-Watt Gold Co. and Kennecott Exploration explored in the Emigrant Creek drainage area on a property leased from Montana Mining and Reclamation.

LEGISLATION AND GOVERNMENT PROGRAMS

The Montana Department of Natural Resources and Conservation awarded the Montana Bureau of Mines and Geology a State grant of almost $150,000 to study the use of zeolites in the cleanup of polluted water and soil. The object of the study was to determine the use of zeolites in selectively removing metals from water and other fluids, with emphasis on the effectiveness of zeolites in reclaiming tailings ponds and soils.

The Governor of Montana proposed placing all environmental regulation under a single agency. Under the proposal, the Environmental Sciences Division of the State's Health Department and the Reclamation Division of the Department of State Lands would be combined with the Department of Natural Resources to form a Department of Natural Resources and Environment. The proposal, which would lead to "one-stop permitting," was to be considered by the 1991 Montana Legislature.

The Montana College of Mineral Science & Technology, Butte, received an allotment of $196,300 from the U.S. Bureau of Mines in 1990. The school has received a total of $2.97 million since inception of the Mineral Institute Program in 1978.

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Aluminum.—The quantity of aluminum produced in Montana remained virtually unchanged from that of 1989, but the value dropped by almost 16% owing to the continued downturn in prices. Columbia Falls Aluminum Co., the State's sole producer, reportedly operated its Flathead County aluminum reduction plant near the annual rated capacity of 163,000 metric tons.

Antimony.—United States Antimony Corp. produced antimony oxide and sodium antimonate for use in the glass industry at its refinery near Thompson Falls, Sanders County. The company mine and mill are on Prospect Creek, about 15 miles from Thompson Falls; antimony metal and sulfide concentrates were purchased on contract from China.

Copper.—Copper production declined 4% in quantity and almost 10% in value from that of 1989. Production was reported by three companies in two counties; Montana ranked fourth in the Nation in copper output in 1990.

The Continental Pit in Butte, Silver Bow County, was the State's leading copper producer. The operation, a joint venture of Montana Resources Inc. and Asarco, also produced molybdenum and silver. In Lincoln County, Asarco operated its Troy Unit, the second largest copper producer in the State. The 8,500-ton-per-day copper-silver mine used the room-and-pillar mining method to extract ore. In an effort to expand reserves, the company conducted exploration in the Ross Creek drainage area. A small amount of byproduct copper production was reported by New Butte Mining Co. from its Butte Hill property.

Gold.—Gold production in Montana increased by almost 5% in quantity and almost 6% in value over that of 1989; the State ranked fifth in the Nation for gold production. Production included nine lode mines in five counties.

The Zortman-Landusky Mine, owned by Pegasus Gold, was the State's largest gold producer; silver was produced as a byproduct. The seasonal open pit, heap-leach operation is in the Little Rockies, just south of the southern border of the Fort Belknap Indian Reservation, Phillips County. After nearly filling the current pad and receiving necessary permits, the company commenced construction of a new leach pad on the Landusky side. The company drilled and identified additional reserves in the Landusky area, successfully replacing what was mined. Work continued on the company's

Zortman Expansion Project, including completion of a preliminary feasibility study that established reserves of nonoxide and oxide ores.

After posting a $38 million bond with the Montana Department of State Lands, Placer Domes Inc.'s Golden Sunlight Mine near Whitehall, Jefferson County, received a permit for an additional lined tailings pond and pit expansion. The expansion was expected to extend the mine life until the year 2006. Golden Sunlight was the State's second largest gold producer; byproduct silver also was produced.

Pegasus enlarged the leach pad at its Beal Mountain Mine at German Gulch near Anaconda, Silver Bow County. The open pit, heap-leach operation was the State's third ranked gold producer, with silver produced as a byproduct. Reclamation of the mine's waste dump and leach pad dike was completed. The company continued exploration of a second unrelated ore body south of the pit.

After encountering lower-than-expected grades and reserves at its Montana Tunnels polymetallic mine near Helena, Jefferson County, Pegasus adopted a new mining plan to reduce the strip ratio and modified its flotation mill to improve recoveries. The 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. The mine was the State's fourth largest gold producer.

The Mineral Hill Mine, a joint venture of American Copper & Nickel Co., a subsidiary of Inco Ltd., and Homestake Mining Co., completed its first full year of production. The 600-metric-ton-per-day underground mine at Jardine, Park County, was the only mine in the State depositing dry tailings. Processing included vat leaching, followed by Merrill-Crowe zinc precipitation. The mine was the fifth ranked gold producer in the State.

Canyon Resources purchased Addwest Gold Inc. and its 60% share of the C.R. Kendall gold mine near Lewiston, Fergus County. Addwest Gold was a subsidiary of Addington Resources, a Kentucky-based coal mining company. With the acquisition, Canyon Resources became the sole owner of the open pit, heap-leach Kendall property, the State's sixth largest gold producer. To accommodate gold and silver ores from several open pits within an expanded permit boundary, the company completed construction of a new heap-leach pad and nearly doubled its fluids processing capacity.

Pegasus produced gold and silver at the Basin Creek Mine, about 18 miles southwest of Helena, Jefferson County. The company purchased the property, then known as the Paupers Dream Mine, from Pangea Resources Ltd. in 1989. Pegasus built a new 11-million-ton heap-leach pad and was enlarging the mining operation. Unable to resolve problems with lower-than-anticipated ore grades and high operating costs, Pegasus suspended mining at yearend; leaching was expected to continue in 1991.

In the Judith Mountains, Fergus County, Blue Range Mining Co. continued production and development of the Gies gold mine. The company produced from two levels, was developing a third level, and was driving a decline toward a fourth. Ore was crushed on-site and shipped to a flotation mill at the former U.S. Gypsum plant near Heath. The company was adding a cyanide leach circuit to the mill to accommodate ores from other sources in the Giltedge district. New Butte Mining reported gold production from its zinc-silver Butte Hill Mine in Butte, Silver Bow County. Cusac Industries purchased Gulf Titanium Ltd.'s 50% interest in the Cruse-Belmont gold mining project, sited in the Marysville area, Lewis and Clark County. Production was later stopped following poor recovery of gold values from the mill the company was using in Basin.

According to the Montana Bureau of Mines and Geology, placer gold production occurred at several localities. Some of the larger known placer operations were on Quartz Creek and Cedar Creek in the Superior area, Mineral County; on McCormick Creek in the Ninemile drainage, Missoula County; Sauerkraut Creek and Lincoln Creek, Lewis and Clark County; the Fish Creek drainage, Silver Bow County; and Grasshopper Creek, Beaverhead County.

Iron Ore.—Hallet Minerals Co. produced iron ore at its Black Butte Mine near White Sulphur Springs, Meagher County. Production dropped by almost 17% from that of 1989. The product was used in-State in the manufacture of cement.

Lead.—Lead production increased by almost 10% in quantity and by more than 28% in value from that of 1989. Montana ranked fifth nationally in lead production in 1990. Lead was reported as a byproduct from three base and precious metal mines in three counties. The Montana Tunnels Mine, Pegasus Gold's polymetallic operation near Helena, and New Butte Mining Co.'s Butte Hill Mine in Butte were the State's leading lead producers.

Molybdenum.—Molybdenum was recovered as a byproduct of copper production at Montana Resources' Continental Pit in Butte. The Silver Bow County mine was the State's only molybdenum producer. Concentrates were shipped to foreign facilities for processing. The quantity of molybdenum produced dropped by almost 9% and value fell by more than 26% from that of 1989. The State ranked fourth nationally in 1990 for molybdenum production.

Platinum-Group Metals.—Platinum-group metal production rose more than 23% in quantity and more than 5% in value from that of 1989. Stillwater Mining Co. began matte production at its new $6.6 million platinum smelter at Columbus, Stillwater County. The palladium-platinum matte, which also contained copper, gold, nickel, and rhodium, was shipped to Belgium for additional processing. The smelter employed about 20 workers. Concentrate for the smelter was produced at Stillwater's mine and mill, about 40 miles away in the Stillwater Complex near Nye, Sweetgrass

County. The mine, the Nation's sole producer of platinum-group metals, utilized the only tunnel-boring machine in Montana. The company was considering opening a second mine, the East Boulder Project south of Big Timber, which would provide additional concentrates for the Columbus facility. Stillwater Mining is a joint venture of Manville Corp. and Chevron Resources Co., with Chevron the managing partner.

Silver.—Although the quantity of silver production increased by more than 13%, the value of production remained relatively unchanged. The State ranked fourth nationally in silver production in 1990.

Asarco's Troy Unit was the largest silver-producing mine in the State. The 8,500-ton-per-day underground copper-silver mine is in Lincoln County near Libby. The company expanded its efforts to prove up additional reserves. The Montana Tunnels Mine, Pegasus Gold's polymetallic operation near Helena, was the State's second largest silver-producing mine.

The Black Pine Mine, owned by Inspiration Consolidated Copper Co. and operated by Black Pine Mining Co., was sold to Asarco. Asarco purchased the property, northwest of Philipsburg, Granite County, as a source of flux for its East Helena lead smelter.

Montana Reserves Co. was attempting to sell part or all of its 45% interest in the Montanore silver-copper deposit in the Cabinet Mountains near Libby, Lincoln County. The company reportedly was unable to pay its portion of project development costs. Noranda Minerals, owner of the other 55% interest, stated that financial problems would not delay the project and continued to drive an 18,000-foot decline toward the ore body. A draft environmental impact statement was completed and in review. The Montanore reportedly may be the largest silver deposit in the world.

Zinc.—The production of zinc increased by more than 29% in quantity and almost 18% in value from that of 1989. The State ranked sixth nationally in 1990 zinc production. The Montana Tunnels Mine was the State's largest zinc producer.

In Butte, New Butte Mining developed and produced from multiple zinc-lead veins that also contained silver and gold. The ore was trucked for processing to the Contact Mill in Philipsburg. Although the company continued the permitting process for development of a new production shaft and flotation mill, the underground mine did not return to production following a temporary closure due to labor difficulties at Cominco's smelter in Trail, British Columbia.

Industrial Minerals

Barite.—Dillon Exploration Inc., formerly Mountain Minerals Co., had limited barite production from its underground mine in the Elk Creek-Coloma mining district, 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.

Cement.—Montana's cement production increased by almost 17% in quantity and 16% in value from that of 1989. Portland cement was produced by Holman Ideal Inc., formerly Ideal Basics Industries 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. Portland cement produced in the State was used by ready-mixed concrete companies (70%), concrete product manufacturers (13%), other contractors (9%), and miscellaneous customers, building material dealers, and highway contractors (8%). Raw materials consumed in cement manufacture were locally mined clay, gypsum, iron ore, limestone, sand, and silica. Both of the one-kiln, wet-process plants used natural gas and coal for fuel and purchased electricity for energy.

Chlorite.—Cyprus Industrial Minerals Co. produced high-purity chlorite at its Golden Antler open pit mine near Silver Star, Madison County. The chlorite was sold for many of the same industrial applications for which talc was used.

Clays.—Clay production more than doubled and its value almost quadrupled that reported for 1989. The bulk of the production was bentonite; the State ranked third nationally in quantity mined. Two companies in Carter County produced swelling-type bentonite; a small amount of nonswelling bentonite also was produced in Carbon County. 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 gem stone production in 1990 rose almost 48% from that of 1989. The State ranked third in the Nation in natural gem stone production. Several sapphire mines continued both commercial and hobbyist production, with some production targeted for international sales.

Near Skalkaho Pass, west of Philipsburg, Granite County, the Gem Mountain Sapphire Mine operated on the West Fork of Rock Creek. In addition to recreational production and bulk concentrate sales, the company had limited sales of cut stones. Adjacent to Gem Mountain, construction continued on a floating wash plant at the Skalkaho Grazing Association Sapphire Mine.

In Lewis and Clark County, sapphires were produced recreationally at French and Spokane Bar. Eldorado Bar had two operations; one was strictly recreational, 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

Yogo Creek and ran old tailings from theAmerican Mine through its washing plant. Vortex sunk a shaft and was mining a split off the main dike system of a sapphire-bearing breccia south of the American Mine.

Lime.—Lime production remained relatively unchanged in both quantity and value from that of 1989. Continental Lime Inc., a subsidiary of Graymont Inc., initiated an expansion project to double capacity at its Indian Creek quicklime plant near Townsend, Broadwater County. The Great Western Sugar Co. operated a plant in Billings, Yellowstone County, and Holly Sugar Corp. produced quicklime at its plant in Richland County.

Peat.—The quantity and value of Montana peat production in 1990 remained essentially the same as that in 1989. Bulk peat was produced by Martins Peat Inc. at Swan Lake, Flathead County. Packaged peat was produced by Farmer's Plant Aid Corp. near Hamilton, Ravalli County.

Phosphate Rock.—The production of phosphate rock decreased by almost 15% in quantity and more than 46% in value from that of 1989. Cominco American Resources produced phosphate rock at its Warm Springs Creek operation, the last underground phosphate mine in the Nation. Cominco shipped the phosphate by rail to its fertilizer plant at Warfield, British Columbia, Canada. There, the phosphate was mixed with sulfuric acid from the company's zinc smelter at Trail and used to make phosphoric acid and other phosphate-based products.

Rhone-Poulenc Chemical's Silver Bow elemental phosphorous plant, west of Butte, operated at capacity. The plant processed phosphate rock from the company's Wooley Valley 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 on odd-numbered years are based on annual company estimates. This chapter contains actual data for 1988 and 1990 and estimates for 1989.

The quantity of construction sand and gravel produced in 1990 dropped 12% from that estimated in 1989 and 36% from that reported in 1988. The value rose 3% compared with 1989 estimates but decreased by more than 29% from that reported in 1988.

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. In 1990, the major producing counties were Cascade, Flathead, Gallatin, and Yellowstone. Major uses were for road base and coverings, including stabilization (43%), asphaltic concrete aggregates and other bituminous mixtures (25%), and concrete aggregates, including concrete sand (17%). The bulk of construction sand and gravel was transported by truck.

Industrial.—Industrial sand and gravel production decreased in both quantity and value from that of 1989. Rhone-Poulenc Chemical reported silica production from its Maiden Rock Quarry, Beaverhead County. The product was used as flux at the company's Silver Bow elemental phosphorus 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 estimates for 1988 and 1990 and actual data for 1989.

Crushed.—Crushed stone production estimated for 1990 increased almost 41% in quantity and by more than 57% in value from that canvassed in 1989. Some of the larger producing counties included Carbon, Gallatin, Jefferson, and Yellowstone. The bulk of the crushed stone produced was limestone.

Dimension.—Dimension stone production estimated for 1990 dropped both in quantity and value from that canvassed in 1989. The Livingston Marble & Granite Works mined travertine building stone from a quarry north of Gardiner, Park County, and marketed the product from the company 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. The quantity of sulfur produced increased more than 11%, but the value dropped by 7% from that of 1989.

Montana Sulphur & Chemical received approval from the State to build an ammonium thiosulfate unit, a small hydrogen plant, and other changes at its fertilizer plant in Lockwood, outside Billings.

Talc.—Although the quantity of talc production dropped more than 5%, the value increased almost 48% from that of 1989. Three companies produced talc from four mines in Madison County. Montana was the Nation's leading producer of talc.

Cyprus Industrial Minerals produced talc at its Beaverhead and Yellowstone Mines. Production at the Beaverhead underground mine, east of Dillon, included cosmetic talc. At the nearby Treasure Chest Mine, Pfizer Inc. began construction of a $8.6 million fully automated talc beneficiation plant that will utilize wet grinding and flotation technology. The company expected the plant to be in full operation in 1991. Sharing a common high wall with Cyprus's Yellowstone open pit south of Ennis, Montana Talc Co. operated its Johnny Gulch Mine. After Pegasus dropped an option on the property, Montana Talc made some administrative and equipment changes and has continued production ever since. Production from the mine is processed at the company's Sappington plant near Three Forks.

Vermiculite.—After almost 30 years of operation, W. R. Grace & Co. closed its Rainy Creek Mine and processing plant near Libby, Lincoln County. As a result of the closure, Montana's vermiculite production dropped by more than one-half quantity and value from that of 1989.

The mine was closed owing to a decline in demand for vermiculite, which contains asbestiform minerals. Vermiculite is a mineral that expands when heated and is used for insulation and as a soil conditioner. Stansbury Mining Corp. continued with its plans to develop a vermiculite mine near Hamilton, Ravalli County, including preparation of an environmental impact statement.

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[1]State Mineral Officer, U.S. Bureau of Mines, Spokane, WA. He has 16 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.

TABLE 2

MONTANA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	888	$3,355	$3.78
Plaster and gunite sands	2	4	2.00
Concrete products (blocks, bricks, pipe, decorative, etc.)	W	W	2.14
Asphaltic concrete aggregates and other bituminous mixtures	1,262	4,235	3.36
Road base and coverings[1]	2,204	5,150	2.34
Fill	193	291	1.51
Snow and ice control	45	138	3.07
Railroad ballast	(2)	(2)	4.80
Other[3]	200	414	2.07
Unspecified:[4]			
Actual	317	733	2.31
Total[5] or average	5,114	14,319	2.80

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes road and other stabilization (cement).
[2]Less than 1/2 unit.
[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.

TABLE 3

MONTANA: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2	
	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	611	2,535	277	819
Plaster and gunite sands	2	4	—	—
Concrete products (blocks, bricks, etc.)	—	—	W	W
Asphaltic concrete aggregates and other bituminous mixtures	495	2,541	767	1,694
Road base and coverings[1]	888	2,228	1,317	2,922
Fill	121	141	72	150
Snow and ice control	W	W	W	W
Railroad ballast	—	—	(2)	(2)
Other miscellaneous[3]	228	497	19	55
Unspecified:[4]				
Actual	259	622	59	111
Total[5]	2,604	8,567	2,511	5,752

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes road and other stabilization (cement).
[2]Less that 1/2 unit.
[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.

TABLE 4
PRINCIPAL PRODUCERS

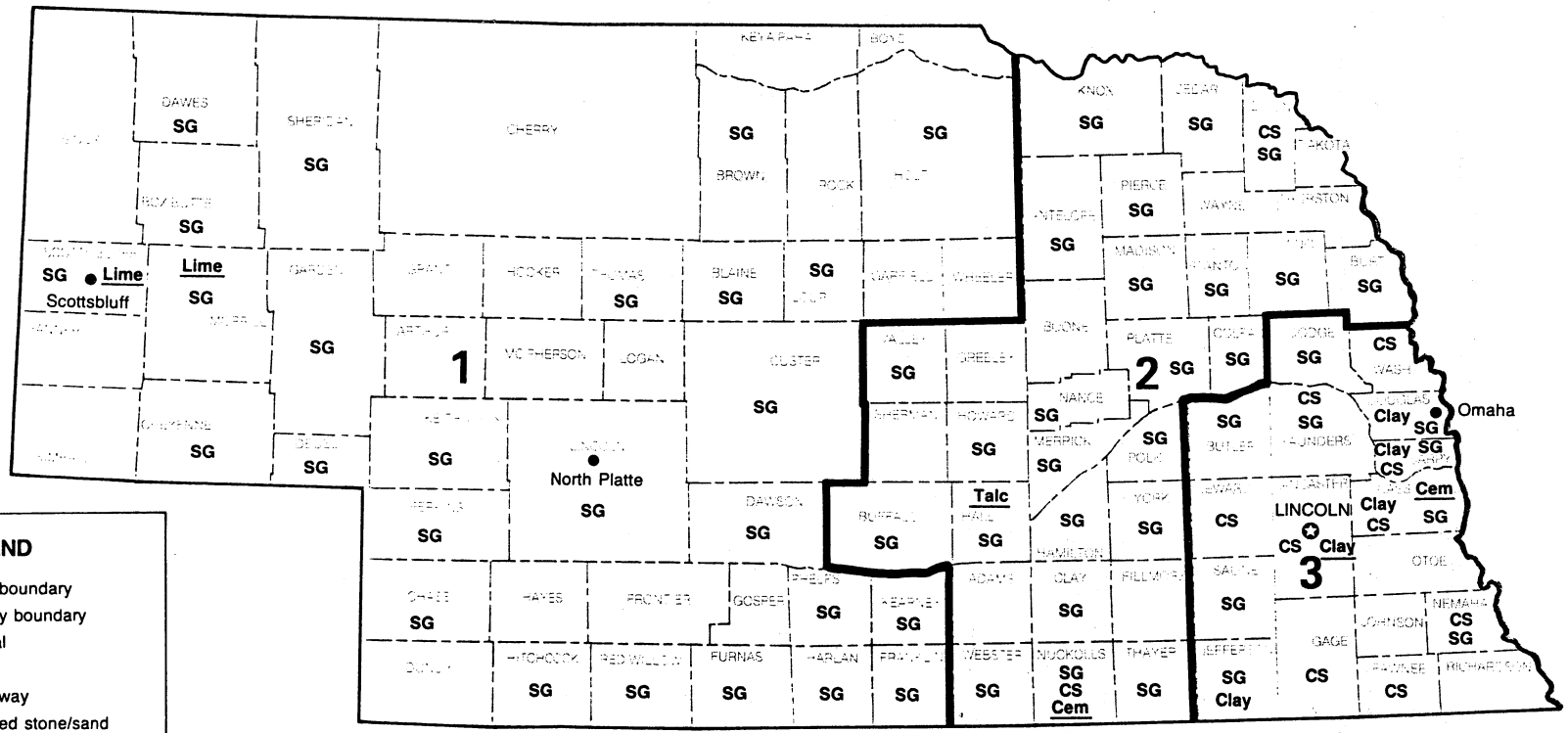
Commodity and company	Address	Type of activity	County
Aluminum:			
Columbia Falls Aluminum Co.	Columbia Falls, MT 59912	Reduction plant	Flathead.
Cement:			
Ash Grove Cement West Inc.	5550 SW Macadam Ave. Suite 300 Portland, OR 97201	Plant and quarry	Jefferson.
Holman Ideal Inc.	Box 8789 Denver, CO 80201	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	Silver Bow.
Gold:			
American Copper & Nickel Co. and Homestake Mining Co.	Box 92 Gardiner, MT 59030	Underground mine and plant	Park.
Pegasus Gold Inc.	North 9 Post Suite 400 Spokane, WA 99201	Surface mines and leach plants	Jefferson, Phillips, and Silver Bow.
Placer Dome Inc.	Box 678 Whitehall, MT 59759	Surface mine and plant	Jefferson.
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	Surface mine and plant	Yellowstone.
Holly Sugar Corp.	Box 1052 Colorado Springs, CO 80901	do.	Richland.
Molybdenum:			
Montana Resources Inc.	600 Shields Ave. Butte, MT 59701	do.	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 Box 365 Nye, MT 59061	do.	Stillwater.
Sand and gravel:			
Construction:			
Empire Sand & Gravel Inc.	Box 1215 Billings, MT 59103	Pits	Yellowstone.
Pioneer Ready-Mix Co.	Box 248 Bozeman, MT 59715	Pit	Gallatin.
Sletten Construction Co.	Box 2467 Great Falls, MT 59403	Pits	Cascade and Toole.
United Materials of Great Falls Inc.	Box 1690 Great Falls, MT 59401	Pit	Cascade.

TABLE 4-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and Gravel—Continued			
Construction—Continued			
Western Materials Div. of United Industrial Inc.	Box 2790 Missoula, MT 59806	Pits	Missoula and Yellowstone.
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	do.	Jefferson.
Sulfur (recovered):			
Montana Sulphur & Chemical Co.	Box 31118 Billings, MT 59107	Plant	Yellowstone.
Talc:			
Cyprus Industrial Minerals Co.	Box 3299 7000 South Yosemite Englewood, CO 80155	Plant, surface, and underground mines	Gallatin, Madison.
Montana Talc Co.	28769 Sappington Rd. Three Forks, MT 59752	Plant and surface mine	Do.
Pfizer Inc.	Box 1147 Dillon, MT 59725	do.	Beaverhead, Madison.
Zinc:			
Pegasus Gold Inc.	North 9 Post Suite 400 Spokane, WA 99201	do.	Jefferson.
New Butte Mining Inc.	Box 188 Butte, MT 59703	Underground mine	Silver Bow.

NEBRASKA



LEGEND

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

MINERAL SYMBOLS

Cem	Cement plant
Clay	Clay
Clay	Clay products
CS	Crushed Stone
Lime	Lime plant
SG	Sand and Gravel
Talc	Talc plant

Principal Mineral-Producing Localities

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 Conservation and Survey Division of the University of Nebraska (Nebraska Geological Survey) for collecting information on all nonfuel minerals.

By Karl Starch[1] and Raymond R. Burchett[2]

The value of nonfuel mineral production in Nebraska fell approximately 13% from 1989's record production level. The $90.3 million of production is about average for the past 9 years and does not indicate a trend in any direction. Of the six industrial minerals produced in Nebraska in 1990, three experienced an increase in value over the preceding year and three a reduction. Three commodities, cement, sand and gravel, and crushed stone, accounted for all but a very small portion of production. Of these, stone production increased very slightly while cement production declined moderately and sand and gravel production declined substantially. No metals were reported mined in Nebraska in 1990.

Nebraska ranked 44th among the 50 states in nonfuel mineral production with just over one-fourth of 1% of the national total.

TRENDS AND DEVELOPMENTS

Nearly all of the decrease in value of nonfuel mineral output can be ascribed to lower production of sand and gravel. Paradoxically, the number of private and public residential units authorized for construction during the year rose almost 12%, to 6,750, while the value of nonresidential construction awards for offices, stores, industrial plants, etc., rose more than 23%, to $357 million. The value of State road contract awards rose more than 16%, to $330 million, which included bridge and highway construction on I-80, I-480, and I-680 in the Omaha area.

Ferret Exploration Co. of Nebraska continued its progress toward operation of an in situ leach uranium mine near Crawford in northwestern Nebraska. The company has operated a pilot mine on 7.7 acres near Crow Butte southeast of Crawford for 5 years. On December 29, 1989, the U.S. Nuclear Regulatory Commission issued the company a license to operate a commercial mine on 3,000 acres. The Nebraska Department of Environmental Control gave its tentative approval to the commercial operation contingent upon the State attorney general's review of a question raised about ownership of Ferret. A Nebraska law prohibits foreign ownership of real estate outside of towns. A citizen watchdog committee concerned with potential water aquifer contamination, Western Nebraska Resources Council, had filed a complaint that Ferret was more than 50% owned by German, Canadian, and Korean interests. In January 1990, the Nebraska attorney general issued an opinion that Ferret had complied with requirements that a majority of its stock be owned by U.S. citizens and that they form a majority of the company's board of directors. In April, the Nebraska Department of Environmental Control issued a commercial mining permit to Ferret. According to the permit, Ferret planned to use an in situ process in which a

TABLE 1
NONFUEL MINERAL PRODUCTION IN NEBRASKA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	215,419	$786	224,624	$880	227,292	$1,685
Gemstones		NA	10	NA	2	NA	7
Sand and gravel (construction)	thousand short tons	11,229	28,928	e15,200	e41,800	11,453	30,056
Stone (crushed)	do.	e4,900	e22,000	3,978	20,050	e4,000	e21,200
Combined value of cement, lime, and sand and gravel (industrial)		XX	39,468	XX	41,085	XX	37,381
Total		XX	91,192	XX	103,817	XX	90,329

eEstimated. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

solution of water, oxygen, and sodium carbonate is injected into wells 400 feet to 800 feet deep. The solution dissolves uranium, which is pumped to the surface through recovery wells and extracted from the recovered solution by ion exchange. The operation was expected to yield about 1 million pounds of uranium yellowcake annually beginning in about April 1991.

The permit is for 20 years and requires review every 5 years and extensive ground water monitoring, restricts activities at the well site, and requires restoration of the aquifer after mining is completed. The Nuclear Regulatory Commission will supervise mining operations. However, before Ferret can actually start mining, it must find a place to store its radioactive waste. The Nuclear Regulatory Commission refused permission to continue to store wastes on the mining site; a Utah waste storage site with which Ferret would like to contract does not have the proper license. The Western Nebraska Resources Council continues to claim Ferret is still foreign owned.

All of the 40,000 pounds of yellowcake recovered to date by the pilot plant was processed into fuel for use by the Nebraska Public Power District. Ferret has drilled more than 3,000 exploratory holes on 210,000 leased acres in several Nebraska panhandle counties.

EMPLOYMENT

Mining employment in the State increased about 11% to almost 1,650 workers, compared with a 3.3% growth in the total labor force in Nebraska. Of these mining workers, about 50 worked in the underground limestone quarries at Weeping Water, 700 worked in surface operations, mostly sand and gravel, and about 240 worked in mills or preparation plants. The balance worked in the oil and gas industry. Average annual pay in mining was about $22,000, which was above the State average annual pay of $18,000, but grew more slowly during the year, approximately 2.3% compared with a 4.6% increase in overall industry average pay, and was considerably less than mining pay in neighboring States.

REGULATORY ISSUES

A plan to establish a low-level radioactive waste facility in Boyd County in northeastern Nebraska continued to draw controversy. In 1987, Nebraska was designated as host State for the facility as a member of the five-State Central Interstate Low-Level Radioactive Waste Compact, which included Arkansas, Kansas, Louisiana, and Oklahoma as well as Nebraska. The compact was formed in response to the 1985 Low-Level Radioactive Waste Policy that requires all States to provide the facilities to dispose of their own low-level radioactive waste by January 1, 1993. U.S. Ecology was selected as the company to develop and operate a facility for the compact States. U.S. Ecology selected a site in Boyd County, 5 miles from the South Dakota border, as the most suitable geologically for the aboveground, reinforced concrete vault system facility that would accept low-level waste such as contaminated gloves and equipment from nuclear power plants and hospitals in the five States of the compact for 30 years. No high-level radioactive waste would be stored in the facility. On July 27, 1990, U.S. Ecology submitted a formal application to the Nebraska Department of Environmental Control for a permit to construct and operate the proposed $60 million to $70 million facility. A $275,000 application fee and 13 volumes, 4,000 pages, of environmental reports and safety analysis accompanied the permit application. The State began what was expected to be a yearlong review of the license application. Submittal of the license application won the Central Interstate Compact an $850,000 award from the U.S. Department of Energy for meeting a 1990 deadline for doing so.

Residents of the State and particularly those in the vicinity of the proposed construction site have differing opinions as to the desirability of the facility in Nebraska. Opposition and support groups have formed. South Dakota's Governor and congressional delegation have expressed their opposition. At midyear, one of Nebraska's Senators who was Governor in 1984 when Nebraska joined the five-State compact, called for a moratorium on construction of the facility. In November, the newly elected Governor of Nebraska stated that he would impose a moratorium on development of the site. A delay in construction of the facility could leave Nebraska and other compact States and all the organizations that would use the facilities in violation of the Federal law requiring that such a facility be in place by January 1, 1993. An act of Congress would be required to change the requirement. State officials are questioning why Nebraska and California appear to be the only sites that have a scheduled completion date for this type of facility.

A University of Nebraska report, "Occurrence of Pesticides and Nitrates in Nebraska's Ground Water, 1990," concluded that nitrate-nitrogen contamination from commercial fertilizers, manure, and other sources was increasing and contaminating large areas of ground water in Nebraska. The report estimated that 755,000 tons of nitrogen fertilizer is applied to Nebraska farmlands annually, in addition to 235,000 tons of nitrogen from cattle and hog manure and 16,500 tons of pesticides. More than 90% of the people in Nebraska rely on ground water for drinking water.

Serious ground water contamination problems were found at three of five solid waste landfills investigated by the State Department of Environmental Control. The five sites were part of 106 landfills out of 290 unlicensed landfills investigated that were felt to have the potential for ground water contamination. The investigation was undertaken under authority of Legislative Bill 639 passed in 1987, which required the department to conduct a comprehensive study of all garbage dumps in Nebraska to determine whether they met State and Federal standards.

Ash Grove Cement Co. studied the feasibility of using part of its quarry along the Platte River near Louisville as

a place to bury trash and garbage. It was questionable whether the local area produces enough refuse to make such an operation profitable. An alternative would be to burn the trash and garbage in Ash Grove's cement kilns along with the hazardous waste already being burned as fuel in the company's kilns.

LEGISLATION AND GOVERNMENT PROGRAMS

No mineral-related legislation was introduced into Nebraska's unicameral legislature in 1990. There were, however, a number of bills introduced relating to low-level radioactive waste disposal. In February, the legislature's Natural Resources Committee heard testimony on seven bills designed to strengthen the State's low-level radioactive waste laws but took no action on them. The focus of this legislative interest was strengthening the role of local monitoring committees, assuring the other compact States would share liability cost with Nebraska, or, in one case, withdrawing Nebraska from the Central Interstate Low-Level Radioactive Waste Compact. At yearend, legislation to hold up licensing of a Nebraska radioactive waste facility pending progress on similar facilities in other States was being proposed for introduction in the next year's legislative session.

The Conservation and Survey Division, Institute of Agriculture and Natural Resources, The University of Nebraska-Lincoln, has issued several dozen Nebraska Geonotes in its series of nontechnical, information booklets on mineral deposits in Nebraska. It also published a series of updated test-hole logbooks on exploration drilling in the State.

FUELS

The number of producing oil wells in Nebraska increased from 1,702 in 1989 to 1,742 in 1990, although production fell from 6.3 million barrels to 5.9 million barrels. The number of natural gas wells decreased from 15 in 1989 to 11 in 1990, and gas production fell from 285 million cubic feet in 1989 to 114 million cubic feet in 1990. Of the 140 oil and gas wells drilled, 75 were for exploration, 63 for development, and 2 for tests.

Petroleum production in Nebraska was mostly located in a dozen southwestern and panhandle counties. Output has been in a slightly declining trend since the mid-1970's because of reduced exploration and depletion of existing wells. Two natural gas processing plants are located in the panhandle in Cheyenne and Kimball Counties. Two underground natural gas storage terminals are associated with these plants. Three underground liquid propane gas storage areas are located in the Lincoln-Omaha area.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Nonfuel mineral production in Nebraska consisted entirely of industrial minerals. In 1990, the Nebraska Geological Survey, Conservation and Survey Division, noted 726 active mining operations in the State, 29 limestone quarries, 667 sand and gravel pits, 8 clay or shale pits, and 22 sandstone pits. These operations disturbed 660 acres during the year but restored 248 acres. The Nebraska Geological Survey estimated that in the 90 years or more that mining has taken place in Nebraska, more than 43,000 acres has been disturbed, of which more than one-half has been reclaimed. Of the estimated 3,600 quarries, pits, and mines that have been active over the years, 84% have been sand and gravel pits and 10% limestone quarries. The remainder included 99 sandstone pits, 30 volcanic ash pits, 11 quartzite pits, 26 clay or shale pits, 14 coal mines, 5 peat pits, 3 flint quarries, and 1 chalk mine.

Cement.—In terms of total value of output, cement was the leading nonfuel mineral produced in Nebraska. The Ash Grove Cement Co. with a single plant near Louisville in Cass County south of Omaha remained Nebraska's sole producer of portland and masonry cement. Although production of portland cement started out strong with deliveries in the first quarter of the year up almost 80%, production for the year was down about 9%. Sales of masonry cement, which were only about 1.5% as large as portland cement, were up almost 10%. Nebraska ranked 28th of the 38 States in which portland cement was produced. Limestone, shale, and gypsum were the chief raw materials used in cement manufacture.

Clays.—Output of clay was little changed from the preceding year. Most of the clay produced was used in the manufacture of common and face bricks at three brick companies, Endicott Clay Products Co. near Endicott in Jefferson County, Yankee Hill Brick Manufacturing Co. near Lincoln in Lancaster County, and Omaha Brick Works near Ralston in Douglas County.

Lime.—Lime was produced by Western Sugar Co. primarily for use in refining sugar from sugar beets. Limekilns at Scottsbluff and Mitchell in Scotts Bluff County in western Nebraska utilized lime from a Wyoming quarry. Output of lime was down about 12% and value of that output was down about 9%.

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 1988 and 1990 and estimates for 1989.

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 and number of companies and people involved.

A total of 108 companies mined sand and gravel at 192 pits located in all but 8 of Nebraska's 93 counties. Output and value of sand and gravel declined

significantly in 1990. The four largest producers, Lyman-Richey Sand and Gravel Corp., Western Sand and Gravel Co., Hartford Sand and Gravel Co., and Central Paving Sand and Gravel Co., produced more than one-third of the total output. All four companies operated in the east-central area of the State with ready access to the State's largest cities, Omaha and Lincoln. More than one-third of the State's total output came from Cass, Douglas, Sarpy, and Saunders Counties in the Omaha area. Nebraska ranked 30th of 50 States producing construction sand and gravel.

About one-third of the material produced was utilized as road stabilization and base material, 16% as concrete aggregate, and lesser amounts in asphaltic concrete, fill, concrete products, plaster/gunite, ice control, railroad ballast, roofing granules, and other uses. Unit values ranged from $1.91 per ton to $4.44 per ton, with an average value of about $2.92 per ton. Most material was transported by truck to the point of use.

The Platte River, which runs the entire east-west length of Nebraska, is a particularly suitable source of both sand and gravel, which washes down to Nebraska from the Rocky Mountains. The easy accessibility and general high quality and abundance of sand and gravel along the Platte River make sand and gravel a viable industry the length of Nebraska wherever sufficient demand is present. An interesting feature across west-central Nebraska where interstate highway I-80 parallels the Platte River is a series of small lakes located at each intersection of the highway. The borrow pits from which sand and gravel was mined to build the intersections have been developed into water recreation and wildlife refuge sites providing a pleasant contrast to the semiarid nature of that part of Nebraska.

Industrial.—The amount of industrial sand produced in the State remained unchanged at a very small level of output.

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 1988 and 1990 and actual data for 1989.

Crushed stone was the third of the industrial minerals that comprised the bulk of Nebraska's nonfuel mineral output and the only one that showed an increase, although small, during the year. Limestone was the principal type of stone produced. There were 17 limestone plants in eastern Nebraska, 5 of them at Weeping Water in Cass County south of Omaha. The quarries at Weeping Water, which touts itself as the Limestone Capital of the World, are somewhat unusual in that they are underground operations. Principal producers of crushed limestone were Fort Calhoun Stone Co., Kerford Limestone Co., and Martin Marietta Aggregates. Cass County south of Omaha and Washington County north of Omaha were leaders in production. Crushed limestone is used for aggregate in concrete, cement manufacture, road base, rip rap, agricultural lime, wallstone, and mineral fillers.

Three firms in Nebraska produced finely ground limestone (calcium carbonate) for feed supplements and fillers for cement, paint, and rubber. Kerford Limestone Co. and Iowa Limestone Co. are west of Weeping Water in Cass County, and Texasgulf is southeast of Weeping Water. Three firms produce agricultural lime exclusively. They are located near the towns of Garland, Seward County; Nelson, Nuckolls County; and Ponca, Dixon County. Most crushed limestone plants in southeast Nebraska produce some agricultural lime. One plant near Weeping Water made patented limestone pellets for agricultural and lawn and garden use.

Although no dimension stone was reported quarried in Nebraska, 10 Nebraska firms cut stone brought in from other States.

Other Industrial Minerals.—Ammonia, ammonium-nitrate, or urea fertilizers were produced by Arcadia Corp. at LaPlatte, Sarpy County; Farmland Industries Inc. at Fremont, Dodge County, and at Hastings, Adams County; and Cominco American Inc. at Beatrice, Gage County. Many small firms around the State cut and polished gems and ornamental stones such as agate, chalcedony, chert, jasper, petrified wood, and quartz. The Zonolite Division of W. R. Grace & Co. was the sole manufacturer of expanded perlite in Nebraska. Zonolite's plant near Omaha, Douglas County, expanded crude perlite brought in from other States and sold the expanded product as filler material, as aggregate for plaster and concrete, and as a horticultural product.

Cyprus Mines Corp., United Sierra Division's plant near Grand Island, Hall County, was the only producer of ground talc in Nebraska. The unground talc is obtained from outside the State. The product is used in paper, ceramics, rubber, paint, insecticides, textiles, and toilet articles. The Construction Products Division of W. R. Grace & Co. exfoliated vermiculite at a plant near Omaha using crude vermiculite from Montana. The exfoliated product was used principally for insulation, concrete aggregate, and fireproofing.

Metals

No metals were mined in Nebraska. ASARCO Incorporated continued to operate a lead refinery in Omaha that was established about 1870. The recently upgraded plant recovers gold, silver, and zinc, as well as lead from the lead bullion brought in from other States and processed at the Omaha plant. Most of the lead produced goes into the manufacture of storage batteries.

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[1]Chief, Branch of State Activities, U.S. Bureau of Mines, Denver, CO. He has 20 years experience with the Bureau of Mines and has covered the mineral activities in Nebraska for 4 years. Assistance in the preparation of the chapter was provided by Pat La Tour and Wanda West, editorial assistants.

[2]Research geologist, Conservation and Survey Division of the University of Nebraska (Nebraska Geological Survey), Lincoln, NE.

TABLE 2

NEBRASKA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	1,869	$5,213	$2.79
Plaster and gunite sands	162	310	1.91
Concrete products (blocks, bricks, pipe, decorative, etc.)	206	469	2.28
Asphaltic concrete aggregates and other bituminous mixtures	755	1,949	2.58
Road base and coverings[1]	3,865	10,078	2.61
Fill	477	919	1.93
Snow and ice control	84	190	2.26
Railroad ballast	3	6	2
Other[2]	115	418	3.64
Unspecified:[3]			
Actual	1,291	3,791	2.94
Estimated	2,626	6,713	2.56
Total or average	11,453	30,056	2.62

[1]Includes road and other stabilization (cement and lime)
[2]Includes roofing granules.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 3

NEBRASKA: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	288	704	744	1,971	837	2,538
Plaster and gunite sands	12	96	26	57	125	158
Concrete products (blocks, bricks, etc.)	W	W	34	49	W	W
Asphaltic concrete aggregates and other bituminous mixtures	425	1,073	162	400	168	476
Road base and coverings[1]	704	1,354	1,279	3,765	1,881	4,959
Fill	30	44	221	449	226	426
Snow and ice control	38	71	33	85	14	35
Railroad ballast	3	6	—	—	—	—
Other miscellaneous[2]	146	343	42	180	99	315
Unspecified:[3]						
Actual	386	1,074	206	570	699	2,146
Estimated	517	1,219	1,051	2,238	1,057	3,256
Total[4]	2,549	5,985	3,797	9,763	5,106	14,308

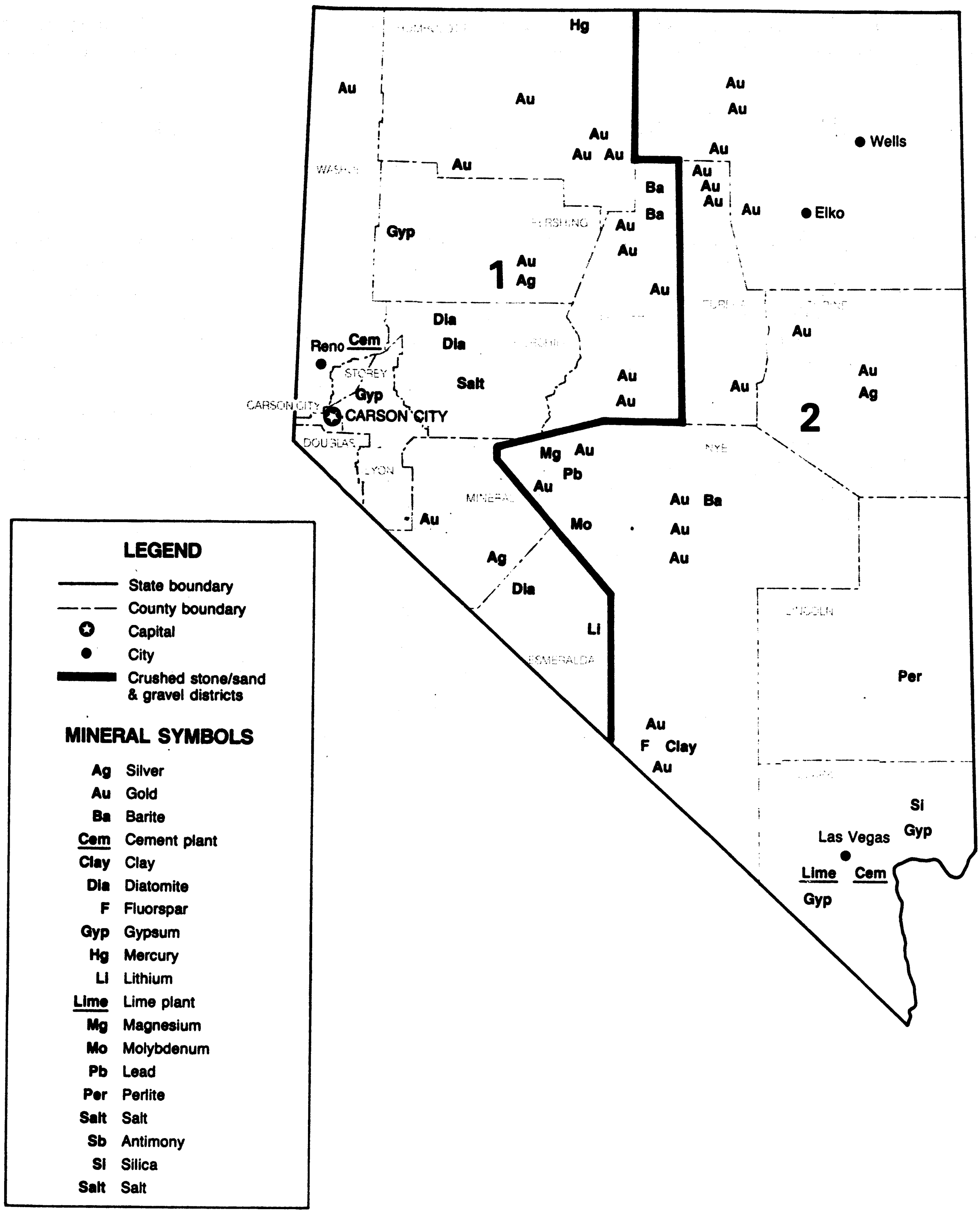
W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules.
[3]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[4]Data may not add to totals shown because of independent rounding.

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.

NEVADA



Principal Mineral-Producing Localities

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] Jonathan G. Price,[2] Stephen B. Castor,[3] and Richard B. Jones,[4]

Nevada's nonfuel mineral production was valued at $2.6 billion in 1990, approximately 13% higher than that of 1989. Nevada ranked third nationally in the value of its nonfuel mineral production, accounting for 7.86% of the U.S. total.

Nevada was the largest producer of barite, gold, mercury, and silver among the States. It was the sole producer of mined magnesite and brucite. Gold mining accounted for 85% of the total nonfuel mineral value produced in the State during 1990 and 61% of the Nation's total gold production. Silver, mostly as a byproduct from gold production, accounted for an additional 5%. Principal non-fuel minerals produced in the State, in order of value, were gold, silver, construction sand and gravel, clay, and barite.

TRENDS AND DEVELOPMENT

Despite drops in exploration and new mine openings, gold production continued to increase, although at a diminishing pace from that of the previous 5 years. For the 11th straight year, the record for annual gold production was broken. However, the 15% increase over that of 1989 was considerably less than the 38% increase from 1988 to 1989. Lower silver and gold prices from the 1989 price of $383 per troy ounce to an average annual price of $380 per troy ounce of

TABLE 1
NONFUEL MINERAL PRODUCTION IN NEVADA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite	thousand metric tons	289	$5,053	209	$3,473	337	$5,884
Clays[2]	metric tons	26,186	2,143	57,264	5,457	34,625	4,098
Gemstones		NA	280	NA	1,402	NA	407
Gold[3]	kilograms	114,322	1,611,020	r153,995	r1,894,172	176,551	2,196,191
Lead[3]	metric tons	W	W	—	—	830	842
Perlite	short tons	5,000	142	5,000	136	W	W
Sand and gravel:							
Construction	thousand short tons	15,729	50,928	e20,000	e70,000	18,387	59,008
Industrial	do.	602	W	718	W	607	W
Silver[3]	metric tons	608	127,760	625	110,442	708	109,653
Zinc[3]	do.	—	—	—	—	7,889	12,973
Stone (crushed)	thousand short tons	e4,1,300	e4,5,700	1,560	4,638	e1,600	e5,000
Combined value of brucite (1989-90), cement (portland), clays [fuller's earth (1990), kaolin], copper, diatomite, fluorspar, gypsum (crude), lime, lithium minerals, magnesite, mercury, molybdenum (1990), salt, stone (crushed dolomite, 1988), and values indicated by symbol W		XX	151,356	XX	r165,181	XX	216,820
Total		XX	1,954,382	XX	2,254,901	XX	2,610,876

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]Recoverable content from ores, etc.
[4]Excludes certain stones; kind and value included with "Combined value" figure.

gold in 1990 and from an average annual price of $5.54 per ounce of silver in 1989 to $5.00 per ounce in 1990 resulted in closures of some marginal precious-metals operations. At the same time, many of the larger northern Nevada gold mines were increasing production. According to the Nevada Department of Minerals, 7 major discoveries, mostly near producing mines, and 10 new deposits were brought into production in 1990. The production increase also led to a record year for gold in terms of value—$2.2 billion.

The McDermitt Mine in Humboldt County, the Nation's major source of prime virgin mercury since 1975, was closed at the end of November because of continuing poor market conditions and depressed mercury prices. Depressed molybdenum prices also closed Nevadas only molybdenum producer near yearend. Cyrus Tonopah Mining Corp. announced closure of its Tonopah (Hall) molybdenum-copper mine in Nye County in December.

EMPLOYMENT

According to the Nevada Employment Security Department, 13,914 workers were employed in the Nevada mining industry in December 1990. Mining employment peaked at 15,012 workers in July 1990 and had an annual average of 14,321 workers. Metal mining employment averaged 12,988 workers during the year. Precious-metals operations employed the largest number of workers, followed by the sand and gravel industry.

REGULATORY ISSUES

The state of Nevada and the U.S. Bureau of Land Management (BLM) agreed on October 1 to new permit-plan approval procedures for exploring and mining on public and mixed public-private lands in Nevada. Under a formal Memorandum of Understanding (MOU), the BLM, the Nevada Division of Environmental Protection (DEP), and the U.S. Forest Service have a joint permitting process. The processing, which is under both Federal regulations and the 1989 State reclamation law and regulations, was designed to avoid duplicative State and Federal review.

BLM also announced implementation of new bonding and cyanide management requirements in Nevada. Coordination with the State regulatory process was begun at a series of workshops conducted with the State regulatory agencies.

EXPLORATION ACTIVITIES

Precious-metals exploration activities in the State declined somewhat as local companies interests shifted to other states, but drilling continued throughout Nevada, centered primarily around known gold mines in the northern part of the State. Exploration drilling in new areas during 1990 was reported from Clark, Elko, Eureka, Humboldt, Lander, Nye, Pershing, and White Pine Counties.

LEGISLATION AND GOVERNMENT PROGRAMS

The Nevada Legislature did not meet in 1990, and all legislation for the year was held in abeyance until 1991. The Nevada Department of Minerals published a new booklet "Mineral Industries in the Nevada Economy" to explain modern mining to the general public. It also prepared, with the Nevada Bureau of Mines and Geology, Special Publication II, "Major Mines of Nevada--1990," second of an annual series of summary reports on major mines of Nevada.

During fiscal 1990, the MacKay School of Mines, University of Nevada, Reno, received allotment grants of $583,204 under the Mining and Minerals Research Institute program (MMRRI). Programs included its Generic Mineral Technology Center; Mineral Industry Waste Treatment; and recovery, pyrometallurgy studies and comminution studies.

Significant achievements were made at the Reno Research Center during 1990 in (1) recovery of platinum group metals from spent automobile catalytic converters, (2) recovery of flake graphite from kish (a steelmaking waste), (3) effective closure methods for metallurgical processing operations, (4) rapid rate reduction and smelting technology, and (5) biohydrometallurgy.

Investigations conducted to improve the small-scale cyanide process for recovering platinum-group metals PGM from spent automobile catalytic convertors resulted in improved extractions of PGM leach solutions. Construction began on a 100-pound-per-batch pilot plant.

Efforts were increased for testing the process to recover flake graphite from kish on a pilot plant scale to determine its commercialization potential. Favorable responses were received from five steel companies and two slag handlers. Preparations were made to provide expertise in graphite product specifications and to test market the pilot plant products.

Researchers conducted laboratory column tests to determine the effects of effluent pH, cyanide, and metal concentrations on the efficient rinsing of spent gold heaps. Thermodynamic and kinetic data that can help to predict the presence of these compounds in mineral processing waste were being compiled into a comprehensive information circular.

Testing of a novel reducing furnace continued using rocket combustion technology to evaluate its performance with respect to temperature, fuel and oxidizer flow rates, and solid feed (iron oxide) flow rate. The new technology offers advantages over other reduction approaches by utilizing finely ground feed materials, thus eliminating the need for pelletizing.

The Bureau continued research on the use of microorganisms in hydrometallurgical applications, including bacterial heap leaching of domestic manganese ores and oxidation of a PGM sulfide concentrate by bacterial preleaching followed by subsequent chemical leaching to recover a high-grade PGM product.

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Copper.—Nevada copper production increased dramatically from 1989 to 1990 despite the drop in secondary copper recovery from molybdenum mining in Nye County, where production ceased during the year. Copper was produced from oxide dumps at the Copper Tek Mine in Lyon County. The Ward Mountain copper and zinc mine shipped to the Alta Gold-Taylor mill in White Pine County, which reached full production in May 1990. Due to depressed metal prices, the mine and mill temporarily closed at yearend. It was announced in December that Magma Copper Co. and Alta Gold Co. had purchased the 12,000-acre Robinson Mining District in White Pine County from Kennecott Corp.

Gold.—Gold operations continued to expand, and Nevada again led the Nation in gold production and value during 1990. The State accounted for 61% of the total amount of gold produced in the United States and about 9% of the world's annual gold production. Nevada mines reported 176,551 kilograms (5,676,239 ounces) of gold produced in 1990, a 15% increase from that of the previous year. Despite a drop in the average selling price from $385 per troy ounce in 1989 to $380 in 1990, the production increase led to a record year in terms of value. The record production, valued at $2.2 billion, increased for the 11th consecutive year.

Lower gold prices led to a drop in exploration activity, although new discoveries, principally near previously known ore bodies, continued to be reported. The Nevada Bureau of Mines and Geology reported 7 major gold discoveries in 1990 and 10 new deposits brought into production. Mine openings were reported in Elko, Humboldt, Lander and White Pine Counties.

Development began at the Elko County Hollister Mine in March of 1990, and the first gold was poured during the fourth quarter of 1990. The mine is a joint venture between Galactic Resources Ltd. and Cornucopia Resources Ltd.

Atlas Gold Mining Inc.'s Gold Bar Mine complex in Eureka County completed installation of a $3.4 million refractory circuit in its mill. The first autoclave at American Barrick Goldstrike Mine was officially commissioned in February and, at yearend was averaging treatment of 1,800 tons per day of ore. Design and engineering work began on the next two autoclaves and a second mill, scheduled for completion in 1992.

The first gold was poured in June at the Adelaide Crown Mine of Gold King Consolidated Inc. in Humboldt. The open pit, heap-leach operation shut down near yearend due to a contract dispute with the mining contractor.

The Humboldt County Pinson Mine began production during the year at its Kramer Hill deposit using the heap-leach facilities at the Preble Mine to process the ore. The Santa Fe Pacific Gold Corp.'s Rabbit Creek Mine began production at the end of the third quarter in 1990 and,by yearend had produced 25,000 ounces of gold. The Elder Creek Mine in Lander County began production at the beginning of 1990. The operation was a joint venture between Alta Gold Co. and Nerco Minerals Co.

Newmont Gold Co., the largest U.S. gold producer, operated along a 38-mile stretch of the Carlin Trend in Eureka County. According to its annual report it recovered 1,676,300 troy ounces of gold from 156,110,000 tons of ore mined and 30,485,000 tons of ore placed on leach pads. During 1990, the treatment of oxide ore was phased out of Mill No. 1, the oldest and highest in operating cost, which was instead dedicated to refractory ore. Mill No. 1's refractory treatment rate was increased from 600 tons per day to 1,000 tons per day. Newmont began testing the use of naturally occurring bacteria to oxidize low-grade refractory material.

American Barrick Resources began operation of its first autoclave at the Goldstrike Mine in February, reaching full design capacity of 1,500 tons per day in March. At yearend it was averaging 1,800 tons per day. Design and engineering work began on the next two autoclaves and a second mill, scheduled for completion in 1992.

Freeport McMoRan Gold Co. operators of the Jerritt Canyon and Big Springs Mines in Elko County, became Independence Mining Co. in March after it was acquired by Minorco S.A. Independence continued operation of the only two oxygen whole ore roasters in the world, both operating above their design capacities of 3,700 dry tons per day for Jerritt Canyon and 1,2300 dry tons per day for Big Springs. Exploratory surface drilling in the Guru Ridge area, southeast of the Ertsberg East ore body at Jerritt Canyon, was completed. The company announced a change in exploration emphasis to assess the overall potential of the area rather than to further delineate known resources into reserves. The Big Springs Mine was selected as a "showcase" mining operation by the U.S. Forest Service on April 17, which recognized the company's efforts to protect the other resources of the Independence Mountains where the mine is located while extracting mineral resources.

Exploration drilling declined considerably in new areas and also continued at a lessor pace than in 1989 throughout the State. Newmont Exploration and Miramar Mining Corp. drilled five anomalies at their Nye County Brunner Project. In Pershing County, Queenstake Resources Ltd. and Amay Gold Exploration Inc. used geochemistry and subsequent drilling to explore its Snowsquall property. Also in Pershing County, Lac Minerals Ltd. continued drilling its Rosebud property. Coral Gold Corp. and Amax Gold Inc. explored the Robertson property in Lander County with deep drilling down to 2,500 feet to test for major, deep gold deposits. Independence Mining Co. explored in Schell Creek Mountains in White Pine County. U.S.M.X. drilled several areas of the Alligator Ridge Trend in White Pine County. FMC Gold Co. earned a 50% interest in the Rossi gold property in Elko County by spending $1 million on

exploration within the 12-square-mile property.

Continued drilling at Independence Mining Co.'s Jerritt Canyon joint venture identified a geologic resource of an estimated 3.2 million tons grading 0.284 ounce per ton about 2,500 feet south of the current Elko County mining area. Homestake Mining Co. reached an agreement with U.S. Gold to enter into a joint exploration venture at its Tonkin Springs gold mine in Eureka County. Newmont Mining Co. announced its exploration budget for the Carlin area in 1990 was $22 million, with exploration concentrated on in-fill drilling of known ore bodies and on finding new, near surface oxide bodies on Newmont properties in the Carlin belt. Chevron Resources explored Elko County claims held by Horizon Gold Shares near the Tuscavova Mine. F.M.C. Gold Co. explored the Rossi Gold property in Eureka County.

Santa Fe Pacific Minerals Corp. defined a significant new gold deposit southeast of Winnemucca in Humboldt County which it designated the Lone Tree Deposit. Exploration at the joint-venture Marigold property in Humboldt County consisting of a $2 million 100-hole drilling project outlined a northwest-trending deposit designated the Stonehouse deposit. Exploration drilling continued below and adjacent to known ore zones at the Getchell Mine and on new targets throughout the property. Geological and geophysical studies were expanded in 1990 at Hycroft Resources and Development Corp.'s Crofoot-Lewis Mine. By the end of the first quarter, exploration drilling indicated gold mineralization in a new zone approximately 4,000 feet east of the current mining operations.

Royal Gold Inc. conducted exploration drilling in Lander County's Crescent Valley near the Gold Acres and Cortez Mines. Queenstake Resources Ltd. continued formal reconnaissance geochemical work at its Snowsquall property with an exploration drilling program and entered into an exploration agreement with Amax Gold Exploration Inc.

In other developments, Tenneco Minerals Fondaway Gold Mine (an open pit, heap-leach operation) was closed in mid-1990 due to a variety of problems. Durvada Resources began processing old dumps in the Keystone Mine area of Clark County. The first gold was poured in June from the heap-leach operation.

Lead.—After several years when only very small amounts of lead products were reported in the State, and none was reported in 1989, production rose dramatically in 1990 to 830 metric tons of lead valued at $842,000. The lead was recovered as a byproduct of copper production from USMX's Ward Mountain operation in White Pine County.

Mercury.—Mercury production at the Nation's sole, primary virgin mercury mine, Placer Dome U.S. Inc.'s McDermitt Mine in Humboldt County, was halted in November because of poor marketing conditions. The mine had announced production of its 300,000th flask of mercury in July, but a decline in the market price, from $335 in 1988 to $200 in November 1990, made operations unprofitable.

A major part of Nevada's 1990 mercury production was derived as byproduct recovery from gold operations in Elko, Eureka, Humboldt, Mineral, Nye, and Washoe Counties.

Silver.—In 1990, Nevada continued to lead the Unite States in not only gold but also silver production. Three mines, NERCO Metals' Candelaria Mine in Mineral County, FMC's Paradise Peak Mine in Nye County, and Coeur-Rochester's Mine in Pershing County, accounted for approximately 72% of total silver production in 1990. Most of the remainder of the production came as a byproduct of gold production.

Other Metals.—Molybdenum production, solely from the Tonopah Mine of Cyprus Mining Corp. in Esmeralda County, was almost 70% lower than that of 1989. Almost 8,000 metric tons of zinc was recovered as a byproduct of copper mining at the USMX Ward Mountain operation in White Pine County, Nevada's only zinc producer.

Industrial Minerals

Barite.—Nevada remained the top 1990 barite producer among the States, with a reported production of 337,000 tons valued at $5,884,000. This 61% increase in production resulted in only a 41% increase in value because about 70% of the barite shipped in 1990 was low-value crude compared with 50% low-value crude in 1989.

Five Nevada barite producers were active in 1990. M.I. Drilling Fluids Co. was the largest producer. Milpark Inc. mined and milled barite at its Argenta operation. Milpark processed barite at its Argenta plant for Baroid Drilling Fluids Inc., which also shipped crude barite from stockpile. Although Baroid did not mine ore in 1990, stripping was performed at its Rossi Mine in Elko County in preparation for mining in 1991. Circle-A construction shipped small amounts from Elko County, while the Standard Magnesium Co. produced paint-grade barite from the P&S Mine in Nye County. Most of the Nevada barite was shipped to the Gulf Coast for use in oil and gas drilling.

A special use permit for barite mining, stockpiling, and shipping was granted to the BSO Co. by the Humboldt County Regional Planning Commission for an operation near Golconda.

Borates.—The American Borate Company continued to produce colemanite from mill tailings at its Amargosa Valley plant in 1990. In late 1990, the American Borate operation was purchased from Owens-Corning Fiberglas Corp. by Newport Minerals Ventures.

Cement.—Portland cement from the Nevada Cement (Centex Corp.) plant at Fernley, Nevada's only cement producer in 1990, was slightly lower than that of the previous year. Construction of the Las Vegas Cement Co. Inc. plant at

Logandale in Clark County was nearly completed at yearend.

Clay.—Clays mined in Nevada were principally bentonite, fuller's earth, and kaolin and were reported by four companies in Esmeralda, Nye, and Washoe Counties. Production at the Amargosa Valley operation of IMV Div. of Floridin Co., Nevada's largest clay producer, increased slightly over that of the previous year. Small amounts of montmorillinite were reported in Pershing and Humboldt Counties by the Nevada Bureau of Mines and Geology for use in ceramic, cosmetic, and laundry products.

Diatomite.—Nevada ranked second after California in production of diatomite during 1990. Five plants in Churchill, Esmeralda, Lyon, Pershing, and Storey Counties reported production. Diatomite from these mines was used primarily in filtration, insulation, and filters. Eagle-Pitcher Mines was the State's largest producer from three locations. (C.R. Minerals and Grefco Inc produced smaller amounts.) Filtration-grade diatomite was produced at the Colada operation in Pershing County, absorbent- and filler-grade diatomite from the Clark Mine in Storey County,and crude diatomite used in the manufacture of calcium silicate from a quarry in Lyon County. Production remained similar to 1989 levels.

Gypsum.—Nevada gypsum production decreased slightly in 1990 from its high in 1989 due to lower demand for construction products. Most of the gypsum produced was used in the manufacture of wallboard at Nevada plants. PABCO Gypsum near Las Vegas was the largest producer in Nevada. Other major Nevada producers in 1990, in order of tons of gypsum used or shipped, were U.S. Gypsum Corp. at Empire in Washoe County, James Hardie Gypsum and Georgia Pacific Corp. near Las Vegas, and Art Wilson Co. in Lyon County near Carson City. Companies with minor 1990 gypsum production were Nevada Gypsum and Mining and White Grow Gypsum Co. both in Clark County.

LimeThree plants reported lime production in Nevada during 1989. Chemstar Inc. was the major producer of quicklime and hydrated lime from two plants in Clark County. Continental Lime Inc. produced quicklime from its Pilot Peak plant in Elko County.

Perlite.—The Wilkin Mining and Trucking Co. shipped both crude and expanded perlite from mines in Lincoln County. "Onion skin" perlite was mined underground at the Delamar Mine and hauled about 35 miles to a popping plant in Caliente. Shipments of crude perlite from the Mackie Mine decreased in 1990.

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 1988 and 1990 and estimates for 1989. Nevada sand and gravel statistics are compiled by geographical districts as depicted in the State map. Tables 2 and 3 present end-use statistics for Nevada's two districts.

Nevada's construction sand and gravel output increased about 17% from 1988's reported production to 18,400,000 short tons in 1990 as the Clark County construction boom continued.

The State's only producer of industrial sand and gravel was Simplot Industries Inc.--Silica Products Div. in Clark County. Major uses were in containers, flat glass, molding and cores, chemicals, and roofing granules. Production of 607,000 short tons was slightly higher than the 602,000 short tons reported in 1988.

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 1988 and 1990, and actual data for 1989.

Nevada's estimated crushed stone production of 1,600,000 short tons was 13% higher than that reported in 1988. Principal producers included Centex Corp.'s Nevada Cement Co. and Dayton Sand and Gravel Inc., both in Lyon County, and Clark County's Chemstar Inc. and Southern Nevada Liteweight Co.

Wollastonite.—Vancouver-listed White Plains Resources Corp. purchased a 25% interest in Sikaman Gold Resources Ltd.'s wollastonite deposit in the Gilbert mining district of Esmeralda County and announced intentions to purchase the remaining 75%. White Plains plans to mine 100,000 to 200,000 tons per year beginning in 1992.

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 Nevada's sole producer of lithium carbonate from its Silver Peak plant in Esmeralda County. The Basic Inc. operation in Nye County was the sole producer of mined magnesite in the United States. Fluorspar sales in 1990 continued to decline by about 50% from those of the previous year. Huck Salt Co. decreased salt production over that of 1989 at its plant near Fallon in Churchill County.

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[1]State Mineral Officer, U. S. Bureau of Mines, Reno, NV. He has 25 years of mineral-related government experience and has covered the mineral activities in Nevada for 9 years. Assistance in the preparation of the chapter was given by Marguerite Roberto, program assistant.

[2]State Geologist, Nevada Bureau of Mines and Geology, Reno, NV.

[3]Geologist, Nevada Bureau of Mines and Geology, Reno, NV.

[4]Geologist, Nevada Bureau of Mines and Geology, Reno, NV.

TABLE 2

NEVADA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	2,726	$12,015	$4.41
Plaster and gunite sands	253	1,350	5.34
Concrete products (blocks, bricks, pipe, decorative, etc.)	85	625	7.35
Asphaltic concrete aggregates and other bituminous mixtures	1,949	6,510	3.34
Road base and coverings[1]	4,814	13,659	2.84
Fill	979	2,090	2.13
Snow and ice control	38	124	3.26
Railroad ballast	8	41	5.13
Other[2]	65	246	3.79
Unspecified:[3]			
Actual	5,897	17,626	2.99
Estimated	1,573	4,732	3.01
Total or average	18,387	[4]59,019	3.21

[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.

TABLE 3

NEVADA SAND & GRAVEL SOLD OR USED BY PRODUCERS IN 1990, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2	
	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	1,160	4,585	1,566	7,430
Plaster and gunite sands	—	—	253	1,350
Concrete products (blocks, bricks, etc.)	—	—	85	625
Asphaltic concrete aggregates and other bituminous mixtures	702	3,021	1,248	3,490
Road base and coveringss[1]	1,075	3,227	3,736	10,428
Fill	770	1,799	209	291
Snow and ice control	31	117	—	—
Railroad ballast	8	41	—	—
Other miscellaneous[2]	64	246	—	—
Unspecified:[3]				
Actual	40	138	5,857	17,489
Estimated	916	2,405	657	2,327
Total	4,766	15,579	13,611	[4]43,429

[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.

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.
Cement:			
Centex Corp., Nevada Cement Co.	Box 895 Fernley, NV 89408	Plant	Lyon.
Clays:			
Industrial Mineral Ventures Inc.	1800 East Sahara Ave. Suite 107 Las Vegas, NV 89104	Surface mine and mill	Nye.
Copper:			
Airmetco Inc.	100 Burch Dr. Yerington, NV 89447		Lyon.
Alta Gold Co.	Box 324 East Ely, NV 89315		White Pine.
Cyprus Minerals Co.	Box 3299 9100 E. Mineral Circle Engelwood, CO 80155		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.
Fluorspar:			
J. Irving Crowell, Jr., & Son	Box 96 Beatty, NV 89003	Underground mine	Nye.
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:			
Genstar Building Products Co.	Box 2580 Irving, TX 75061	Surface mine and plant	Clark.
Pacific Coast Building Products Inc.	Box 45 Newark, CA 94560	do.	Do.
USG Corp	101 South Wacker Dr. Chicago, IL 60606	do.	Pershing.
Lime:			
Chemstar Inc.	901 Mariner's Island Blvd. Suite 425 San Mateo, CA 94404	Surface mine and plant	Clark.

See footnotes at end of table.

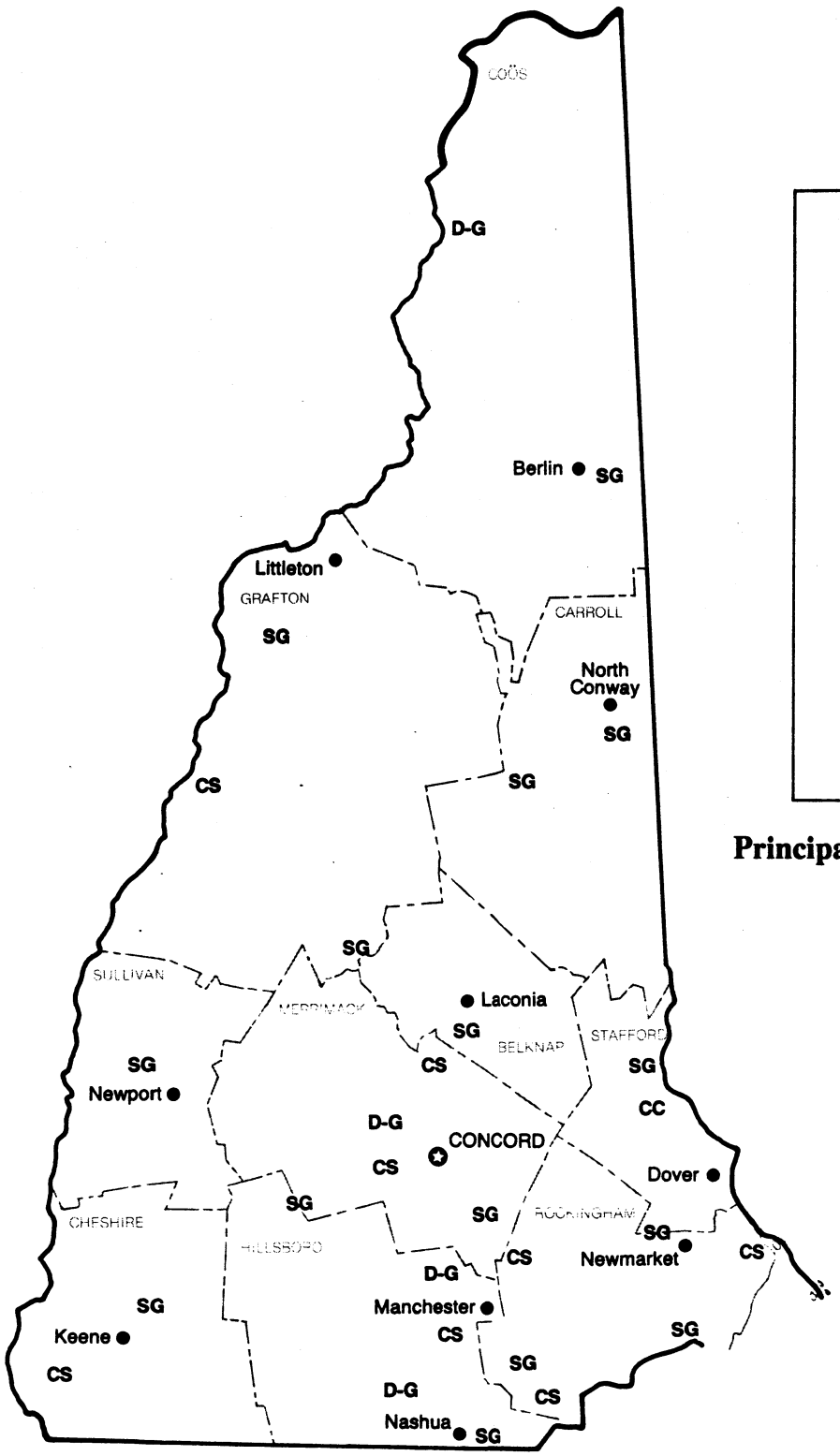
TABLE 4-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Lithium compounds:			
Cyprus Foote Mineral Co.	301 Lindenwood Dr. Suite 301 Malvern, PA 19335-1740	Dry lake brines and plant	Esmeralda.
Magnesite:			
Basic Inc.	845 Hanna Bldg. Cleveland, OH 44115	Surface mine and mill	Nye.
Mercury:			
FMC Corp.	Box 1237 Hawthorne, NV 89415	Surface mine and plant	Do.
Placer Dome U.S. Inc., joint venture	Box 497 McDermitt, NV 89421	do.	Humboldt.
Perlite (expanded):			
USG Corp.	Empire, NV 89405	Plant	Washoe.
Salt:			
Leslie Salt Co., 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.
Beazer USA	5894 Sheep Dr. Carson City, NV 89701	Pits and mill	Carson City, Douglas, Lyon, and Storey.
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.
CSR Corp., ARC Materials 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.
Silver:			
Coeur-Rochester Inc.	Box 1057 Lovelock, NV 89419	Surface mine and plant	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.

[1]Listed in descending order of production.

NEW HAMPSHIRE



LEGEND

- State boundary
- County boundary
- Capital
- City

MINERAL SYMBOLS

CC	Common Clay
CS	Crushed Stone
D-G	Dimension Granite
SG	Sand and Gravel

Principal Mineral-Producing Localities

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 1990 was $35.2 million, an increase of $2 million over that of 1989. Construction sand and gravel and crushed and dimension stone accounted for most of the State's mineral production; common clay and a small amount of gem stones accounted for the remainder. Gypsum imported into the State was calcined at two plants in Rockingham County.

TRENDS AND DEVELOPMENTS

In 1990, the value of total construction contracts, which relied heavily on mineral aggregates, was down 39% from that of 1989. Declines were reported in all building categories. The hardest hit sector was in residential construction contracts, which fell almost 50%, from $397 million in 1989 to $204 million in 1990. These same contracts were down 58% from 1988 values. Decreases were also posted for nonbuilding construction contracts (down 17% from 1989) and nonresidential contracts (down 21% from 1989). As a result of these construction declines, demand for crushed and dimension stone and construction sand and gravel continued to be soft in 1990. Although output of construction sand and gravel was up 32% from the 1989 estimated output, the tonnage produced was 17% lower than the peak years of 1987 and 1988 when 9.1 million short tons was produced in each of those years. In 1990, the estimated output of dimension stone, the State's second leading mineral commodity, was down by 18%. Estimated crushed stone output also declined by 22% from 1989 levels.

The Portsmouth Port Authority unveiled plans for a $25 million to $30 million port expansion in conjunction with a $581 million industrial development at a separate site in the area. An out-of-State developer proposed to finance a three-pier expansion at the port in exchange for setting up a coal slurry pipeline at the location. The pipeline, using coal received at the port, would ship the liquified material to powerplants. The developers also plan to spend $581 million to construct a 400-megawatt powerplant, a small-scale steel mill, and a concrete facility in the area. The Governor and Executive Council must review and approve the plans before construction could begin.[2]

EMPLOYMENT

In 1990, the average number of workers[3] employed in the mineral extractive industries was 465. This included 331 workers in the sand and gravel industry, 115 in the stone industry, and 2 at other nonmetal operations. In addition, 17 workers were employed at mineral-related mills and preparation plants in the State.

LEGISLATION AND GOVERNMENT PROGRAMS

Several bills concerning mineral-related regulatory and tax issues were addressed in the 1990 legislative session. A proposal (House bill 429) to tighten

TABLE 1
NONFUEL MINERAL PRODUCTION IN NEW HAMPSHIRE[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$100	NA	$51	NA	$38
Sand and gravel (construction)	thousand short tons	9,089	32,614	e6,000	e20,400	7,901	26,599
Stone:							
Crushed	do.	e2,400	e9,800	771	4,020	e600	e2,500
Dimension	short tons	e73,393	e10,546	55,305	8,769	e45,073	e6,029
Total[2]		XX	53,060	XX	33,240	XX	35,166

eEstimated. 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.

regulations on quarrying and mining was killed in committee. Bills, carried over from 1989, to establish a construction aggregate severance tax (H.B. 382-FN-A) and to create a solid waste reduction and cleanup program (H.B. 734-FN-A) never got out of committee hearings. These bills may be taken up again in the 1991 legislative session. However, a bill (H.B. 1438) was enacted that sets the year 2000 as a goal for reducing solid waste in the State by 40%.

Several towns in New Hampshire rewrote or were rewriting new regulations for extractive mining operations. The revisions were the result of a new State law (Chapter Law 363) passed in 1989 requiring towns to have more extensive regulations than were required previously. One major change is that the new State law requires all excavations to have reclamation plans. New sand and gravel excavation regulations were written in Bennington and Charlestown; the towns of New Ipswich and Winchester were also rewriting their sand and gravel ordinances.

During the year, the Office of the State Geologist continued cooperative projects with the U.S. Bureau of Mines, U.S. Geological Survey (USGS), and Minerals Management Service (MMS).

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Clays.—Kane-Gonic Brick Corp., the State's only 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. National Gypsum Co. operated a wallboard manufacturing plant at Portsmouth, Rockingham County. Crude gypsum was imported from the company's subsidiary through the Port of Portsmouth. During the year, the company reported the completion of production improvements at the plant costing $17 million. The 5-year modernization project included a new laboratory, mixers, kiln, and bundler.

Domar Inc., a Canadian-based company, operated a gypsum wallboard manufacturing plant along the Piscataqua River in Newington, Rockingham County. Crude gypsum was shipped from a company-owned quarry in Canada.

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 1988 and 1990 and estimates for 1989.

Construction sand and gravel was the State's leading mineral commodity produced and accounted for more than three-quarters of the State's total value. In 1990, output increased 32% from the estimated output of 1989. The average unit value in both 1989 and 1990 was $3.40. A total of 42 companies mined construction sand and gravel from 55 operations at 71 pits in 11 counties. Leading counties, in order of output, were Merrimack, Carroll, Hillsborough, and Strafford. Major uses were for concrete aggregate, asphaltic concrete, and roadbase.

The State Supreme Court upheld a lower court ruling preventing a company from operating a sand and gravel pit in Barrington. In 1986, the company had received permission from the town to mine 3 acres of land. However, in May 1987, an investigation by the town revealed that land outside the 3-acre area was being mined. The defendants received a cease and desist order in July, which, according to the Court, was ignored. Later that summer, Strafford Superior Court ruled that all mining activities cease and fined the company $8,000 and awarded $14,000 to the town for legal fees. The gravel pit operators appealed the decision on the basis that mining began prior to August 1979, and thus, by State law, the operation was grandfathered. However, the State Supreme Court ruled that the activity on the property in 1979 did not constitute a mining operation.

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 1988 and 1990 and actual data for 1989.

Crushed.—Crushed stone was the State's third leading mineral commodity after construction sand and gravel and dimension stone. The estimated crushed stone production of 600,000 short tons was 22% lower than that of 1989.

Traprock, granite, and limestone were produced by eight companies at eight quarries in four counties. Leading counties, in order of output, were Rockingham, Cheshire, Grafton, and Hillsborough. Crushed stone was used mainly for bituminous aggregate, road surfacing, roadbase, and fill.

Dimension.—New Hampshire ranked 10th of 34 States that produced dimension stone in 1990. Dimension granite was mined by four companies at five quarries in Coos, Hillsborough, and Merrimack Counties. Primary uses were for curbing, rough blocks, and monumental stone.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related experience and has covered the mineral activities in New Hampshire for 6 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Foster Daily Democrat (Dover, NH). Port Plan Unveiled. May 4, 1990, p. 6.

[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.

TABLE 2

NEW HAMPSHIRE: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	778	$4,612	$5.93
Plaster and gunite sands	W	W	6.68
Concrete products (blocks, bricks, pipe, decorative, etc.)	42	251	5.98
Asphaltic concrete aggregates and other bituminous mixtures	731	3,693	5.05
Road base and coverings	513	2,129	4.15
Fill	571	1,223	2.14
Snow and ice control	170	444	2.61
Other[1]	67	490	7.31
Unspecified:[2]			
Actual	2,886	9,736	3.38
Estimated	2,143	4,021	1.88
Total or average	7,901	26,599	3.37

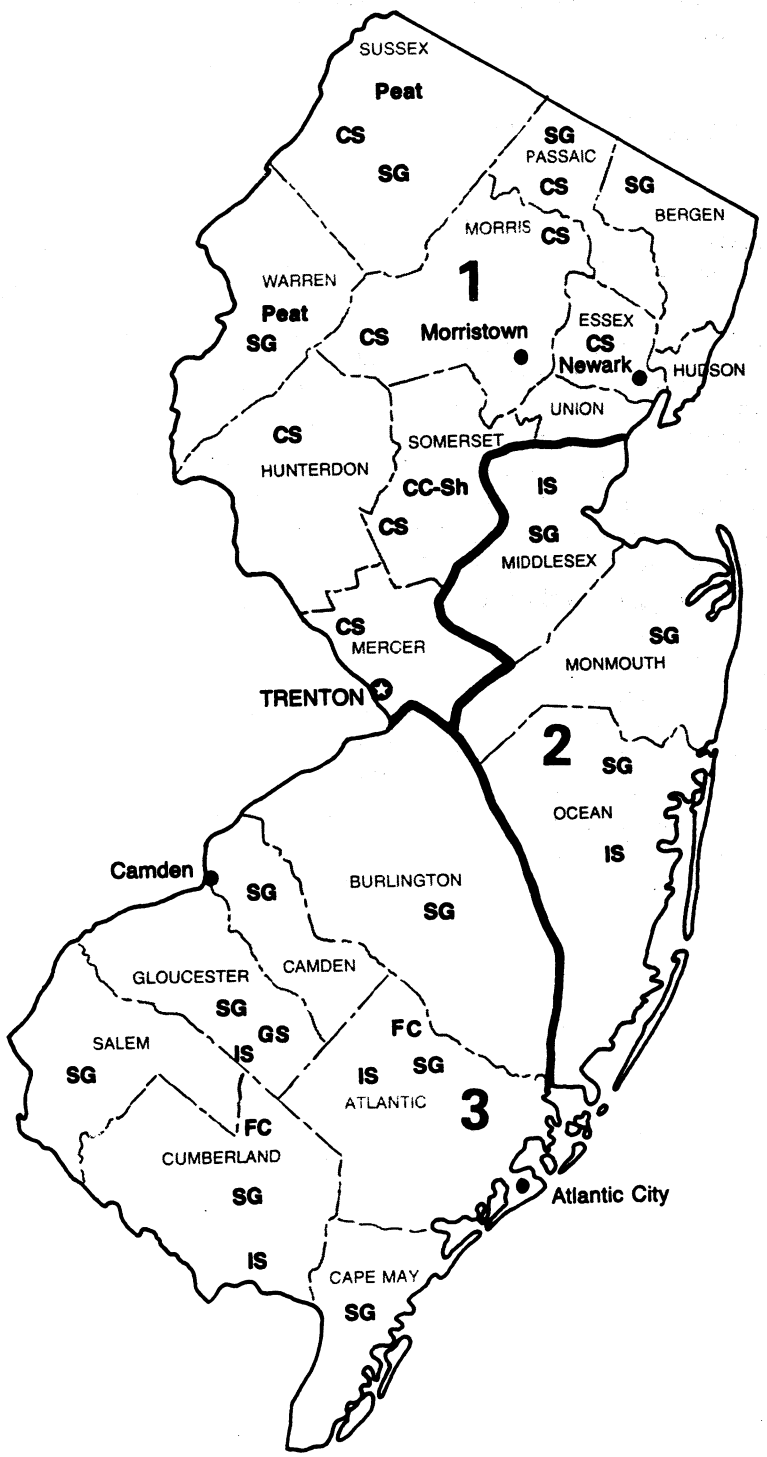
W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes roofing granules and filtration.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.

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 (construction):			
Brox Paving Materials	1471 Methuen St. Dracut, NH 01826	Pits	Hillsborough, Merrimack, Strafford.
Coastal Material Corp.	Box 415, Dunbarton Rd. Manchester, NH 03105	Pits	Hillsborough and Strafford.
Concord Sand & Gravel Inc.	Route 106, Box 1133 Concord, NH 03301	Pit	Merrimack.
Manchester Sand & Gravel	Box 415 Hooksett, NH 03106	Pits	Carroll and Merrimack.
Plourde Sand & Gravel Co. Inc.	21 Union St. Suncook, NH 03275	Pit	Merrimack.
Rosenfeld Concrete Corp.	Box E Milford, MA 01757	Pit	Carroll.
A. Whitcomb Inc.[1]	Lancaster Rd. Gorham, NH 03581	Pits	Belknap, Cheshire, Coos, Grafton.
Stone (1989):			
Crushed:			
Continental Paving Inc.	150 Lowell Rd. Hudson, NH 03051	do.	Do.
John Iafolla Co. Inc.	Peverly Hill Rd. Portsmouth, NH 03801	do.	Rockingham.
Lebanon Crushed Stone Co.	Plainfield Rd. West Lebanon, NH 03784	do.	Grafton.
F. W. Whitcomb Construction Corp.	Box 429 Bellows Falls, VT 05101	do.	Cheshire.
Dimension:			
Leo Belisle Granite Co.	315 Hackett Hill Rd. Hooksett, NH 03106	Pits	Merrimack.
Kitledge Granite Corp.	Armory Rd. Milford, NH 03055	do.	Hillsborough.
Rock of Ages Corp.	Box 482 Barre, VT 05641	do.	Coos.
J. Swenson Granite Co.	North State St. Concord, NH 03301	do.	Merrimack.

[1]Also crushed stone.

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

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 Geological Survey, Division of Water Resources, New Jersey Department of Environmental Protection, for collecting information on all nonfuel minerals.

By Donald K. Harrison[1]

The value of nonfuel mineral production in 1990 was $229.5 million, a decrease of more than $19 million from the 1989 total. The combined value of crushed stone and construction sand and gravel, the State's two leading mineral commodities, accounted for the majority (85%) of the mineral production value. Other commodities mined or recovered included clays, greensand, industrial sand, peat, and zircon. New Jersey was the only State that produced greensand, which was used primarily for water filtration. The State ranked fifth of 38 States that produced industrial sand and fourth of 20 States that reported exfoliated vermiculite production.

TRENDS AND DEVELOPMENTS

New Jersey's economy remained depressed in 1990. Residential, nonresidential, and nonbuilding construction, which relied heavily on mineral aggregates, remained well below the peak building years of 1987 and 1988. At yearend, overall construction contract values were down 26% from the same period a year ago. Values for residential, nonresidential, and nonbuilding permits all decreased. The hardest hit sector was building permits for new housing, which dropped to a 44-year low in 1990. The number of building permits issued were 73% lower than the peak 1986 volume. The value of nonresidential building contracts fell 26% in 1990, and nonbuilding contract values were down almost 12% from that of the previous year. This construction slowdown resulted in a loss of about 30,000 jobs in this sector since 1989. As a result of these construction contract declines, demand for aggregates remained soft. In 1990, the estimated output of crushed stone, the State's leading mineral commodity, remained essentially the same as that of 1989. Output of construction sand and gravel, the second leading mineral commodity, declined 9% during the same period.

In August, the State's first mining museum was opened to the public. The museum is at the former Sterling Hill zinc mine in Ogdensburg. The Sterling Hill Mine, which began production in 1860, closed in 1986 and was the last working metal mine in the State. The

TABLE 1
NONFUEL MINERAL PRODUCTION IN NEW JERSEY[1]

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
Clays[2]	metric tons	14,954	$368	18,492	$400	W	W
Gemstones		NA	3	NA	3	NA	$3
Peat	thousand short tons	43	797	W	638	W	527
Sand and gravel:							
Construction	do.	18,318	74,183	e15,200	e68,400	13,862	64,245
Industrial	do.	1,860	25,437	1,797	26,138	1,762	26,190
Stone (crushed)	do.	[3] e19,300	[3] e123,500	20,799	140,998	e21,200	e131,700
Zircon concentrates	metric tons	W	W	W	8,988	W	W
Combined value of clays (common, fire [1990]), marl (greensand), stone (crushed limestone 1988), and values indicated by symbol W		XX	10,044	XX	3,318	XX	6,805
Total		XX	234,332	XX	248,883	XX	229,470

[e]Estimated. 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; value included with "Combined value" figure.
[3]Excludes certain stones; value included with "Combined value" figure.

new venture, called the Sterling Hill Mining Co., was formed not to mine ore, but to provide to the public a complete display of this world famous mine's activities, equipment, and memorabilia.

EMPLOYMENT

In 1990, the average number of workers[2] employed in the minerals extractive industries in New Jersey was 1,657. This included 1,270 workers at surface operations, primarily for sand and gravel and stone, and 387 working in mills and preparation plants. There was no underground mining in New Jersey in 1990.

REGULATORY ISSUES

The U.S. Environmental Protection Agency (EPA) announced that it would spend more than $250 million under Federal Superfund Authority to remove radium-contaminated soil from around and under as many as 400 houses in Glen Ridge, Montclair, and West Orange. The radium was dumped early in the century by a factory that used the metal to make glow-in-the-dark watch faces. The total area to be treated covers 200 acres in the three towns. Under the plan, more than 324,000 cubic yards of dirt, or enough to fill 15,000 large dump trucks, will be removed. According to the EPA, the contaminated soil will be sent to an out-of-State dump. The project was expected to take 10 years.

Initial efforts were underway in Jersey City to clean up chromium-contaminated sites. The 148 identified sites were believed to have been caused by the use of chromium slag as fill and diking material by former chromate processing firms. The State is expected to seek reimbursement from the companies for any public dollars spent in the cleanup efforts. By yearend, at least two of the companies involved had already pledged $130 million for the cleanup.

LEGISLATION AND GOVERNMENT PROGRAMS

A number of bills involving environmental issues were introduced in the State Legislature. Topics of bills introduced included radon gas exposure, solid waste management, recycling, asbestos abatement, and removal of toxic metals from soils near former metal refineries. At yearend, most of the bills were still in committee study, but may again be reintroduced in the 1991 legislative session.

One of the largest, most ambitious, and most expensive coastal projects was being undertaken along 30 miles of the New Jersey shoreline from Monmouth Beach to Lavalette. In the initial stages of the $250 million project, 90,000 tons of rock and 23 million cubic yards of sand would be used. Seawalls would be built or rebuilt, and the pumped sand from offshore would create a beach at least 100 feet in width. Both dimension stone and crushed stone would be obtained from quarries in New Jersey, as well as other east coast States. The sand would be obtained by dredges and hydraulic pumps that would carry the sand from the ocean floor 1½ miles offshore. The Federal Government is committed to paying 65% of the project. State, county, and local sources will pay the remaining 35%.

The New Jersey Geological Survey (NJGS), part of the Department of Environmental Protection (DEP), continued to be the primary State agency responsible for investigating the State's mineral and ground water resources. During the year, the cooperative geologic mapping (COGEOMAP) program with the U.S. Geological Survey resulted in the completion of the State's 1:24,000 scale, 7.5-minute geologic maps. Surficial geologic maps were also published for the Boonton and Dover quadrangles, and a bedrock map of the Califon quadrangle was also made available.

In the environmental sector, the NJGS continued a Statewide scientific study of radon. As part of the EPA-funded Indoor Radon Grant Project, the DEP was offering training courses to local health officers to carry out high-quality, outdoor gamma surveys when provided with pertinent geologic data. In addition to the training courses, the NJGS was assembling radon-related data, which will be offered to local health officers throughout the State.

The NJGS continued to provide emergency assistance to the Borough of North Arlington, Burlington County, following the collapse of an abandoned copper mine shaft in the township in 1989. Additional shafts still need to be located and defined. The NJGS was evaluating the collected data and continued to meet with local officials, consultants, and U.S. Bureau of Mines officials.

The New Jersey DEP began work on a teachers' guide that will supplement existing earth science curriculums with information and activities specific to New Jersey's geology and resource management issues. The guide was being prepared by the Office of Communications and Public Education, the NJGS, and committees including elementary, secondary, and college teachers; ground water geologists; coastal geologists; and soil scientists. Materials will be directed toward, but not restricted to, Core Course Proficiencies identified by the Department of Education for high school graduation. They will be designed for the 4th through 6th grades and 9th through 10th grade levels at which earth science is commonly taught in New Jersey.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Clays.—Two companies produced clay 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.

Greensand.—New Jersey was the only State that produced greensand. The Inversand Co., a subsidiary of

Hungerford and Terry Inc., hydraulically mined greensand near Clayton, Gloucester County. The greensand was processed and sold mainly as a filtration medium to remove soluble iron and manganese from well water.

Peat.—Three companies mined peat in 1990, two in Sussex County and one in Warren County. Most of the output was used 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 1988 and 1990 and estimates for 1989.

New Jersey 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 three New Jersey districts.

Construction sand and gravel was the State's second leading mineral commodity produced, accounting for 28% of the State's mineral value. Construction sand and gravel was produced by 52 companies at 75 pits in 15 of the State's 21 counties. Leading counties, in order of output, were Ocean, Cumberland, Morris, Cape May, and Sussex. Major uses were for concrete aggregates, asphaltic concrete aggregates, fill, and roadbase and coverings.

In response to citizens' complaints concerning a proposed sand and gravel mining operation in Fairfield Township, the township committee adopted an ordinance that placed a moratorium on new mining applications and permits for 1 year. The moratorium applied to all mineral resource extraction operations not legally in existence in the township as of April 10, 1990. Earlier in the year, Benstar Stone Products Inc., a Maryland-based firm, expressed interest in opening a sand and gravel mining operation on 200 acres the firm owns in the township.

Industrial.—Nationally, New Jersey ranked fifth of 38 States that produced industrial sand in 1990. Seven companies operated 19 pits in six counties and produced 1.8 million short tons valued at $26.2 million. Leading counties, in order of output, were Cumberland, Ocean, Atlantic, Camden, Cape May, and Gloucester. Principal uses for the industrial sand were for glass products, molding and core, and sandblasting.

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 1988 and 1990 and actual data for 1989.

Crushed stone, the State's leading mineral commodity, accounted for almost two-thirds of the State's total mineral value. Estimated crushed stone production totaled 21.2 million short tons valued at $131.7 million. Leading counties, in order of output, were Somerset, Morris, Mercer, and Sussex. Major uses of crushed stone were for concrete aggregate, road base and coverings, and bituminous aggregate.

Zircon.—Two companies recovered zircon in 1990. Heritage Minerals Inc. recovered zircon and lectontite from tailings at the former ASARCO Incorporated ilmenite mine at Lakehurst. Nord Ilmenite Corp., a wholly owned subsidiary of Nord Resources Corp., recovered zircon and other heavy minerals from tailings at Glidden Co.'s former mineral sands operation near Lakewood.

Other Industrial Minerals

In addition to the 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. The calcined gypsum was used primarily to manufacture wallboard.

Crude iodine was shipped into New Jersey by five companies to manufacture various iodine-containing compounds. The compounds were used as laboratory reagents and in sanitation products, pharmaceuticals, and specialty organic and inorganic compounds.

Rowan Industries Inc., Monmouth County, used cultured quartz crystal primarily for electronic purposes.

Crude perlite from out-of-State sources was expanded by The Schundler Co., Edison, and sold primarily for horticultural purposes and cavity fill insulation.

Ronson Metals Corp., Newark, which has produced rare-earth metals for industrial use since 1915, ceased operations in July. The company indicated that it had incurred sizable losses in recent years with the decline of the U.S. steel industry. Ronson produced flints for lighters and also marketed mischmetal to the steel industry. Mischmetal, a natural mixture of the rare-earth metals cerium, lanthanum, and didymium, is used as a metallurgical additive for desulfurizing steel and zinc plating.

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.

Nord Ilmenite Corp., Jackson, recovered ilmenite from a previously mined mineral sands deposit near Lakehurst.

Crude vermiculite was exfoliated at W. R. Grace & Co., Construction Products Div., Trenton, and by Schundler in Edison. Its principal uses included fireproofing, loose-fill insulation, block insulation, and horticultural agents.

Metals

Although there was no metal mining in New Jersey in 1990, a number of companies processed or manufactured metal commodities.

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.

Shieldalloy Corp., a subsidiary of Metallurg Inc., produced ferroalloys at a plant in Newfield, Gloucester County.

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.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related experience and has covered the mineral activities in New Jersey 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.

TABLE 2

NEW JERSEY: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	5,226	$24,687	$4.72
Plaster and gunite sands	377	1,906	5.06
Concrete products (blocks, bricks, pipe, decorative, etc.)	251	1,390	5.54
Asphaltic concrete aggregates and other bituminous mixtures	1,108	5,504	4.97
Road base and coverings	1,017	6,239	6.13
Fill	953	3,752	3.94
Snow and ice control	121	621	5.13
Railroad ballast	62	487	7.85
Other[1]	105	592	5.64
Unspecified:[2]			
Actual	3,188	12,766	4.00
Estimated	1,453	6,301	4.34
Total or average	[3]13,862	64,245	4.63

[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.

TABLE 3

NEW JERSEY: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	1,597	10,119	641	3,059	2,988	11,509
Plaster and gunite sands	68	502	W	W	W	W
Concrete products (blocks, bricks, etc.)	W	W	W	W	W	W
Asphaltic concrete aggregates and other bituminous mixtures	443	2,703	W	W	W	W
Road base and coverings	92	449	298	1,513	626	4,277
Fill	397	2,414	88	295	467	1,043
Snow and ice control	64	357	W	W	W	W
Railroad ballast	—	—	—	—	62	487
Other miscellaneous[1]	86	623	400	1731	902	4,097
Unspecified:[2]						
Actual	145	615	2,668	10,758	375	1,393
Estimated	1,034	5,411	152	457	266	434
Total[3]	3,926	23,193	4,248	17,813	5,687	23,239

Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
cludes filtration.
cludes production reported without a breakdown by end use and estimates for nonrespondents.
ta may not add to totals shown because of independent rounding.

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.
Hyponex Corp.	14111 Scotslawn Rd. Marysville, OH 43041	Bog	Do.
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:			
Clayton Sand Co.	Box 928 Lakewood, NJ 08701	Pit	Ocean.
Continental Somerset	P.O. Box 1475 Blackwood, NJ 08012	Pit and plant	Camden.
Dallenback Sand Co. Inc.	Box 333 Dayton, NJ 08810	Dredge	Middlesex.
Mays Landing Sand & Gravel Co.	Box 539 Vineland, NJ 08360	Pit	Cumberland.
The Morie Co. Inc.	1201 North High St. Millville, NJ 08332	Dredge	Atlantic, Cape May, Cumberland.
Saxon Falls Sand & Gravel	Box 576 Stanhope, NJ 07874	Pit	Morris.
Tuckahoe Sand & Gravel	Box 248 Tuckahoe, NJ 08250	Pit	Cape May.
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.

See footnotes at end of table.

TABLE 4—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Industrial—Continued			
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.
Stone (1989):			
Granite (crushed and broken):			
Mt. Hope Rock Products Inc.	625 Mt. Hope Rd. Wharton, NJ 07885	Quarry	Morris.
Riverdale Quarry Co.	125 Hamburg Turnpike Riverdale, NJ 07457	do.	Do.
Tri-County Asphalt Corp.	Route 15 Hopatcong, NJ 07843	do.	Sussex.
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.
Trap Rock Industries Inc.	Box 419 Kingston, NJ 08528	Quarries	Hunterdon, Mercer, Somerset.
Sulfur (recovered):			
Exxon Co. U.S.A.	Box 23 Linden, NJ 07036	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:			
Heritage Minerals Inc.	Box 468 Route 70, Mile Marker 41 Lakehurst, NJ 08733	do.	Ocean.
Nord Ilmenite Corp.	Box 118 Jackson, NJ 08527	do.	Do.

[1]Also industrial sand.
[2]Also milled zircon.
[3]Also exfoliated vermiculite.

NEW MEXICO

LEGEND

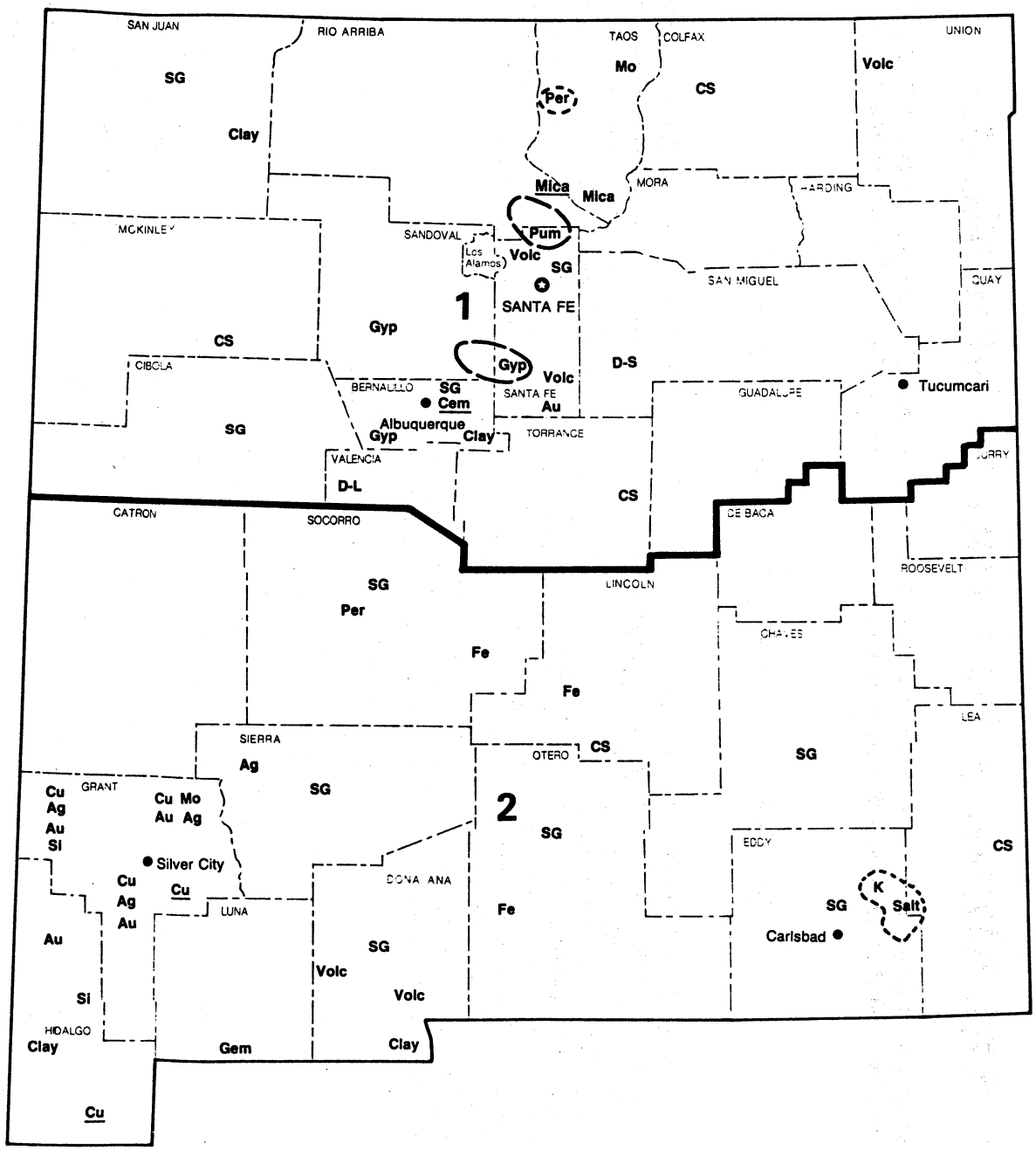
- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Ag	Silver
Au	Gold
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
Cu	Copper
Cu	Copper plant
D-L	Dimension Limestone
D-S	Dimension Sandstone
Fe	Iron
Gem	Gemstones
Gyp	Gypsum
K	Potash
Mica	Mica
Mica	Mica Plant
Mo	Molybdenum
Per	Perlite
Pum	Pumice
Salt	Salt
SG	Sand and Gravel
Si	Silica
Volc	Volcanic cinder

Concentration of mineral operations

Principal Mineral-Producing Localities



THE MINERAL INDUSTRY OF NEW MEXICO

This chapter has been prepared under a Memorandum of Understanding between the 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 Michael N. Greeley[1] and Robert W. Eveleth[2]

New Mexico ranked 10th nationally in the production of nonfuel minerals in 1990. The value of output was slightly under $1.1 billion. Metal production in 1990 accounted for approximately 70% of the mineral value, with copper, gold, molybdenum, and silver as the principal contributors. The mines of the State also produced important quantities of mica, perlite, potash, pumice and zinc.

TRENDS AND DEVELOPMENTS

Although New Mexico was among the top ten mineral producing States in 1990, the total value of its mineral output dropped slightly below that of the previous year. Unit prices of essentially all the metals produced in the State declined substantially. Partially offsetting the low prices, however, was increased output and total sales volume of molybdenum. Among industrial minerals, only gypsum and salt showed significant gains in sales volume. The production value of most other nonmetallic minerals, including construction materials, either fell during 1990 or was similar to that of the preceding year.

TABLE 1
NONFUEL MINERAL PRODUCTION IN NEW MEXICO[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	28,555	$83	31,012	$94	[3]27,994	[3]$74
Copper[2]	do.	258,660	687,182	r259,640	r749,540	262,815	713,622
Gem stones		NA	200	NA	279	NA	225
Gold[2]	kilograms	W	W	1,076	13,231	888	11,041
Perlite	short tons	458,000	14,294	487,000	13,080	501,000	11,049
Potash	thousand metric tons	1,271	213,800	1,365	242,619	1,451	245,571
Pumice	metric tons	76,204	852	77,000	795	W	W
Sand and gravel (construction)	thousand short tons	8,787	31,367	e11,800	e45,400	10,362	39,708
Silver[2]	metric tons	W	W	W	W	48	7,431
Stone:							
Crushed	thousand short tons	e3,500	e13,900	2,784	11,672	e2,400	e12,800
Dimension	short tons	e21,893	e626	W	W	W	W
Combined value of cement, clays (fire, 1990), gypsum (crude), helium (Grade-A), iron ore (includes byproduct material), lead, mica (scrap), molybdenum, salt, zinc (1989-90), and values indicate by symbol W		XX	60,368	XX	r45,593	XX	56,029
Total		XX	1,022,672	XX	1,122,303	XX	1,097,550

eEstimated. 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]Recoverable content of ores, etc.
[3]Excludes certain clays; value included with "Combined value" figure.

EMPLOYMENT

Approximately 6,520 people were employed by the nonfuel minerals industry according to the New Mexico Energy, Minerals and Natural Resources Department (NMEMNRD).[3] The industrial minerals sector employed about 53% of these workers during 1990; the metals sector employed the balance. During the year, the average weekly earnings of a worker in the nonfuel minerals industry was about $611.

REGULATORY ISSUES

Phelps Dodge Corp. and the New Mexico Environmental Improvement Division (EID) reached an agreement over a release of water that occurred during the summer of 1988 at the company's mining operation near Hurley. Unusually heavy rainfall forced Chino Mines Co., a subsidiary of Phelps Dodge, to release stormwater runoff mixed with mine process water into Whitewater Creek. Terms of the agreement required Chino Mines to improve its water storage system at an estimated cost of $2.8 million and to contribute a total of $301,000 to the EID, New Mexico State University, and New Mexico Hazardous Waste Emergency Fund. At yearend, however, the environmental group, New Mexico Citizens for Clean Air and Water, asked the State Water Quality Control Commission to overturn the settlement.

The national director of the Bureau of Land Management (BLM) rescinded the agency's earlier approval of a plan submitted by Molycorp Inc. to construct a new tailings pond on Guadalupe Mountain, northwest of the company's Questa Mine. The State office of the BLM was directed to write a supplement to the project's environmental impact statement because the original statement did not adequately assess alternative tailings sites. Officials estimated the new study will be completed in about 2 years. Molycorp originally proposed the Guadalupe site in 1982.

Molycorp announced its intention to repair the company's entire tailings pipeline from the Questa Mine in Red River Canyon to the tailings disposal area west of the town of Questa. The 27-mile pipeline will be replaced with rubber-lined pipe at an estimated cost of $3 million. Several tailings spills occurred during the year when weak sections of the pipeline ruptured, prompting the Environmental Protection Agency (EPA) to threaten the company with fines.

Despite objections by the local citizenry and members of the scientific community in Socorro, the EPA characterized the town's nearby, abandoned Billing smelter site as hazardous and began remediation procedures shortly after midyear. Approximately $2 million was to be spent by September 30, removing several inches of contaminated soil from the area. Although the EPA asserted that the soil contained anomalous lead, scientists at the New Mexico Institute of Mining and Technology and the New Mexico Bureau of Mines and Mineral Resources contended that the lead, chemically fixed in the alkaline soil, was not bioavailable and therefore not hazardous.

During the year, the EPA completed a remedial investigation and feasibility study of the Cimarron Mining and Milling site near Carrizozo (Lincoln County). The cost of the study, estimated at $800,000, was conducted on the Superfund site because of the perceived threat of cyanide contamination of the ground water. After the study, the EPA announced that it would have the ground water pumped into the Carrizozo sewage treatment system until the cyanide was reduced to acceptable levels. EPA planned to request that the State EID pay for 10% of the $95,000 project. Earlier in the year, another source of potential cyanide contamination was identified by the EPA at the nearby Sierra Blanca mill site.

Other areas in the State that were investigated during 1990 for potential health hazards included a portion of the Pecos River near Terrero (San Miguel County) and active mill sites near Socorro (Socorro County) and Velarde (Rio Arriba County). The Pecos River and nearby campgrounds were reported to have received heavy-metal contamination from an abandoned mine site at Terrero. Wind-borne dust was cited as an environmental problem at the Grefeco perlite plant near Socorro and the Mineral Industries Corporation of America mica mill in Velarde.

EXPLORATION ACTIVITIES

The level of exploration effort for nonfuel minerals was relatively low in New Mexico. According to the BLM, the State ranked eighth in the Nation for the number of unpatented claims considered active in 1990.

In addition to general, ongoing interest in the precious-metals potential of southwestern New Mexico, gold exploration continued to be fairly active in the Ortiz Mountains of Santa Fe County and the Sierra Blanca Mountains of Lincoln County. Efforts to explore and develop mineral properties in Santa Fe County, however, became increasingly difficult as the Santa Fe County Commission assumed a greater regulatory role in mineral development. The joint exploration and development of the Ortiz property by LAC Minerals Ltd. and Pegasus Gold Inc. was effectively placed on standby at midyear because of commission rulings. Delays imposed by the commission with regard to an application by Placer Dome Inc. to explore another property in the County forced the company to eventually abandon the project.

Molycorp Inc. continued to evaluate its yttrium-zirconium deposit near Pajarito Mountain on the Mescalero Apache Indian Reservation in Otero County. Extensive metallurgical testing of the mineralization was conducted during the year. Objections to the entire mineral project were raised by some members of the tribe.

Some exploration activity occurred in the industrial mineral sector. Among several commodities receiving interest during the year was sulfur, which was explored for fairly intensively in the Permian Basin of the Carlsbad area.

LEGISLATION AND GOVERNMENT PROGRAMS

In July, the Santa Fe County Commission unanimously passed a moratorium on the acceptance of new applications for permits to explore and extract minerals on private lands. The 6-month moratorium was to be in effect from August 13, 1990, to February 9, 1991. During the interim, the commission was to draft a new set of regulations governing mineral development in the county. Approval of the new regulations was scheduled for January 1991. Actions by the commission were initially taken in response to complaints by a citizens' coalition that current regulations controlling the local minerals industry were inadequate.

Most legislation introduced by the 1990 State legislature affecting the minerals industry was generally favorable. Two tax bills (HB-428 and SB-208) beneficial to mining interests were passed and signed by the Governor. Mine wastes were specifically excluded from the comprehensive solid waste management program enacted in Senate bill 2 by the legislature. At the urging of the mining industry, State funds that were to be cut from the New Mexico Transportation Authority were restored.

The U.S. congress passed legislation that protects a stretch of the East Fork of the Jemez River in Sandoval County from mining within an area of 1/4 mile on either side of its banks. The legislation designates the river as part of the National Wild and Scenic Rivers System. Although the right to locate minerals in the 11-mile strip of land will be withdrawn and mining will be prohibited, the Copar Pumice Co. will be allowed to mine on its property near the river because the company had valid claims prior to the legislation. Additionally, in a move to prevent Copar from obtaining patent on its 1,700-acre parcel of mining claims, congressional hearings were held to consider legislation to create a National Recreational Area that would encompass the pumice property. Opponents, however, argued that this proposed legislation will have no effect on Copar's patent application because it has already been filed with the proper authorities.

A report summarizing the impact of government policies on extractive industries in the State was issued by the Mining and Minerals Division of the NMEMNRD and the Institute for Public Policy of the University of New Mexico. In September, a conference of panelists convened to discuss the report and make recommendations in the principal areas of concern including community assistance, education, marketing, regulation, and taxation. Toward yearend, these recommendations were submitted to the State legislature.

As part of its ongoing function, the Mining and Minerals Division published the "Annual Resources Report" for 1989. This report contains tables and discussions of statistics on the extractive resources of New Mexico. Also issued in 1990 was a directory of "Mines and Mills in New Mexico."

During the year, the U.S. Bureau of Mines continued to investigate mineral deposits near the margin of the Great Plains in New Mexico. The study was conducted in conjunction with the NMBMMR and the U.S. Geological Survey. A report on rare-earth mineralization in the Laughlin Peak area (Colfax County) was completed toward yearend. Two other studies, begun in 1990 by the Bureau of Mines, were a mineral appraisal of the 14.5 million-acre Roswell Resource Area in southeastern New Mexico and the mineral resource evaluation of a 100,000-acre addition to the Carson National Forest in the northern part of the State.

The Bureau continued to supervise the administration of the New Mexico Mining and Mineral Resources Research Institute (MMRRI) during 1990. The Institute was housed at the New Mexico Institute of Mining and Technology and was administered by a faculty member of the Department of Materials and Metallurgical Engineering. Total funds allocated by the Bureau to the MMRRI was $145,000.

FUELS

The fuel minerals industry was a major economic factor in New Mexico during 1990. Coal, oil and gas, and uranium were produced in the State.

Net production of coal during the year exceeded 24 million short tons, a record high valued at $583 million which was almost 10% over that of 1989.[4] Most of the coal was mined in the San Juan Basin of McKinley and San Juan Counties and the Raton Basin of Colfax County. Five companies operated seven surface mines and one underground mine, employing 1,783 workers.

The State ranked 7th nationally in oil production and 4th in natural gas during 1990. Although oil output declined slightly from that of the previous year to about 68.8 million barrels, the total value increased almost 24% to more than $1.5 billion. Natural gas production rose 12% compared with that of 1989 to 899.2 billion cubic feet; the total value in 1990 was almost $1.6 billion.

About 7% of the Nation's domestically produced uranium was mined in New Mexico. Eleven separate operations recovered approximately 612,000 pounds of uranium from milled ore and uranium-bearing mine waters during the year. The total value was estimated to be $5.4 million. The low output, which was the lowest on record, was due to the January closure of the Mount Taylor Mine (Cibola County) by Chevron Resources Co. and cessation of all uranium recovery operations in the State by Homestake Mining Co.

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Copper.—New Mexico mines collectively ranked second in the Nation for their output of copper in 1990. Production remained relatively constant during the year, showing a slight increase over that of the previous year. This output accounted for nearly 17% of the total domestic production. The Tyrone

and Chino Mines in Grant County were, respectively, the third and fifth leading primary copper producers in the country.

The producer copper price dropped from a 1989 average of $1.31 per pound to $1.23 in 1990. The drop in price was moderate because supply and demand for copper remained fairly balanced during the year. Total value of copper produced in the State declined about 5% from that of 1989. This value, approximately $714 million, represented 65% of the value of all nonfuel mineral production in the State.

The Tyrone Mine maintained its position as the largest producer of copper in the State during the year. According to the 1990 annual report of the mine owner, Phelps Dodge Corp., 144,500 metric tons (159,300 short tons) of recoverable copper was produced at the property. Approximately 35% was electrowon copper, produced by the company's wholly owned subsidiary Burro Chief Copper Co. This division, operating the expanded solvent extraction-electrowinning (SX-EW) facility, increased its production 48% over that of the previous year.

The impending closure of the Tyrone Mine prompted an appraisal of the economic impact by Western New Mexico University. A report issued by the school estimated that closure of the mine would decrease revenues to the Silver City area by about $21 million per year.

Late in the year, Tyrone workers filed a petition with the National Labor Relations Board to decertify the unions at the mine.

At the Chino Mine, the Phelps Dodge 1990 annual report stated that 132,800 metric tons (146,400 short tons) of recoverable copper was produced. The SX-EW plant at the mine contributed almost 33% of the total copper output. A partner, the MC Minerals Corp. (Mitsubishi), received one-third of the total copper and byproduct production from the mine at Santa Rita and the smelter at Hurley.

A new 3-year contract, effective July 1, was approved by union members at the Chino Mine. The contract provided wage increases and an improved medical plan.

The underground Pinos Altos Mine in Grant County, operated by the Cyprus Minerals Co., produced approximately 1,100 metric tons (1,200 short tons) of copper according to the company's form 10-K for 1990.

Small amounts of copper were also produced at the Center Mine (Grant County) and the Midnight Mine (Sierra County). According to Goldfield Corporation's 1990 annual report, its subsidiary, the St. Cloud Mining Co., produced about 274 metric tons (302 short tons) of copper contained in concentrates from the Midnight operation and sold them to a smelter.

An additional 9 metric tons (10 short tons) of copper was reported by Goldfield as a byproduct of siliceous fluxing ore. This ore was produced from mines in the Lordsburg Mining District of Hidalgo County.

Several copper deposits in the State were examined and pronouncements made in 1990 concerning their possible development. Cyprus continued assessing the Continental property in Grant County and reviewed the potential for a joint venture agreement with the mine owner, Sharon Steel. Technical Mineral Services announced plans to mine a copper oxide deposit in the Deadman Canyon area adjacent to the Tyrone Mine in Grant County. This is the same property operated briefly by U.S. Natural Resources in the 1960's. Technical Mineral Services planned to heap leach the ore and recover copper in an SX-EW plant. The Copper Flat deposit in Sierra County was purchased during the year from Rio Gold Mining Ltd. by the Gold Express Corp. Gold Express reportedly paid approximately $670,000 cash and 2.4 million shares to Rio Gold.[5] The property, operated briefly in 1982 by Quintana Minerals, reportedly contains 53 million short tons of open pit ore at an average grade of 0.45 percent copper. The ore deposit also contains gold, molybdenum, and silver.

Gold.—There was a 17% decrease in gold output during the year compared with that of 1989. The total value dropped about the same percentage owing to a decrease in the average price.

The largest amount of gold produced in New Mexico originated as a byproduct of copper ores and metal-bearing silica flux materials. The Chino and Tyrone copper mines were significant contributors to total production. A minor amount was recovered from Pinos Altos ore. Additional gold was recovered from direct smelting ore shipped from underground mines in Grant County by the Mount Royal Mining and Exploration Co. and Royal Minerals Inc. Mount Royal operated the Center Mine throughout the year and Royal Minerals operated the Carlisle Mine until about midyear.

Ore concentrates recovered from the Midnight Mine produced about 11.2 kilograms (kg), or 360 troy ounces, of gold according to Goldfield's 1990 form 10-K; the company's Lordsburg-area mines produced about 17.5 kg (563 troy ounces) from siliceous smelter flux.

Molybdenum.—The combined total output of molybdenum at the Chino Mine (Grant County) and the Questa Mine (Taos County) more than doubled in 1990 compared with that of the previous year. The total value increased almost 87%.

Most of the increased production was due to the 200% jump in output at Questa. The underground mine was operated by Molycorp Inc. for a full year since resuming production in late 1989. According to the 1990 annual report of its parent company, Unocal Corp., Molycorp produced about 4,700 metric tons (10.3 million pounds) of molybdenum during the year.

Silver.—The State maintained its position as the seventh largest producer of silver in the country during 1990. Output of the precious metal fell by more than one-third during the year, however, and the total value dropped significantly as silver prices continued their downward trend.

Most of the silver produced in New Mexico was a byproduct of primary base metal ores. Silver recovered from copper

concentrates at the Tyrone Mine, for example, qualified that property as the 18th largest silver-producing mine in the United States during 1990. Substantial amounts of silver were also produced at the Chino and Pinos Altos Mines.

Other mine sources of silver in the State included direct shipping ores from the Carlisle and Center Mines and ores produced at the Midnight and Lordsburg area mines by Goldfield's subsidiaries. In its 1990 form 10-K, Goldfield reported that concentrates recovered during 1989 and 1990 from Midnight ore yielded, after smelter deductions, 16.7 metric tons (536,779 troy ounces) of silver. Also after smelter deductions, siliceous smelter flux produced from the Lordsburg area was credited with 343 kg (11,027 troy ounces) of silver.

Zinc.—Production of zinc rose more than 11% in 1990 over that of the previous year. The total value of output was virtually unchanged, however, because of the offsetting effect of declining zinc prices.

The largest producer of zinc in the State was Cyprus' Pinos Altos Mine. Approximately 3,700 metric tons (8.2 million pounds) of zinc was recovered from the mine according to the company's form 10-K. Targeted production of 15 million pounds for the year was not achieved because of development and startup difficulties.

Pinos Altos ore was hauled by truck to the Groundhog concentrator in Deming. The concentrator, which had not operated since 1978, was leased from ASARCO Incorporated. Cyprus spent a little over $1 million to refurbish the concentrator and construct a new tailings pond. Routine operations at the Deming facility began in mid-January at a rated capacity of about 450 short tons of zinc-copper ore per day. Zinc concentrates were processed by the Zinc Corp. of America in Bartlesville, OK, and copper concentrates were treated at Asarco's smelter in El Paso, TX.

Zinc was also produced during the last third of the year by St. Cloud at the Hanover open pit mine in Grant County. The ore was mined at the rate of about 400 short tons per day and taken by truck to the company mill at Winston. Goldfield's form 10-K stated that, after smelter deductions, the concentrates yielded about 580 metric tons (1.3 million pounds) of zinc. Mining ceased in December because of low zinc prices.

Other Metals.—The Sharon Steel Corp. continued to ship a small amount of magnetite stockpiled at its Continental Mine in Grant County. The iron ore was originally recovered as a byproduct of copper production. Some of the magnetite was purchased by a potash refinery in southeastern New Mexico to prepare a heavy-media fluid that was used to separate various saline minerals.

The Center Mine at Steeplerock produced lead as a byproduct during 1990.

Industrial Minerals

Cement.—As construction activity and cement consumption remained low in New Mexico, the production of cement continued to trend downward in 1990. Output in the State has declined steadily since 1984.

The production of masonry cement was off 20% from that of 1989 while portland cement was down about 4%. Although the average value of portland cement remained relatively constant, the value of masonry cement fell more than 40% from that of the previous year.

During the year, Ideal Basic Industries Inc., owner of a cement plant at Tijeras in Bernalillo County, was merged into Holnam Inc. Holnam, the largest producer of cement in the United States, is an indirect subsidiary of "Holderbank" Financiere Glaris Ltd. of Switzerland. The company's facility in New Mexico has an annual capacity of 505,000 short tons. According to Holnam's 1990 annual report, the dry-process plant operated at 50% of capacity.

Gypsum.—Production of crude gypsum in 1990 increased over 60% more than that of the previous year, reversing a declining trend begun in 1986. Output value also rose a comparable amount as average prices remained constant. The State ranked 10th in domestic production of crude gypsum. Calcined gypsum production and value also increased about 60% over that of 1989.

A new $33 million gypsum wallboard manufacturing facility in Bernalillo (Sandoval County) was completed during the year by Centex American Gypsum Co. Upon completion, the original plant in Albuquerque was shut down. The new plant more than doubled total productive capacity, but throughout the year it experienced difficulty in reaching full efficiency and output levels.

Mica.—New Mexico is one of just two western states that reported mica production in 1990. Muscovite and sericite ores were produced at the MICA Mine in Taos County and beneficiated at a mill in Velarde in Rio Arriba County. Although the average price fell 5% below that of the previous year, an increase in total output of about 12% raised the total value of production for 1990.

At midyear, the mine and mill were purchased by Franklin Industries from Mineral Industrial Commodities of America Inc. Plans were announced by the new owner to expand the mica plant at Velarde.

Perlite.—Mining more than 80% of the domestically produced perlite in 1990, New Mexico producers continued to dominate the industry in the United States. An increase in perlite sales of about 3% over that of 1989 was registered during the year while production was derived from four mines. Grefco Inc., the largest producer of perlite in the Nation, operated mines in Socorro and Taos Counties; two other producers operated perlite mines in Cibola and Taos Counties.

Sales volume rose for the seventh consecutive year, but the average value of the ore declined almost 18% to $22.05 per short ton. All crude perlite produced was shipped out of State for expanding.

Potash.—New Mexico's mines contributed nearly 85% of the Nation's potash production in 1990. The value of potash sales, $242.6 million, represented more than 22% of the total nonfuel mineral production in the State. The average potash value during the year dropped about 5% compared with that of 1989 to approximately $169 per metric ton. More than $4 million in revenues were generated for New Mexico by potash leasing on State and Federal lands during the State's 1989-90 fiscal year.[6]

The Permian Basin potash deposit in southeast New Mexico supported six mining and processing operations. The operating properties were composed of underground mines and ancillary surface facilities near Carlsbad in Eddy County. With more than 1,900 workers, the Carlsbad area potash industry employed about 30% of the State's nonfuel mineral work force in 1990.

To further lower potash costs and keep local producers competitive, the governments of Lea and Eddy Counties explored the feasibility of forming a Transportation Development District. It was thought that the District could enable potash producers to lower freight rates to eastern markets by tying new rail lines into closer, established rail routes. Discussions were held during the year with the State Transportation Authority.

According to the form 10-K of AMAX Inc., its subsidiary, AMAX Potash Corp., produced about 408,000 metric tons (449,800 short tons) of potash in 1990. AMAX continued efforts to sell its potash operations during the year.

IMC Fertilizer Group, Inc. produced a record 960,700 metric tons (1,059,000 short tons) of potash from its mine in New Mexico during the fiscal year ended June 30, 1990, according to the company's form 10-K. IMC Fertilizer reported that the New Mexico operation was the largest domestic producer of double sulfate of potash magnesia (langbeinite) and the largest producer of sulfate of potash.

Mississippi Chemical Corp., according to its form 10-K, produced 262,600 metric tons (289,458 short tons) of potash at its Carlsbad facility during the fiscal year ended June 30, 1990. During the previous fiscal year, when production was resumed, the company produced 177,400 metric tons (195,551 short tons). Total estimated production capacity was reported to be 300,000 short tons of granular muriate of potash per year and 100,000 short tons of standard muriate of potash.

In the 1990 annual report of Rayrock Yellowknife Resources Inc., the parent company of Western Ag-Minerals Co., potash output by Western for the year was said to be about 288,500 metric tons (318,000 short tons). This quantity represented a 4% drop from the previous year's production of 300,300 metric tons (331,000 short tons). During the year, Western Ag-Minerals negotiated a new 3-year contract with union members.

Pumice.—In 1990, New Mexico was the third largest producer of pumice in the Nation. The combined output of four operating mines in the State was approximately 15% of total U.S. production. The average value fell about 6% to $9.66 per metric ton and production decreased significantly from that of the previous year.

Rio Arriba, Sandoval, and Santa Fe Counties each had one active pumice mine and accompanying mill during the year. Another mill that continued to operate near Santa Fe (Santa Fe County) purchased ore from the mines and sold a variety of sized products. The Utility Block Co. closed its Esquire Mine in Sandoval County and opened another mine in the same county.

Salt.—Salt production in the State increased 14% over that of the previous year and the value of the output increased almost 25%. The average value per short ton of salt rose to $16.48. Three companies recovered salt from potash tailings in Eddy and Lea Counties, and one other employed solution mining in Lea County to recover brines and the contained salt.

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 1988 and 1990 and estimates for 1989.

New Mexico construction sand and gravel statistics are compiled according to geographical districts as depicted on the State map. Table 3 presents end-use data for this commodity, by district, in 1990. In 1990, the construction sand and gravel industry ranked third in total dollar value behind copper and potash. The State's output during the year rose approximately 18% over that of 1988. District 1 sand and gravel mines, encompassing the two principal population centers of Albuquerque and Santa Fe, produced 64% of the total output in New Mexico.

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 1988 and 1990 and actual data for 1989.

Crushed.—New Mexico's production of crushed stone in 1990 was estimated to have dropped 14% from actual production reported in 1989. This decline was apparently offset, however, by a rise in the total value owing to an increase in the average price.

Dimension.—Estimates indicate that the output and value of dimension stone in 1990 was essentially the same as that of the previous year. Several quarries in operation produced chiefly limestone or marble.

Other Industrial Minerals.—The quantity and value of total clay and shale production in New Mexico dropped slightly in 1990 compared to that of 1989. Output of fire clay, a component of total clay production, fell approximately 30% from 1989 to 1990.

Gem stones and gem materials produced in the State included agate, azurite, fluorite, onyx, smithsonite, and

turquoise. The value of reported production during 1990 decreased approximately 20% from that of 1989.

New Mexico is one of only four States that produced Grade-A Helium during the year. Production within the State was comparatively small but increased about 6% over that of 1989.

Humate, derived from weathered coal and associated carbonaceous shales and claystones, has become an important nonfuel mineral commodity in the State. Enormous reserves of the humic acid-rich material have been identified, and in 1990 there were two producing mines. Although figures are withheld because of confidentiality, the New Mexico Mining and Minerals Division reported that production increased over that of 1988. Humate is used chiefly as an additive in drilling muds and soil conditioners.

Elemental sulfur production, recovered as a byproduct of natural gas processing, increased slightly in 1989 from the previous year. Total shipments for the State were 48,000 metric tons valued at $3 million. Most of this production was in southeastern New Mexico.

The State was the second largest domestic producer of sulfuric acid, recovered as a byproduct of the roasting and smelting of base metals. All acid produced in this manner was obtained at two copper smelters operated by Phelps Dodge. Sulfuric acid production increased approximately 16% over that of 1989.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tucson, AZ. He has covered the mineral activities in New Mexico for 3 years. Assistance in the preparation of the annual report was given by Barbara Stinnett, editorial assistant.

[2]Senior mining engineer, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM.

[3]New Mexico Energy, Minerals and Natural Resources Dep. Annual Resources Report, Jan. 1992, 65 pp.

[4]Reference cited in footnote 3.

[5]Pay Dirt Magazine, Southwestern ed., June 1990, p. 2A.

[6]Reference cited in footnote 3.

TABLE 2

NEW MEXICO: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	1,881	$7,788	$4.14
Plaster and gunite sands	156	635	4.07
Concrete products (blocks, bricks, pipe, decorative, etc.)	11	27	2.45
Asphaltic concrete aggregates and other bituminous mixtures	1,720	7,163	4.16
Road base and coverings[1]	1,708	6,367	3.73
Fill	338	755	2.23
Railroad ballast	3	18	6.00
Other[2]	1,609	6,148	3.82
Unspecified:[3]			
Actual	W	W	3.82
Estimated	2,936	10,806	3.68
Total or average	10,362	[4]39,708	3.83

W Withheld to avoid disclosing company proprietary data; included with "Other."
[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.

TABLE 3

NEW MEXICO: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2	
	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	1,189	4,323	692	3,465
Plaster and gunite sands	119	504	37	131
Concrete products (blocks, bricks, etc.)	—	—	11	27
Asphaltic concrete aggregates and other bituminous mixtures	1,078	4,407	641	2,756
Road base and coverings[1]	1,128	3,464	579	2,902
Fill	136	326	202	430
Railroad ballast	W	W	—	—
Other miscellaneous[2]	5	23	—	—
Unspecified:[3]				
Actual	1,588	6,074	20	69
Estimated	1,409	3,704	1,528	7,102
Total[4]	6,651	22,825	3,711	16,884

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[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.

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. Inc.	Box 12336 El Paso, TX 79913	Pit	Dona Ana.
Garcia & Son Inc.[1]	Box 841 Farmington, NM 87401	Pit	San Juan.
Mathis & Mathis Mining & Exploration Co.[1]	Box 2577 Silver City, NM 88061	Pit	Luna.
New Mexico Brick Co. Inc. (doing business as Kinney Brick Co. Inc.)	Box 1804 Albuquerque, NM 87102	Pit	Bernalillo.
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]	Box 7 Hurley, NM 88043	Surface mine, flotation mill, precipitation plant, smelter	Do.
Cyprus Pinos Altos Corp.[4]	Box 2198 Silver City, NM 88062	Underground mine and mill	Do.
Phelps Dodge Corp.:			
Hidalgo Smelter[5]	Box 67 Playas, NM 88009	Smelter	Hidalgo.
Tyrone Branch[3 5]	Drawer B Tyrone, NM 88065	Surface mine, mill, solvent extraction-electrowinning plant	Grant.
Gold:			
Mount Royal Mining & Exploration Co.[6]	100 Mesquite Ave. Duncan, AZ 85534	Underground mine	Do.
Royal Minerals Inc.[7]	Box W Duncan, AZ 85534	do.	Do.
Gypsum:			
Centex American Gypsum Co.	Box 6345, Station B Albuquerque, NM 87197	Pit and plant	Bernalillo and Sandoval.
Humate:			
Agronics Inc.	701 Madison St. NE. Albuquerque, NM 87110	Surface mine	Do.
Mesa Verde Resources	Box 8632 Albuquerque, NM 87198	Surface mine and mill	McKinley and Sandoval.
Mica:			
Franklin Limestone Co., a subsidiary of Franklin Industries Inc. (formerly Mineral Industrial Commodities of America Inc.)	Box 3648 Fairview, NM 87533	Pit and mill	Rio Arriba and Taos.
Perlite:			
Grefco Inc., Mineral Div., a subsidiary of General Refractories Co.	Box 308 Antonito, CO 81120	Surface mines; crushing, screening, air separation	Socorro and Taos.
Manville Sales Corp., a division of Manville Products Corp.	Box 338 Antonito, CO 81120	do.	Taos.
United States Gypsum Co., a subsidiary of USG Corp.	Box 216 Grants, NM 87020	Surface mine and crushing plant	Cibola.

See footnotes at end of table.

TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Potash:			
AMAX Potash Corp., a subsidiary of AMAX Inc.	Box 279 Carlsbad, NM 88220	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.
New Mexico Potash Corp., a subsidiary of Trans-Resources Inc.[8]	Box 610 Hobbs, NM 88240	do.	Do.
Western Ag-Minerals Co., a subsidary of Rayrock Yellowknife Resources Inc.	Box 511 Carlsbad, NM 88220	do.	Do.
Pumice:			
American Pumice Co.	Box 4305 Santa Fe, NM 87502	Mill	Santa Fe.
Copar Pumice Co. Inc.	Box 38 Espanola, NM 87532	Surface mines and crushing and sceening 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.
Utility Block Co.	Box 6036 Albuquerque, NM 87197	Surface mine and crushing and screening plant	Bernalillo and Sandoval.
Salt:			
New Mexico Salt & Minerals Corp.	Box 2262 Carlsbad, NM 88220	Tailings treatment	Eddy.
Unichem International Co.	Box 1659 Eunice, NM 88321	Solution mining	Lea.
United Salt Corp., Carlsbad Div.	Box SS Carlsbad, NM 88220	Tailings treatment	Eddy.
Williams Brine Co.	2501 Dona Ana Carlsbad, NM 88220	do.	Lea.
Sand and gravel:			
Arco Materials Inc.[1]	Box 2439 Farmington, NM 87499	Pit and plant	San Juan.
CalMat Co.	Box 829 Albuquerque, NM 87103	Pit and plant	Bernalillo.
Colony Materials Inc.	Box 4337 Santa Fe, NM 87502	do.	Sandoval.
Connie H. Danley Construction Inc.	Drawer K Alamogordo, NM 88310	do.	Otero.
Espanola Transit Mix Co.	Box 38 Espanola, NM 87532	do.	Rio Arriba.
James Hamilton Construction Co.	Box 1287 Silver City, NM 88062	do.	Dona Ana, Eddy, Lea, San Miguel.
Mountain States Constructors Inc.	Box 6325 Albuquerque, NM 87197	do.	Bernalillo, Cibola, McKinley.
Rio Grande Rock Inc.	Box 28 Las Cruces, NM 88005	do.	Dona Ana.
San Juan Concrete Co.	Box 16 Farmington, NM 87499	do.	San Juan.

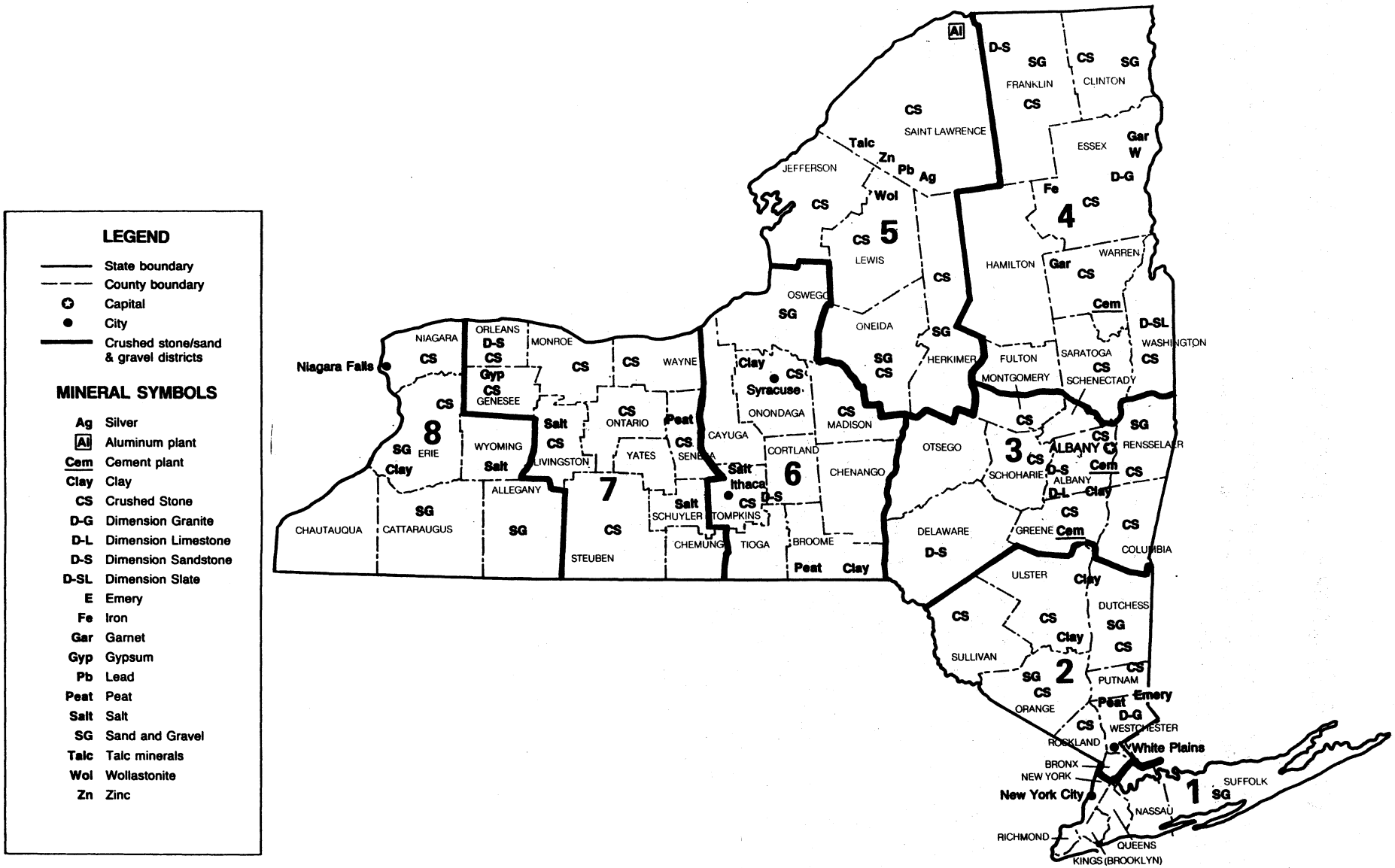
See footnotes at end of table.

TABLE 4—Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Western Mobile New Mexico Inc.	Box 91570 Albuquerque, NM 87199-1570	do.	Bernalillo and Sandoval.
Silver:			
St. Cloud Mining Co.[9]	Box 1670 Truth or Consequences, NM 87901	Underground and surface mines, mill	Sierra.
Stone:			
Crushed:			
Big Chief Stone Inc.	900 North Morton Ln. Las Cruces, NM 88005	Quarries	Colfax, Dona Ana, Santa Fe.
Gallup Sand & Gravel Co.	Box 1119 Gallup, NM 87305	do.	Dona Ana and McKinley.
Hamilton Brothers Inc.	Box HH Gallup, NM 87305	Quarry	McKinley.
Rose Gravel Co.	Box 220 Carlsbad, NM 88220	do.	Eddy.
Western Rock Products Inc.	Box 135 Encino, NM 88321	do.	Torrance.
Wylie Corp.	Box 3921 Albuquerque, NM 87190	do.	Chaves.
Dimension:			
Apache Springs Co.	Box 1 Radium Springs, NM 88054	do.	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:			
Chevron Resources Co.	Box 1150 Grants, NM 87020	Underground mine	Cibola.
Homestake Mining Co.	Box 98 Grants, NM 87020	Underground mines, concentrator, ion-exchange from mine waters	Cibola and McKinley.
Quivira Mining Co., a subsidiary of Rio Algom Ltd.	Box 218 Grants, NM 87020	do.	Do.

[1]Also crushed stone.
[2]Also byproduct molybdenum.
[3]Also gold and silver.
[4]Also gold, silver, and zinc.
[5]Also fire clay and quartzite.
[6]Also copper, lead, and silver.
[7]Also silver.
[8]Also salt.
[9]Also copper, gold, and lead.

NEW YORK



Principal Mineral-Producing Localities

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 1990 was $772.8 million, a $27.7 million increase over that of 1989. Leading mineral commodities produced in terms of value were crushed stone, salt, portland cement, construction sand and gravel, and zinc.

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 that mined garnet. The State ranked third in output of salt and zinc and fourth in crude talc production. Of the minerals processed in the State, New York ranked second in synthetic graphite and fifth in primary aluminum output.

EMPLOYMENT

In 1990, the average number of workers[3] employed in the mineral extractive industries in New York was almost 6,000. This included 568 personnel in underground mines, 3,818 at surface operations, and 1,608 working in mills and preparation plants.

LEGISLATION AND GOVERNMENT PROGRAMS

Three assembly bills (A 1226, A 4961, and A 8040) were reintroduced into the 1990 legislature. All three bills were intended to amend the environmental conservation law in relation to local regulations concerning the extractive mining industry. Although each bill differed slightly from each other, they primarily were written to determine what roles the State and local governments should have in the regulation of mining and reclamation. At yearend, the bills were still in committee. They may be addressed again in the 1991 legislative session.

In July, a law setting the limits on the amounts of lead, mercury, cadmium, and hexavalent chromium in packages and packaging components was signed by the Governor. The legislation, which is scheduled to take effect in January 1992, bans the use of heavy metals in inks, dyes, pigments, adhesives, stabilizers,

TABLE 1
NONFUEL MINERAL PRODUCTION IN NEW YORK[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	551,375	$3,654	531,559	$3,429	490,552	$2,906
Gem stones		NA	200	NA	350	NA	365
Peat	thousand short tons	W	W	W	10	W	W
Salt	do.	4,614	127,994	5,424	161,427	5,401	162,900
Sand and gravel:							
Construction	do.	33,884	124,341	e31,600	e118,500	29,750	121,525
Industrial	do.	53	625	53	633	W	W
Stone:							
Crushed	do.	e39,900	e193,500	39,851	201,749	e39,900	e207,600
Dimension	short tons	e30,751	e4,333	23,756	3,575	e23,437	e3,589
Combined value of cement, emery (1988), garnet, gypsum (crude), iron ore (includes byproduct material, 1988-89), lead, silver, talc and pyrophyllite, wollastonite, zinc, and values indicated by symbol W		XX	241,053	XX	255,495	XX	273,954
Total		XX	695,700	XX	745,168	XX	772,839

eEstimated. 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).

and other additives in excess of the following concentration levels: 600 parts per million (ppm) by weight, effective January 1992; 250 ppm, effective January 1993; and 100 ppm, effective January 1994. Although sponsors of the bill indicated that metals as packaging components were generally safe for intended use, they would nevertheless be harmful to the environment when landfilled or incinerated.[4]

The New York State Geological Survey, the geological research and information agency of the New York State Museum, continued studies of beach erosion on Long Island, State aggregate resources, and the heavy minerals on the Continental Shelf south of Long Island. Other activities included earthquake preparedness investigations, evaluation of disposal sites for low-level radioactive waste, bedrock mapping of the Adirondack Mountains, and petrologic studies of Devonian sandstone used as raw material by the dimension stone industry. The Geological Survey published a Landslide Inventory map at a scale of 1:500,000. The map includes records from 1836 to the present and incorporates earth movements caused both by nature and man.

The Geological Survey completed a 6-year project with the publication of the Adirondack sheet of the State surficial geological map. This five-sheet map, at a scale of 1:250,000, shows the distribution of various types of surficial materials--sand, gravel, lake sediments, peat, and till. Locations of radiometrically dated organic materials are indicated along with the age. Surficial deposits incorporating organic material range in age from 10,300 to greater than 54,000 years before the present time. Personnel for the mapping project were drawn from the Survey, academia, and industry consultants. A large proportion of the funding for this program was provided by the Empire State Electric Energy Research Corp.

Under the State Mining and Mineral Resources Research Institute Program Act, the U.S. Bureau of Mines awarded a basic allotment grant of $145,000 to Columbia University's Henry Krumb School of Mines to conduct research and training in the mineral-related disciplines. In addition to the allotment grant, $148,340 was provided for studies of mineral industry waste treatment and recovery and $71,464 for pyrometallurgy studies for a total of $364,804. Under stipulations of the act, the State of New York was required to match the grant on a 2:1 basis.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Cement.—New York ranked 8th of 38 States that produced portland cement; it also ranked 11th 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 Catskill plant. In 1990, the shipments and value of portland cement rose 14% and 13%, respectively. Shipments and value of masonry cement, on the other hand, dropped 11% and 18%, respectively. The cement was used primarily for ready-mix 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.—In 1990, production of common clay decreased 8% from that of 1989. Common clay was produced by six companies at six operations in five counties. Leading counties, in order of output, were Albany, Ulster, Orange, Onondaga, and Erie. The clay was used principally in the manufacture of portland cement, face brick, and lightweight aggregate for use in structural concrete and block.

Garnet.—Garnet was produced by three companies in New York. Barton Mines Corp. operated a surface mine near North Creek, Warren County, and produced technical-grade garnet for use in coated abrasives, glass grinding and polishing, and metal lapping. The NYCO Div. of Processed Minerals Inc., Essex County, recovered andradite garnet as a byproduct from its wollastonite mining operation. The garnet was sold to a garnet producer for further refinement. International Garnet Abrasives Inc., Essex County, produced garnet for use as blasting and filtration media.

Gemstones.—Value of gem stones and mineral specimens collected by mineral dealers and amateur collectors in New York, based on a survey of the curator of mineralogy of the New York State Museum, was estimated at $147,000. Of this amount, $103,000 entered the market as specimens and educational-grade samples and $44,000 remained in private collections and museums. Popular gem- and mineral-collecting areas include Gore Mountain near North Creek, Warren County; refuse areas of zinc mines in St. Lawrence County; southern Herkimer and western Montgomery Counties where quartz crystals locally known as "Herkimer diamonds" were found; and carbonate stone quarries in Niagara, Monroe, and Wayne Counties.

Gypsum.—USG Corp., the State's only crude gypsum producer, mined crude gypsum from an underground mine at Oakfield in Genesee County. Output remained essentially the same as that of 1989. The crude gypsum was calcined and made into wallboard at an adjoining plant.

Imported gypsum was also calcined at three plants in the State. USG calcined gypsum imported from Nova Scotia, Canada, at Stony Point, Rockland County. In terms of total output, the Stony Point plant ranked 10th of 71 plants that calcined gypsum in the United States. The two other companies that calcined gypsum using imported ore were National Gypsum Co., which operated a

plant in Rensselaer, Rensselaer County, and Georgia-Pacific Corp. which operated a plant at Buchanan, Westchester County. Total gypsum calcined in the State in 1990 was 1.1 million short tons valued at $19.8 million.

In addition to the calcined gypsum produced in the State, the Paul Blum Co. Inc., Greene County, resold byproduct gypsum that the company purchased from other processors.

USG Corp.'s Oakfield Mine in Genesee County was a runner-up in the underground nonmetallics category for the prestigious Sentinels of Safety Award. The annual award is presented by the U.S. Department of Labor, Mine Safety and Health Administration, and the American Mining Congress to honor the mines in each of six categories that have worked the most employee-hours during the year while suffering no lost-time injuries.

In the town of Amherst, developers were proposing to build a large residential and commercial project on a 288-acre site. However, a large portion of the area was believed to be over abandoned gypsum mines, which could potentially pose subsidence problems. The magnitude and the exact locations of the mines' workings are not accurately known because there are no reliable and accurate maps that show the mines' extent. During the year, personnel at the U.S. Bureau of Mines, the Office of Surface Mining Reclamation and Enforcement, and the New York Geological Survey were contacted to help determine the mines' borders and evaluate their subsidence potential.

Peat.—One company mined peat in Seneca 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 ranked third in the Nation in salt sold or used; it was first in value. Salt sold or used totaled 5.4 million short tons (13% of the Nation's total) and was valued at $162.9 million. Rock salt was produced by Akzo Salt Inc. in Livingston County and by Cargill Inc. in Tompkins County. Both companies also produced evaporated salt at plants in Schuyler County. Morton International Inc. also produced evaporated salt in Wyoming County, and Texas Brine Corp. produced brine for use as feedstock to chloralkali producers in the region.

In late November, operations at Akzo's Retsof salt mine in Livingston County were temporarily suspended after a massive roof fall killed two miners and injured a third. Inspectors from the U.S. Department of Labor, Mine Safety and Health Administration, investigated the accident. The Retsof Mine is the world's largest producer of rock salt, primarily for highway ice control.

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 1988 and 1990 and estimates for 1989.

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 fourth leading mineral commodity in terms of value, accounted for almost 16% of the total State mineral value. In 1990, 350 companies mined construction sand and gravel from 409 operations in 51 counties. Leading counties, in order of output, were Suffolk, Cattaraugus, and Dutchess. Construction sand and gravel was used mostly for road base and coverings, concrete aggregates, and fill.

Industrial.—Two companies mined industrial sand in 1990. Whitehead Bros. Inc. operated one pit near Rome, Oneida County, and another near Gansevoot in Saratoga County. G. W. Bryant Core Sand Inc. operated a pit near McConnellsville, Oneida County. Major uses for the industrial sand were for molding and core, glassmaking, and 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 1988 and 1990 and actual data for 1989.

Crushed.—New York ranked 14th of 49 States that reported crushed stone production. Crushed stone was the State's leading commodity and accounted for more than one-quarter of the State's total nonfuel mineral value. The estimated production in 1990 was about equal to that of 1989. 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.

Dimension.—Dimension stone was produced by 13 companies operating 19 quarries. The majority of the production was in Washington County. Estimated production and value remained essentially unchanged from 1989 levels. Types of stone quarried included granite, limestone, quartzite, sandstone, and slate.

Despite opposition from the Dresden Town Board, the Adirondack Park Agency (APA) approved a proposal to mine black granite from 3 acres in Dresden, inside the park boundary. Orex Decorative Stone Inc., the company that planned to quarry the site, was also proposing to construct a stone processing plant in Whitehall, just outside the Adirondack Park boundary. In addition to APA approval, Orex must also obtain necessary mining permits from the New York State Department of Environmental Conservation.

One of the largest dimension stone shipments in the Northeast in recent years was coming from Lone Star Industries' Clinton Point Quarry on the Hudson River, a few miles south of Poughkeepsie. The company was supplying 495,000 short tons of various stone categories for the reconstruction of the south jetty at Barnegat Inlet on the

Jersey shore 130 miles south of the quarry. Four types of stone were required: 230,000 tons of 6- to 20-ton capstone; 160,000 tons of 1- to 2-ton corestone; 70,000 tons of 2- to 75-pound matstone; and 35,000 tons of 1¼-inch crushed bedding stone. All the stone was shipped to Barnegat Inlet down the Hudson River by specially modified barges.

Talc.—New York ranked fourth of 11 States that produced talc in 1990. The Gouverneur Talc Co., a subsidiary of R. T. Vanderbilt Co. Inc., mined talc from both a surface and an underground operation in St. Lawrence County. The ore was ground and processed at an on-site mill and sold primarily for ceramics and paint additives.

Wollastonite.—New York was the only State in the Nation that mined wollastonite. Two companies, both in Essex County, each operated a mine and mill. The largest producer, NYCO, operated the Lewis surface mine 14 miles west of Willsboro. R. T. Vanderbilt, the State's other producer, operated the Valentine No. 4 underground mine near Lewis, Essex County. The material was shipped to a company-owned mill in St. Lawrence County. Some of the wollastonite produced by Vanderbilt was shipped to Holland for further refinement. Major uses of wollastonite were as a filler in ceramic tile, marine wallboard, paint, plastics, and refractory liners in steel mills.

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) Inc. and by General Abrasives, a division of Sterling Operations Products Co., 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 second of the 13 States that produced synthetic graphite. A total of three companies, all in Niagara County, produced and shipped graphite. Principal uses were for electrodes; anodes; unmachined graphite shapes, and crucibles and vessels; and motor brushes.

Indium Corp. of America, one of two indium producers in the United States, produced indium at a plant in Utica.

Crude iodine was shipped into New York by three companies and used to produce specialty organic chemicals, pharmaceuticals, catalysts, and sanitation products.

Electric-furnace-fused mullite was produced by Electro Minerals U.S. Inc. 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.—New York continued to rank fifth in the Nation in primary aluminum output and value. Two companies, both in Massena, St. Lawrence County, operated primary aluminum plants at full capacity. Reynolds Metals Co. operated a 123,000-metric-ton-per-year smelter, and Aluminum Co. of America (Alcoa) operated a 127,000-metric-ton-per-year plant.

Both Reynolds and Alcoa were investigating possible environmental contamination by polychlorinated biphenyls (PCB's) at their Massena operations. Under Department of Environmental Conservation (DEC) consent orders, both companies have carried out interim remedial measures to identify and reduce the flow of contaminants and remove contaminated sediments in the river environs at Massena.

Iron Ore.—Stockpiled byproduct magnetite concentrate was shipped from NL Chemicals Inc.'s MacIntyre Mine at Tahawus, Essex County. The concentrate, which averaged almost 63% Fe, was sold primarily for coal washing. The company's mill at Tahawus was shut down indefinitely in November 1989.

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 ranked third behind Alaska and Missouri in zinc output. In 1990, zinc output increased 10% from the 1989 level. Zinc Corp. of America 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 1990, the Pierrepont Mine was the Nation's third leading zinc mine in terms of total output; the Balmat Mine ranked fifth. These rankings were lower than the previous year because the largest zinc mine in the Western World, Red Dog in Alaska, began production in early 1990. Concentrate from the Balmat mill was shipped by rail to a company-owned smelter in Monaca, PA.

[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related experience andhas covered the mineral activities in New York for 8 years. Assistance inthe preparatin 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 continous) of active operations.

[4]Americam Metal Market. New York Law Sets Heavy Limits. V. 98, No. 129, p. 3.

TABLE 2

NEW YORK: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	8,667	$43,812	$5.06
Plaster and gunite sands	316	1,403	4.44
Concrete products (blocks, bricks, pipe, decorative, etc.)	957	4,957	5.18
Asphaltic concrete aggregates and other bituminous mixtures	1,893	9,682	5.11
Road base and coverings[1]	6,725	21,741	3.24
Fill	2,571	6,192	2.41
Snow and ice control	1,613	5,694	3.53
Railroad ballast	19	97	5.11
Other[2]	1,441	6,323	4.39
Unspecified:[3]			
Actual	3,045	11,753	3.86
Estimated	2,503	9,873	3.94
Total or average	29,750	[4]121,525	4.08

[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules and 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.

TABLE 3

NEW YORK: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	2,499	13,298	1,446	9,266	664	2,365	753	2,386
Plaster and gunite sands	257	1,086	—	—	23	108	W	W
Concrete products (blocks, bricks, etc.)	W	W	31	218	57	249	37	111
Asphaltic concrete aggregates and other bituminous mixtures	W	W	241	1,239	93	383	726	3,720
Road base and coverings[1]	—	—	476	2,050	809	2,352	1,138	3,253
Fill	116	541	250	928	714	874	466	1,306
Snow and ice control	W	W	297	1,682	265	882	331	966
Railroad ballast	—	—	W	W	—	—	—	—
Other miscellaneous[2]	429	2,881	167	589	156	390	78	335
Unspecified:[3]								
Actual	3	12	163	1,129	75	226	137	576
Estimated	184	408	351	2,262	891	2,569	—	—
Total[4]	3,488	18,225	3,423	19,364	3,747	10,397	3,666	12,653

	District 5		District 6		District 7		District 8	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	399	1,248	1,488	8,329	670	3,192	747	3,728
Plaster and gunite sands	—	—	W	W	W	W	(5)	1
Concrete products (blocks, bricks, etc.)	W	W	575	2,978	163	828	18	90
Asphaltic concrete aggregates and other bituminous mixtures	W	W	296	2,398	(5)	9	287	976
Road base and coverings[1]	515	1,421	965	2,694	1,350	4,111	1,472	5,859
Fill	285	515	331	643	175	274	234	1,111
Snow and ice control	147	305	301	859	W	W	171	615
Railroad ballast	—	—	—	—	—	—	W	W
Other miscellaneous[2]	220	575	432	1,668	253	1,198	186	818
Unspecified:[3]								
Actual	56	217	150	422	246	615	2,214	8,557
Estimated	167	470	196	1,325	707	2,817	6	20
Total[4]	1,790	4,750	4,735	21,316	3,566	13,045	5,337	21,775

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules and 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]Less than 1/2 unit.

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Abrasives:			
General Abrasives Div. of Sterling Operation Products Co.	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:			
Norlite Corp., a subsidiary of P. J. Keating Co.	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	Do.
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	Genessee and Rockland.
Iron ore:			
NL Chemicals Inc.	Macintyre Development Tahawus, NY 12879	Pit	Essex.
Peat:			
Malcuria Bros Inc.	1436 Gates Rd. Geneva, NY 14456	Bog	Seneca.
Perlite (expanded):			
Scolite International Corp.	6 Madison St. Troy, NY 12181	Plant	Rensselaer.

See footnotes at the 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.	Box 483 Farmingdale, NY 11735	Pit	Suffolk.
Carlson Sand & Gravel Corp.	Town Line and Old Northpoint Rd. Kings Park, NY 11754	Pit	Do.
Clemente Latham Concrete Corp.	RD 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 Watervliet, 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.

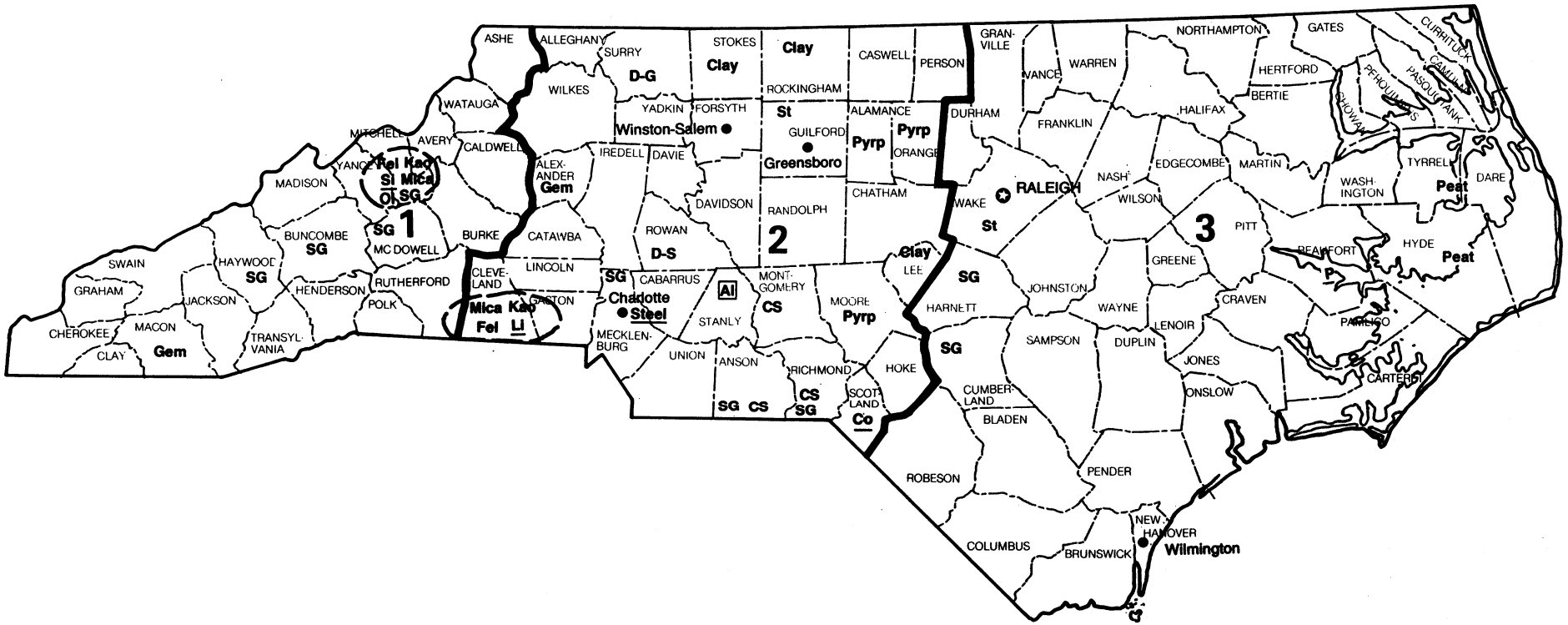
See footnotes at the end of table.

TABLE 4-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone—Continued			
Dimension—Continued			
Ritchie Bros. Slate Co.	Main St. Middle Granville, NY 12849	Quarries	Washington.
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.



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
D-G	Dimension Granite
D-S	Dimension Sandstone
Fel	Feldspar
Gem	Gemstones
Kao	Kaolin
Li	Lithium mine and plant
Mica	Mica
Ol	Olivine
P	Phosphate rock
Peat	Peat
Pyrp	Pyrophyllite
SG	Sand and Gravel
Sl	Silica plant
St	Stone
Steel	Iron and Steel plant

Concentration of mineral operations

Principal Mineral-Producing Localities

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 mineral commodities produced in North Carolina in 1990 totaled $564.6 million, a decrease of 2.9% from the 1989 value. The decrease marked the first time in 8 years that the value of minerals produced did not increase to a record high. The recessionary slowdown of the Nation's economy was the principal reason for the decline in North Carolina's mineral output. The State's three leading commodities, lithium minerals, phosphate rock, and crushed stone, accounted for more than 80% of the total value. North Carolina led the Nation in the production of lithium minerals, feldspar, scrap mica, olivine, and pyrophyllite. It also ranked second in phosphate rock production. Nationally, North Carolina ranked 11th in the value of industrial minerals produced and 20th in overall mineral production. No metals were mined in North Carolina in 1990.

TRENDS AND DEVELOPMENTS

North Carolina's first decrease in the value of mineral commodities produced resulted from decreases in 8 of the 13 commodities mined. This decrease was largely offset by increases in construction aggregates and dimension stone or the total decline would have been much greater. The increase in construction aggregates resulted from the State's $9.1 billion highway improvement program that was implemented in 1990. Dimension stone production increased significantly because North Carolina granite was used to replace the Italian marble facing on a Chicago, IL, skyscraper. Decreases in most of the State's other mineral commodities, clays, feldspar, mica, lithium minerals, and phosphate rock, could be linked to the economic recession. Competition from a foreign source contributed to a large loss in the value of olivine mined.

Environmental apprehension had an increased impact on North Carolina's mineral industry. (See Regulatory Issues section for details.) The U.S. Fish and Wildlife Service (USFWS) created a new

TABLE 1
NONFUEL MINERAL PRODUCTION IN NORTH CAROLINA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	2,880,103	$16,349	2,270,384	$15,529	[2]2,179,428	[2]$9,356
Feldspar	do.	460,838	17,312	435,845	14,024	418,402	13,389
Gemstones		NA	688	NA	784	NA	1,057
Mica (scrap)	thousand metric tons	79	4,512	73	4,192	65	3,796
Peat	thousand short tons	21	W	W	W	13	W
Sand and gravel:							
Construction	do.	11,076	38,459	e11,200	e43,700	11,733	44,872
Industrial	do.	1,246	15,953	1,627	19,902	1,177	15,338
Stone:							
Crushed	do.	e50,500	e250,000	51,519	257,976	e52,900	e276,200
Dimension	short tons	e31,977	e5,026	62,665	10,477	e66,531	e11,551
Combined value of clays (kaolin, 1990), lithium minerals, olivine, phosphate rock, talc and pyrophyllite, and values indicated by symbol W		XX	181,135	XX	214,984	XX	189,032
Total		XX	529,434	XX	581,568	XX	564,591

e Estimated. 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; value included with "Combined value" figure.

wildlife refuge on a tract of land containing large peat reserves.

The high level of exploration activity for heavy-mineral sands waned during the latter part of 1990, although the exploration for base and precious metals continued at about the same level as that of the previous year.

Indusmin Inc.'s North Carolina feldspar, mica, and industrial sand operation was sold to Hecla Mining Co., and its out-of-State silica sand operations were sold to Unimin Corp. Unimin also purchased a silica sand plant in Spruce Pine, Mitchell County, from the Feldspar Corp. The latter moved its corporate headquarters to Asheville, Buncombe County. Its parent company, Zemex Corp., also moved its international headquarters to Asheville from New York City, NY. Piedmont Mining Co. Inc. purchased the assets and sericite mining operation of Minerals Mining Corp., Kershaw, SC.

Joint Ventures Partners (Texasgulf Inc., Olin Corp., and Albright and Wilson Ltd.) dedicated a new purified acid plant at Aurora, Beaufort County. Texasgulf also began construction on a $30 million wastewater recycling system.

EMPLOYMENT

U.S. Department of Labor (DOL) statistics[4] indicated 5,000 workers were employed by the mining industry in North Carolina at the end of 1990, a reduction of 200 from a year earlier. The Mine Safety and Health Administration (MSHA)[5] reported 5,903 workers employed in mining at yearend. MSHA's higher number apparently resulted from including employees of manufacturing facilities at mine sites as mine workers, whereas DOL included them in the manufacturing sector.

REGULATORY ISSUES

Regulatory issues focused on protests against existing users of hazardous waste for fuel in mineral processing and manufacturing operations and against the siting of proposed hazardous waste and low-level nuclear waste storage facilities. Residents living near existing and proposed facilities were joined by environmentalists from State, national, and international organizations in staging protests. In May, environmentalists from Greenpeace International and a coalition of State environmental organizations conducted a 10-day, 11-stop tour of North Carolina to protest the State's handling of hazardous waste issues. The demonstrators focused primarily on the hazardous waste treatment facilities the State is obligated to build and on alleged pollution-law violations.

The two projects in which North Carolina was committed to build waste treatment facilities as a condition of membership in regional compacts drew especially heavy fire. The first was a waste incinerator, landfill, and solvent-recycling center that North Carolina agreed to build as part of a regional five-State compact for the disposal of hazardous waste. North Carolina is the only State in the compact, which includes Alabama, Kentucky, South Carolina, and Tennessee, that did not have commercial hazardous waste treatment facilities. The NC Hazardous Waste Management Commission (NCHWMC), which had responsibility for selecting the site, selected 1,089 acres of State-owned farmland near Butner, Granville County. On December 13, 1990, the Council of State rejected the transfer of the State-owned land in Granville County to NCHWMC. This effectively killed any chance the State had to meet a compact deadline that required North Carolina to have a site selected by December 31. Both Alabama and South Carolina banned the importation of hazardous waste from North Carolina late in December when it became apparent that the deadline would not be met. At yearend, both bans had been appealed in Federal Court, and implementation of the bans was being delayed. North Carolina exported more than 50,000 tons of hazardous waste to South Carolina and less than 5,000 tons to Alabama in 1989.[6]

The second project was to be built under a Southeastern Compact Commission for Low-Level Radioactive Waste Management (SCCLLRWM) agreement in which North Carolina was chosen in 1986 to open a facility for the disposal of low-level radioactive waste from Alabama, Florida, Georgia, Mississippi, South Carolina, Tennessee, and Virginia. In 1989, Chem-Nuclear was selected to build the facility, which will be either in Richmond County or on the border of Wake and Chatham Counties. The North Carolina Low-Level Radioactive Waste Management Authority voted on May 1, 1990, to continue the study of the two sites for an additional year. Cost overruns and delays that increased the expected cost of the facility from $35 million to more than $69 million caused SCCLLRWM to propose an "access fee" for 175 industrial and government radioactive waste generators in States covered by the compact.[7]

The other focus of environmental protest was on the Carolina Solite Co. plant in Stanly County that used hazardous liquid wastes as kiln fuel to produce lightweight aggregate from slate. Largely as a result of the protests, Solite reduced the amount of hazardous waste burned from 67 million pounds in 1989 to 22 million pounds in 1990. Solite temporarily stopped burning toxic solvents twice during the year.

Two environmental groups filed a letter of intent in Raleigh Federal Court on December 19, 1990, to sue Carolina Solite Corp. for $18.25 million in civil penalties. The suit alleges violations of State and Federal regulations.

Public protests were also lodged against almost every proposed new or expanded mining operation and several existing operations. Issuance of mining or zoning permits to construction aggregate operators were contested in at least 13 counties. Also challenged were permit applications for several clay pits and one mica mine.

An administrative ruling by the U.S. Environmental Protection Agency (EPA) allowed North Carolina to set higher standards than those set by Federal regulations. The decision allowed North Carolina to prohibit the construction of a wastewater-treatment plant that could have dumped a projected 500,000 gallons of treated water daily into the Lumber

River by GSX Chemical Services. GSX's application for the chemical treatment facility was still on hold when the EPA decision was issued. The State's legislation, which requires discharge water to be diluted by a factor of 1,000, was aimed specifically at blocking the GSX facility.

North Carolina had been regulating only 18 chemicals or chemical groups as toxic air pollutants affecting the general public. This list included lead, arsenic, mercury, vinyl chloride, and asbestos. On May 1, 1990, limits on 84 additional chemicals became effective, and 21 more were scheduled to be added beginning in 1991.

Statistics compiled from EPA data by the Environmental Defense Fund listed 12 of the most dangerous chemicals emitted in North Carolina, the largest producer, and the amount of each emitted. They also listed the 10 biggest industrial polluters and the amount of pollutants each emitted. The only mining company on the list was Texasgulf, which ranked fifth.

North Carolina objected to the proposed drilling by Mobile Oil Co. of an exploratory gas well on the State's outer continental shelf about 40 miles off Cape Hatteras (by Mobil Oil Co.). After reviewing the exploration plan Mobile filed with the Minerals Management Service, North Carolina rejected the plan on the grounds that it did not adequately analyze the impact on the environment, the risk of spills, interference with fishing, and other issues. The State also objected to Mobil's application to EPA for a permit to discharge drilling fluids at the site. The issue will finally be decided by the U.S. Commerce Department, which has authority to overrule the State.

In August 1990, The Conservation Fund, in coordination with the Richard King Mellon Foundation, turned over to the USFWS 93,000 acres of the more than 100,000 acres of First Colony Farms Inc. (FCF) land they acquired in 1989. The Conservation Fund auctioned the peat mining equipment, formerly belonging to FCF, on September 20 to help finance the project. The deposit contains about 35 million dry tons of high-energy, fuel-grade peat averaging 6 feet in thickness over 70,000 acres of the partially altered wetlands.

While most environmentalists expressed concern that mining might still be possible on the refuge, at least one official of the Conservation Fund said[8] that mining was one option that should not be ruled out, especially in an 18,000-acre tract of disturbed land that had been ditched, drained, and cleared by previous owners. Mining the dried peat might prove to be the most economical way to restore the land as wildlife habitat. Some local residents also feared that the area is susceptible to vast wildfires such as one that scorched almost 100,000 acres of woodlands and peat bogs and destroyed 25 homes on the shore of Lake Phelps in the mid-1980's. The fire, fueled by peat, burned for more than 2 months.

The USFWS was charged with preserving the property as a wildlife habitat to include fire control, maintenance of drainage canals, provision of grain for feeding, and enforcement of wild-game hunting.

North Carolina ranks third in the Southeast in the number of acres designated as wetlands. In 1980, 5.69 million acres, 16.9% of the State's surface area, was classified as wetlands. In 1990, more than 11 million acres, 32%, was so classified.

The North Carolina Department of Transportation (DOT) reported that, since it began testing sites in March 1989, carcinogens (trichloroethylene, trichloromethane, and carbon tetrachloride) were discovered at 74 DOT asphalt laboratory sites at rock quarries across the State. The DOT conducted more intensive testing during 1990 to determine the exact limits of contamination. Estimated cleanup could cost as much a $2 million per year and take 20 years, according to DOT estimates. Top priority sites are near Plymouth, Charlotte, Rockingham, Concord, and Elizabeth City.

Chatham County considered imposing a tax on stockpiles of petroleum-contaminated soil that Cherokee Sanford Group Inc. blends with clay in making brick at its plant in Lee County. Chatham County contends the tax is justified because the county might be responsible for cleanup should hazardous waste from the stockpiles leach into the ground water and not be discovered until after Cherokee discontinued operations. Cherokee views the process as recycling of a hazardous material in the most environmentally sound manner possible.

Lee Brick and Tile Co. also uses petroleum-contaminated soil in its brick manufacturing operation in Chatham County. The soil averages about 12 parts per million of petroleum products and is blended with 95% clay to make the brick. The impurities are burned out when the clay is fired.

The North Carolina Department of Environmental Management, on August 22, assessed a fine of more than $22,000 against FMC, Lithium Div. The company uses locally generated liquid hazardous waste as fuel at its Bessemer City, Cleveland County, plant. The fine resulted from 22 violations, occurring in 1989, of the company's daily 1,000-gallon limit on burning hazardous waste, mainly hexane, a component of gasoline. Company officials attributed the excess consumption to a faulty meter and noted that the violations were self-reported.

Occidental Chemical Corp. cut chromium emissions from its Castle Hayne, New Hanover County, plant by more than one-half between 1987 and 1988 and plans to further reduce emissions by more than one-half by 1992. However, even with these cuts, Occidental says it will be unable to meet North Carolina's proposed standard for chromium that was scheduled to go into effect in 1991. Occidental maintained[9] that the State limit was technologically impossible to meet. Occidental cut emissions from 94,000 pounds in 1987 to 38,000 pounds in 1989 and planned to further cut them to 17,000 pounds by 1992, resulting in an overall drop of more than 80% in 5 years. Occidental completed the addition of a $500,000 scrubbing unit and has installed seals at the ends of the rotary kilns in which chromium ore is melted. Construction

also started on a $5 million wet electrostatic precipitator.

EXPLORATION ACTIVITIES

Interest continued in exploration and potential development of mineral sands in North Carolina and adjoining Virginia. However, as the year progressed, the level of activity waned as a result of the slowing U.S. economy that led to declines in the price, consumption, and demand for both TiO_2 pigments and titanium metal. Those companies that leased land and conducted exploratory drilling in 1989 remained active in 1990. Included in this group were Associated Minerals (USA) Ltd. Inc. and RGC (USA) Minerals Inc., both members of the RGC group of companies (Australia); Southeast Tisand Co., a joint venture of Becker Minerals Inc. (United Kingdom) and CRL America Inc. (a subsidiary of Consolidated Rutile Ltd. of Australia); and Du Pont Chemical and Pigments Co.

Extensive drilling by Piedmont Mining Co. at the old Russell-Coggins Mine in Montgomery County has placed estimated gold reserves at 1.18 million tons, with an average grade of 0.047 ounces per ton.[10]

Triple H Associates of Lexington, Davidson County, requested a zoning permit from Randolph County to develop a potential copper, manganese, silver, zinc, and possibly gold discovery in the Uwharrie National Forest. The Randolph County Board of Commissioners delayed a decision in November on a request to rezone 55 acres until an environmental assessment is completed. The request to rezone included three 15-acre mining sites and a 10-acre milling site. Completion of the assessment was scheduled for early Spring 1991.

Field studies conducted by the U.S. Geological Survey (USGS) near Asheboro suggest a connection between the Caraway-Back Creek volcanic center (CBCV) and gold deposits (Hoover Hill, Scarlet, Sawyer, and New Sawyer) surrounding the CBCV structure at distances from 0.6 to 3 miles. The USGS model should serve as a guide to future exploration in the area.[11]

The study was part of a larger study[12] on the regional structural setting of gold deposits in the North Carolina portion of the Carolina slate belt. The study suggests that two episodes of shearing localized gold mineralization. Previous exploration efforts have concentrated on areas of known gold occurrences or former production. However, much sheared ground exists outside these areas and should provide targets for future exploration.

LEGISLATION AND GOVERNMENT PROGRAMS

The most significant legislation passed in North Carolina in 1990 was House bill 1177 (Environmental Crimes Penalties). The law made it a felony to "knowingly and willfully" violate several North Carolina environmental laws. Felony conviction could lead to sentence of up to 10 years of imprisonment. The law becomes effective January 1, 1991.

North Carolina's $9.1 billion highway improvement program, which became effective in 1990, came under heavy pressure from politicians seeking to reduce a projected $880 million shortfall in the State's budget. The highway program is funded by a 5.5% gasoline tax that goes into a Highway Trust Fund separate from the State's General Fund. Lawmakers defeated a bill that would have diverted part of the highway fund money to the general fund to help offset the projected deficit.

Other proposed legislation to lower the deficit that would have affected the minerals industry included a severance tax on extracted minerals that died in committee during the 1990 legislative session.

On July 17, the North Carolina Court of Appeals issued an opinion upholding a $5,000 per day penalty imposed by the North Carolina Mining Commission on a construction sand and gravel producer (Crowell Constructors, Inc.) for mining sand without a permit.

The North Carolina Geological Survey (NCGS), a section of the Division of Land Resources, published the results of several projects during the year. A series of open-file reports provided information on seismic reflection data from the Coastal Plain and adjacent continental shelf, an alphabetical listing of theses and dissertations on North Carolina geology, and a listing of permitted active and/or inactive mining operations in North Carolina. Also included were reports on the heavy-mineral resource potential of surficial sediments on the Atlantic Continental Shelf offshore of North Carolina and on heavy-mineral exploration along the Fall Zone of Northampton, Halifax, Nash, and Wilson Counties. A map showing the bedrock geology of the Powhatan 7.5-minute Quadrangle, Johnston County, was also issued as an open-file report. An information circular provided the results of studies on the high-silica resource potential of the Upper Chilhowee Quartzite, McDowell County. The NCGS released two field guidebooks during the year on the central and west-central Blue Ridge.

NCGS staff completed a comprehensive review of Chem-Nuclear Systems Inc.'s site characterization plans for potentially suitable sites in Wake-Chatham and Richmond Counties for the low-level radioactive waste facility . Geologic mapping continued in both the Raleigh and Asheville 1:100,000 sheets. NCGS mapping was supplemented by contract geologic mapping partially funded by USGS as part of its Federal-State Cooperative Geologic Mapping Program. The Coastal Plain staff continued its heavy-mineral resource assessment on the inner continental shelf with funding from the American Association of State Geologists/Minerals Management Service cooperative program.

A study of ultrapotassic rocks was undertaken in conjunction with the South Carolina Geological Survey and East Carolina State University. The study was to determine the origin of diamonds in North Carolina and South Carolina. Work was started on a geochemical atlas of stream sediment data from the National Uranium Resource Evaluation data base. A small-scale generalized geologic map of North Carolina was well underway by

yearend. The map will be useful for earth science education and interested visitors to North Carolina.

The North Carolina State University Minerals Research Laboratory (MRL) conducted numerous studies on the evaluation and beneficiation of various, predominantly industrial, minerals and the development of new or improved processing techniques. Projects included those sponsored by private industry, as well as State financed research.

The Resource Evaluation Branch of the Intermountain Field Operations Center, U.S. Bureau of Mines, identified and compiled, as Property Evaluation File Report addenda, mining and beneficiation waste characteristics, generation rates, and waste storage facilities for the Texasgulf operation. The work was part of a project to add site-specific descriptive and quantitative information on mine wastes to the Bureau's Mineral Availability System.

On December 28, 1990, U.S. Department of Interior Secretary Manuel Lujan announced the selection of Environmental Review Panel members who would assess available oceanographic, ecological, and socioeconomic information related to Mobil Exploration & Producing U.S. Inc.'s proposal to explore for natural gas offshore North Carolina. The panel was selected jointly by Lujan and North Carolina Governor James G. Martin from a list of individuals provided by the National Academy of Sciences. After assessing the data, the six-member panel will recommend, early in 1991, to Secretary Lujan whether additional information is needed for him to determine if Mobil can drill an exploratory well. The proposed well site, 45 miles east-northeast of Cape Hatteras, NC, is thought to contain large commercial quantities of natural gas.

Over the past 10 years, the Minerals Management Service (MMS), which is funded by the Bureau, has spent more than $10 million studying Gulf Stream dynamics offshore North Carolina. This information is routinely shared with the State and will be among the data considered by the panel. Additionally, $2 million has been invested in active physical oceanographic studies and literature reviews pertinent to the area, and more than $25 million has been spent on environmental studies relevant to the area of the proposed drill site.

The USFWS formed the Nation's newest wildlife refuge when it combined the 93,000 acres received from the Conservation Fund (see discussion in Regulatory Issues section), the existing 12,000-acre Pungo Wildlife Refuge, and a 6,000-acre tract from the Alligator River Refuge to form the Pocosin Lakes National Wildlife Refuge. Prior to forming the refuge, USFWS prepared an environmental assessment[13] for the area.

The U.S. Army Corps of Engineers issued a feasibility report and environmental assessment of harbor improvement for Morehead City. The report resulted from Texasgulf Inc.'s request to deepen the harbor at Morehead City from 40 feet to 45 feet to permit bulk ocean transportation in larger, deeper draft vessels. If implemented, it will improve the competitive export position of Texasgulf.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Thirteen industrial mineral commodities were mined in North Carolina in 1990. Eight additional industrial mineral commodities (andalusite, synthetic graphite, byproduct gypsum, calcined gypsum, iodine, expanded perlite, sodium sulfate, and steel slag) were produced from raw materials mined within the State, shipped from other States, or imported. The 13 mined commodities accounted for all of the value of minerals reported in table 1.

Clays.—The quantity of clay produced in North Carolina decreased 4.0% from that produced in 1989 to 2.2 million tons. The value of the clay produced decreased by a much greater figure, 39.8%, to $9.4 million. Although part of the decline can be explained because kaolin production data were withheld in 1990 but included with clay in 1989, a significant decrease in the value of total clay still occurred. This decrease can be attributed, in part, to a downturn in building construction that particularly impacted the brick industry, a major user of clay in North Carolina.

Common Clay and/or Shale.—Mannington Ceramic Tile announced on June 27, 1990, an $18 million investment to build a new tile plant and modernize its existing plant in Lexington, Davidson County. Mannington, a subsidiary of Mannington Mills, Salem, NJ, manufactures tile products for walls, counters, and floors.

A new $10 million plant, scheduled to be built as a completely separate facility from its existing plant in Lexington, will increase the company's production capacity by 30%. The new 100,000-square-foot facility will employ an additional 40 people. The company has 240 employees at its existing plant and headquarters. Mannington plans to spend $8 million to upgrade this 30-year-old facility, which was purchased from Mid-State Tile Co. in 1984. The modernization and upgrading will involve the installation of new state-of-the-art equipment purchased from Nassettti of Italy. The same company supplied equipment for the $10 million floor-tile plant recently added to Mannington's Mount Gilead plant in Montgomery County. Included in the equipment to be installed in Lexington are spray drying equipment, 800-ton hydraulic presses, and 400-ton trim presses.

Kaolin.—As aforementioned, both the quantity and value of kaolin produced decreased from the record levels attained in 1989. NGK Ceramics, Mooresville, Iredell County, began production of ceramic filters for catalytic converters in January 1990. An expansion that will add a second kiln to the plant was expected to be completed by mid-1991. The expansion will increase the plant's annual capacity from 3 million units to 6 million units. The kilns harden at 2,800° F a special blend of thermally inert bauxite, kaolin, and talc that is extruded

to form an 8-inch by 4-inch blank. Each blank contains 400 cylindrical openings per square inch of cross-section. A new generation of cores that will have 1,000 openings per square inch is under development. The cores are shipped to automotive catalytic converter manufacturers who coat the surfaces of the openings with palladium, platinum, and rhodium. A typical converter manufactured in 1989 contained approximately 1.77 grams of platinum, 0.47 gram of palladium, and 0.2 gram of rhodium.[14] The new cores will increase surface area in which exhaust gases can react with catalysts and result in improved pollution control without increasing the size of the converters.

Feldspar.—The quantity of feldspar produced was 17,400 metric tons less than 1989 production, a drop of 4%. Feldspar production has declined by more than 14% since reaching a record high in 1986. The value of feldspar produced decreased to $13.4 million, a decrease of 4.5% from the 1989 value.

Hecla Mining Co. announced on December 17, 1990, that it had acquired two feldspar mines and a feldspar processing plant in North Carolina. Hecla purchased the operation from Falconbridge Ltd. Falconbridge originally sold the Spruce Pine operation to Indusmin as part of the latter's acquisition of Indusmin last August. However, the U.S. Justice Department disallowed Indusmin's purchase of the Spruce Pine operations because the purchase violated fair-trade regulations. Hecla officials[15] said the acquisition cost between $8 and $10 million. The feldspar facility will operate under Hecla's Kentucky-Tennessee Clay Co. subsidiary as the K-T Feldspar Co.

By yearend, Zemex Corp. had completed the move of its corporate headquarters and the headquarters of its wholly owned subsidiary, the Feldspar Corp., from New York City and Spruce Pine, NC, respectively, to Asheville. Formal announcement of completion of the move was expected to be made early in January 1991. The move will allow Zemex to be closer to its mining operations in Florida, Georgia, and North Carolina. The company mines feldspar, mica, silica sand, and other materials used in the glass and ceramic industries. It also mines tin oxide in Malaysia and refines iron and steel powders used in the manufacture of automobiles and machinery.

Gemstones.—North Carolina ranked seventh nationally in the value of gem stones produced and is the only State in which all four major gem minerals, diamond, ruby, sapphire, and emerald, are found. The value of gem stones produced increased from $0.7 million in 1989 to $1.1 million in 1990.

The last time all four major gems were found the same year was 1988. The diamond was found in a gold placer mine, rubies and sapphires were recovered from the Cowee Valley in Macon County, and emeralds were found near Hiddenite and Little Switzerland in Alexander County.

Production of ruby and sapphire from the Cowee Valley began in 1895 when the American Prospecting and Mining Co. systematically mined and washed the gravels of Cowee Creek. Today some dig-for-fee operators are in the Cowee Valley. Many people pay to dig or purchase buckets of gravel to wash to recover gem corundum, garnets, and other gem minerals. Public-panning operations were at Hiddenite in Alexander County, Canton in Haywood County, Franklin in Macon County, New London in Stanly County, and Apex in Wake County. Most operations charge an admission fee of $5 and an additional 50 cents for each bucket of sediment. Although some operations use only ore mined on the property, others sweeten the ore with rough gem stones shipped in from other areas. A new wrinkle was added to the concept of panning for fee in 1990 when a Wake County operation added coastal gravel to its public gem stone panning operation. The marine sediments contain whale bone, sharks teeth, corals, and marine invertebrate shells. Amateur prospectors and rock hounds can also select from sediments enriched with rough gem stones and flakes of gold from mines all over the world.

The first attempt at commercial mining of emeralds was made in 1881. Other attempts at mining were made in the 1920's, the 1950's, the 1970's, and the latest ended in 1990. At different times, the emerald deposits in the Hiddenite area have produced large emerald crystals, and some significant stones have been cut from Hiddenite material. Yet, to date, the area has not been able to sustain an economically viable mine operation on any of the deposits. This includes the last attempt that would have mass mined the deposit and used a berylometer to sort the emerald from the waste rock. The berylometer worked well, but the amount of emerald present did not support the project.

Lithium.—FMC Corp.'s investment, since it acquired Lithco in 1985, reached more than $35 million in 1990. Improvements included increasing plant capacity, building a production plant for complex organic chemicals, and building a pilot plant to demonstrate the company's unique process for the preservation and strengthening on aging books and documents. The pilot plant was dedicated on May 7, 1990.

FMC-Lithium Div. announced that it terminated on May 4, 1990, a contract to build a lithium processing plant in Bolivia. FMC had planned to spend $46 million on the project. Political unrest in Bolivia was given[16] as the reason for terminating the contract.

Mica.—The quantity of scrap mica produced in 1990 decreased 11% from 1989's production to 65,000 metric tons. The value showed a similar reduction of 9.4% to $3.8 million. North Carolina remained the major producing State, with 60% of the total U.S. production. Four of the top five producers were in North Carolina. They were The Feldspar Corp., Spruce Pine, Mitchell County; FMC, Lithium Div., Bessemer City, Cleveland County; KGM Minerals Inc., Kings Mountain, Cleveland County; and Unimin Corp., Spruce Pine. Mica is produced as a coproduct of feldspar,

kaolin, and silica by The Feldspar Corp., KGM, and Unimin and as a byproduct of FMC's lithium operation. Mica was also produced by Cyprus Foote Mineral Co. and J. M. Huber Co.

The largest domestic use of ground mica was in gypsum plasterboard joint cement. The mica acts as a filler and extender, provides a smooth consistency, improves the workability of the cement, and imparts resistance to cracking. In the paint industry, ground mica is used as a pigment extender that also facilitates suspension, reduces checking and chalking, prevents shrinking and shearing of the paint film, increases resistance of the paint film to water penetration and weathering, and brightens the tone of colored pigments. Ground mica is also used in well drilling fluids, by the rubber and plastics industries, and in the production of roofing and asphalt shingles. Minor uses included decorative coatings on wallpaper and on concrete, stucco, and tile surfaces; as an ingredient in some special greases; as a coating for cores and molds in metal casting; and as a flux coating on welding rods.

The dry-ground plants of Deneen Mica Co. at Micaville in Yancey County and J. M. Huber at Kings Mountain were inactive during the year. Huber offered its operation for sale on April 1, 1990, and closed it in September. At yearend, the operation was still for sale.

Imperial Mining Corp.'s request for a permit to mine mica from a pegmatite 10 miles south of Marion, McDowell County, was denied by the North Carolina Department of Environment, Health, and Natural Resource's Division of Land Resources (DLR). DLR based the denial on Imperial's going into Chapter 11 bankruptcy while the application was pending. Imperial's bankruptcy resulted from the failed Christy Destiny Gold Mine that closed early in 1990. The gold mine, which Imperial opened in 1988, was near Vein Mountain, south of the proposed mica mine. It produced a minor amount of gold and mixed heavy-mineral sands concentrate consisting primarily of ilmenite with monazite and lesser amounts of zircon and the yttrium-rich mineral, xenotime.

Piedmont Mining Co. Inc., headquartered in Charlotte, exercised its option to purchase the assets of MMC Holding Inc. (formerly Minerals Mining Corp.) in May. MMC, which operated a sericite mica mine near Kershaw, SC, also did contract mining for Piedmont at its Haile Gold Mine. Included in the $3.5 million sale were MMC's mining equipment and mineral resources, some of which were under lease to Piedmont. MMC produced sericite mica for use as filler in paint.

Olivine.—North Carolina remained the leading producer of olivine in the United States, although both the quantity produced and its value declined from those of the previous year. As noted earlier, part of the decrease resulted from increased imports from Norway. However, because olivine usage is largely dependent upon the steel industry, which is its largest tonnage user, part of the decline in olivine production resulted from a decline in steel production. Olivine acts as a flux and as a slag conditioner, improving the performance of sinter and reducing coke consumption.

Applied Industrial Minerals Corp. (AIMCOR), headquartered in Deerfield, IL, operated the Daybrook Mine in Yancey County and remained North Carolina's sole olivine producer. AIMCOR's mines in Avery and Jackson Counties were idle during 1990.

Phosphate Rock.—Phosphate was the second most valuable mineral commodity mined in North Carolina, ranking below crushed stone. North Carolina ranked second nationally, behind Florida, in both the quantity and value of phosphate produced. According to Bureau projections, planned phosphate rock production in North Carolina will hold at 5.5 million metric tons from 1990 through 1994, then increase to 6.8 million metric tons for 1995 and 1996. Estimated phosphate rock reserves in North Carolina based on a cost (includes capital, operating expenses, taxes, royalties, miscellaneous costs, and a 15% rate of return on investments) of less than $40 per metric ton f.o.b. mine are 390 million metric tons. Costs and reserves are as of January 1990. Reserves increase to 790 mmt if a cost of $100 per ton is used.

Phosphate was mined in North Carolina by one company, Texasgulf Inc. Texasgulf's Lee Creek Mine ranked seventh nationally, in order of output of crude ore, for industrial mineral mines exclusive of crushed stone. It also ranked third overall in output of total materials handled. Texasgulf mined the Pungo River Formation, a primary marine phosphate deposit up to 12 meters thick overlain by 27 to 40 meters of clay, marl, and sand. In 1989, bucket wheel excavators replaced draglines to remove the upper 12 meters of overburden. Startup problems encountered by the two bucket wheel excavators put into service in 1989 were overcome as the new year started. The major problem caused by water in the ground ahead of the digging excavation was overcome by digging an 18-inch-wide, 12-foot-deep ditch to drain off the water into a collecting sump from which it was pumped out of the pit. Not having to operate in mud made the excavators much more efficient. Other improvements included relocation of auxiliary equipment and modifications in the bucket wheel itself to free some obstructions and bottlenecks. The excavators' average stripping rate was more than 20 acres per month for the first three months of 1990.

The remaining overburden and ore was removed by draglines with buckets as large as 55 cubic meters. The ore was slurried with high-pressure waterjets, pumped to the beneficiation plant, washed, and classified to produce a minus 16-mesh, plus 200-mesh flotation feed that was either calcined or dried.

Self-unloading barges were used to transport phosphate concentrates from the Aurora Mine to the Morehead City Port Terminal. Texasgulf completed installation of a new shuttle conveyor to load phosphate rock at its Morehead City facility in August. The conveyor was designed to move 1,200 tons of rock per hour and normally loads two 2,200-ton

barges per day. More than 2 million tons of phosphate products was shipped from Texasgulf's docks at Morehead City in 1990.

The purified acid plant at Tg's Aurora facility was dedicated on March 5, 1990. The plant was a joint venture of Texasgulf Inc., Olin Corp., and Albright and Wilson Ltd. Purified phosphoric acid was used to add moisture to packaged dog food and tasty tartness to soft drinks; in the purification of vegetable, corn, and soy oils; and to control the curd size in cottage cheese. Other uses included yeast, toothpaste, flavorings, and other food products and in the manufacture of bricks and aluminum. The new plant cost $40 million and will employ approximately 35 additional people.

Construction of Texasgulf's $30 million wastewater recycling system began in May after its permit application was approved in April. The permitting process took almost 4 years. Cost of the system was estimated at $24 million for installation and $4 million annually for operating expenses. The system is designed to reduce wastewater pickup of phosphorus discharged into Pamlico Sound by more than 90% and of chlorides by at least 75%. The discharge of 60 million gallons per day will be less than one-third the volume Tg is allowed under existing regulations. The system is expected to be operational by May 1992.

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 1988 and 1990 and estimates for 1989.

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 use and district in table 3.

The value of construction sand and gravel produced in 1990 increased by 17% over the value for 1988, reflecting a unit price increase of 10% from $3.47 per ton to $3.82. Total volume of sand produced increased only 6%. 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 increased by 18% and the value by 33.2%. Coastal district 3 where sand and gravel is abundant, in contrast, showed increases of only 1.7% and 11%, respectively. Central district 2 was intermediate, with increases of 7.2% and 16.1%, respectively. All above comparisons are between 1988 and 1990 because construction sand and gravel production was not canvassed in 1989.

The increases reflect increased highway construction resulting from the $9.1 billion highway improvement program that was authorized in 1989. Greater relative increases occurred in rural district 1 than in the more populous districts 2 and 3 because the program was designed to improve rural rather than urban roads.

Industrial.—Unimin Corp., the Nation's leading industrial sand and gravel producer, was also the leading producer in North Carolina. W. R. Bonsal Co. Inc. ranked 21st nationally and 2d in the State. Other North Carolina producers, in descending order of tonnage produced, were B. V. Hedrick Gravel and Sand Co., KMG Minerals Inc., Southern Products & Silica Co. Inc., and Becker Minerals Inc.

On July 13, 1990, Unimin Corp. of New Canaan, CT, reached a definitive agreement to buy Falconbridge Ltd.'s Indusmin Div. for an undisclosed amount. The sale, which closed in August, originally included Indusmin's feldspar operations at Spruce Pine. The U.S. Justice Department ruled, however, that the feldspar part of the sale violated fair-trade laws and requested Falconbridge to sell the feldspar operations to a different buyer. Hecla Mining Co. subsequently bought the Spruce Pine operations (see discussion in Feldspar section).

In a nonrelated transaction, The Feldspar Corp. sold its industrial silica sand plant to Unimin. The sale, which occurred late in the year, included only the processing facilities and was subject to approval by the Justice Department. Indusmin will supply the plant with ore mined from pits approximately 10 miles north of Spruce Pine on land acquired when Indusmin purchased the Harris Mining Co. in the early 1980's.

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 1988 and 1990 and actual data for 1989.

Crushed.—Estimated crushed stone production in North Carolina increased to 2.2 million short tons valued at $276.2 million. North Carolina ranked seventh nationally in the production of crushed stone. The top four producing companies were Martin Marietta Aggregates Co., Vulcan Materials Co., Beazer USA (Nello L. Teer Co.), and Wake Stone Corp.

Nello L. Teer opened a new quarry and asphalt plant southwest of Holly Springs, Wake County, in mid-1990. Martin Marietta opened a new quarry 5 miles northwest of Fuquay-Varina, Wake County, in September 1990.

Lone Star Industries Inc. filed for protection from creditors under Chapter 11 of the U.S. Bankruptcy Code in December. Lone Star had been active in crushed stone production in North Carolina until they sold their interest in the Tarmac-Lone Star joint venture to Tarmac America Inc. in 1989. Tarmac's British parent, Tarmac PCL, completed the purchase in June 1990 by repurchasing from Lone Star the entire issue of Tarmac America preferred stock that was issued to Lone Star as part of the original purchase.

Dimension.—Dimension stone production for North Carolina for 199C was estimated at 66,531 tons valued a $11.6 million. This represents increase of 6.2% in the quantity and 10.3% ir value over those of 1989.

North Carolina Granite Co. of Mount Airy continued shipping granite panels to Illinois to be used in replacing the marble cladding on the Amoco Building in Chicago. Over the next 3 years, the marble will be replaced at the approximate rate of one floor per week. Estimated cost of replacing the marble is $75 million, more than the entire building cost when it was built in the early 1970's.

Talc and Pyrophyllite.—Almost all of the pyrophyllite produced in the United States in 1990 was mined in North Carolina. Pyrophyllite is a naturally occurring hydrous aluminum silicate formed during hydrothermal alteration of acid tuff. It is often confused with talc because of its appearance and with clay because finely ground pyrophyllite mixed with water in small proportions appears to be a clay-water mixture. 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, Standard Mineral Co. Inc., owned by R. T. Vanderbilt Co., and Piedmont Minerals Div. of Resco Inc. Three mines in Alamance and Moore Counties, a mill in Moore County owned by Glendon Pyrophyllite Inc., and a mine in Granville County owned by Tredmont Inc. were inactive in 1990.

Standard Mineral Co. mined and processed pyrophyllite ore at Robbins and Glendon in Moore County. The deposit at Robbins consists of a series of pods of pyrophyllite schist occurring between tuff and volcanic ash on the hanging wall and a rhyolite tuff on the foot wall. Pyrophyllite in the Robbins area was discovered by gold prospectors in the 1800's. Standard was organized in 1920. During the late 1920's, H. H. Beckwith and R. T. Vanderbilt purchased interest in the company and brought it under the control of the R. T. Vanderbilt Co. as an affiliate. Later the company purchased the Beckwith interest, and Standard Minerals became a wholly owned subsidiary.

Standard mined about half of its ore from a 120-acre tract in Glendon about 20 miles from the Robbins' plant site. The company owns approximately 900 acres at Robbins and mined the rest of its ore there. Mining was originally conducted underground with open-pit mining starting in 1940. Underground mining was discontinued in 1966.

Piedmont Minerals Div. of Resco Products Inc. operates the Hillsborough Mine in Orange County. Ore occurs as lenticular pods in an andalusite-pyrophyllite-quartz ore body. Finished products have an andalusite content of between 35% and 50% and a total alumina content of about 35%. Particle sizes range from a coarse 100 millimeter grade down to minus 325 mesh. Milled product capacity was increased by the installation of a new pebble mill that became operational in 1990. In addition to the alumino-silicates, Piedmont produces sericite for ceramic tile, brick, and quarry tile manufacturers.

Titanium.—Associated Minerals (USA) Ltd. Inc. (AMU) and RGC (USA) Minerals Inc., both members of the RGC group of companies (Australia), continued exploration and lease acquisition near Aurelian Springs in Halifax County and Bailey in Nash and Wilson Counties. Southeast TiSand Joint Venture, formed by Becker Minerals Inc. of England and Consolidated Rutile Ltd. of Australia, continued development work on its leases in the same general area. TiSand was working with the North Carolina State University Minerals Research Laboratory in Asheville on pilot plant studies to be used as an aid in determining processing plant design and the quality of concentrates that could be produced. Piedmont Mining Co. Inc., Charlotte, announced a preliminary agreement with Corona Corp., Toronto, Canada, to form a joint venture to explore for and develop heavy-mineral sand deposits in the Carolinas. Piedmont had been investigating occurrences of such sands in eastern North Carolina since 1989.

Other Industrial Minerals.—There was one active peat operation in North Carolina. The Pamlimarle Peninsula is the site of North Carolina's largest peat reserves. The peninsula is estimated to include 360 square miles of peatlands containing about 210 million tons of peat on a moisture-free basis.

Metals

Aluminum.—In terms of value, aluminum was the most important metal refined in North Carolina. A large percentage of this value was derived from the Aluminum Co. of America (ALCOA) smelter at Baden. According to Bureau projections, ALCOA's annual capacity will remain at 115,000 metric tons from 1990 through 1995. The plant is 100% owned by ALCOA, which supplies 60% of its power needs from hydro sources. The remaining 40% is supplied by Duke Power Co. from thermal sources (coal and nuclear).

J. W. Aluminum Co. (JW) was nearing completion of an expansion program designed to increase annual production capacity by 30 million pounds, bringing its total capacity to 110 million pounds. Equipment being installed included a third supercaster; an intermediate cold-rolling mill; a sixth annealing furnace; and additional oil room, cast house, and warehouse space. Cost of the expansion was not available. JW produced foil, finstock, and coiled sheet for a number of commercial and consumer applications. With the expansion, JW will also have the capability to make litho sheet. The company, which was founded in 1979 as Jim Walter Metals, has operated under a Chapter 11 bankruptcy filing since December 1989 when its parent company, Hillsborough Holdings Co., sought protection under Federal bankruptcy laws.

Other Metals.—Occidental Chemical Corp. started construction on a $5 million wet-electrostatic precipitator as part of its program to reduce toxic air emissions from its chromium chemical manufacturing plant in Castle Hayne. (See discussion in Regulatory Issues section).

Carolmet Inc., a subsidiary of Acer Union Miniere of Belgium, became the leading U.S. producer of extra-fine cobalt powders in 1990. The powders are used as binder material in the production of

carbide-tipped cutting tools, drill bits, tools and other machinery, as well as for wear parts. Its plant at Laurinburg, Scotland County, completed partial automatization of its furnace. The company employs approximately 30 people, more than one-half of which have been with the company since it opened in 1980. 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. Lithium metal was manufactured by FMC, Lithium Div., at its Cherryville plant in Cleveland County.

Nucor Corp. of Charlotte ranked 7th in raw steel production in 1990, moving up from 10th in 1989. Total production was 3.8 million tons and enabled the company to earn $75 million from sales of almost $1.5 billion. Nucor announced in December that it had placed an order for a 1-million-ton-per-year thin-slab caster to be installed in its plant in Mississippi County, Arkansas. Carolina Steel Corp., Greensboro, a subsidiary of Citicorp Venture Capital Ltd., operated 10 full-line service centers in the Southeast, a steel fabrication division with 6 steel bridge and building facilities in North Carolina and Virginia, and an affiliate company, Carolina Steel Industries. Florida Steel Corp. produced steel from scrap using a 70-ton capacity electric arc furnace that was installed in 1989 at its minimill in Charlotte.

Teledyne Allvac's plant at Monroe, Union County, had a capacity of 5.7 million metric tons of titanium metal ingot in 1990. Included in the capacity was 2.1 million tons of single-melt capacity.

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[1]State Minerals Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 32 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]U.S. Department of Labor. Employment and Earnings. V. 38, No.5, May 1991, p. 133.

[5]U.S. Department of Labor. Mine Injuries and Worktime Quarterly. Jan.-Dec., 1990, pp. 33-41.

[6]Birmingham (AL) Post Herald. SC Ban On NC Waste Delayed 10 More Days. Jan. 3, 1990.

[7]———. Proposal for Waste Fee Draws Complaints. Aug. 24, 1990.

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[9]The News and Observer (Raleigh, NC). Chromium Plant Cuts Emissions, but Still Won't Meet State Standard. Oct. 30, 1990.

[10]Society of Exploration Geophyscists Newsletter. Exploration Review, Appalachians. Spring 1991, p. 13.

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[12]Offield, T. W., and Klein, T. L. Regional Structural Setting of Gold Deposits in the Carolina Slate Belt of North Carolina in Seventh Annual V.E. McKelvey Forum on Mineral and Energy Resources. U.S. Geol. Surv. Circ. 1062, 1991, pp.58-59.

[13]U.S. Fish and Wildlife Service. Environmental Assessment for the Proposed Pocosin Lakes National Wildlife Refuge. A Wildlife Habitat Preservation Proposal in Tyrrell, Hyde, and Washington Counties, NC. May 16, 1990, 37 pp.

[14]Loebenstein, J. R. Platinum-Group Metals. BuMines Minerals Yearbook, 1990, V. 1, 11 pp. (preprint).

[15]Spokane (WA) Spokesman-Review. Hecla Buys Two Feldspar Mines, Plant. Dec. 18, 1990.

[16]Observer (Charlotte, NC). Bolivan Politics Hurt Gastonia Company. May 15, 1990.

TABLE 2

NORTH CAROLINA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,569	$12,582	$3.53
Plaster and gunite sands	1,122	3,056	2.72
Concrete products (blocks, bricks, pipe, decorative, etc.)	118	354	3.00
Asphaltic concrete aggregates and other bituminous mixtures	1,217	6,614	5.43
Road base and coverings[1]	750	2,597	3.46
Fill	906	1,463	1.61
Snow and ice control	14	48	3.43
Other[2]	661	5,790	8.76
Unspecified:[3]			
Actual	1,060	4,152	3.92
Estimated	2,317	8,215	3.55
Total[4] or average	11,733	44,872	3.82

[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules and 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.

TABLE 3

NORTH CAROLINA: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	331	1,639	1,456	5,754	1,782	5,189
Plaster and gunite sands	12	60	757	2,110	353	885
Concrete products (blocks, bricks, etc.)	—	—	79	247	38	107
Asphaltic concrete aggregates and other bituminous mixtures	W	W	W	W	833	4362
Road base and coverings[1]	395	1,907	W	W	W	W
Fill	30	77	180	260	695	1,126
Snow and ice control	10	35	W	W	W	W
Other miscellaneous[2]	102	487	1,007	7,642	296	616
Unspecified:[3]						
Actual	14	84	153	411	893	3,657
Estimated	936	4,203	362	1,050	1,019	2,962
Total[4]	1,830	8,494	3,995	17,474	5,908	18,904

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules and 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.

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.
Clay:			
Cherokee Sanford Co.	Box 458 Sanford, NC 27330	Open pit mines and plant	Chatham and Lee.
Hammill Construction Co.	Route 2, Box 33H Gold Hill, NC 28071	do.	Cabarrus and Rowan.
Carolina Solite Corp.	Box 987 Albemarle, NC 28001	do.	Rockingham and Stanly.
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.[1 3 6]	23157 Sanders Rd. Northbrook, IL 60062	do.	Do.
Lithium:			
Cyprus Foote Mineral Co.[2]	Box 689 Kings Mountain, NC 28086	Open pit mine and plant	Cleveland.
FMC Corp., Lithium Div.[1 2]	Box 795 Bessemer City, NC 28016	do.	Gaston.
Mica:			
KMG Minerals Inc.[2 3 6]	Box 729 King Mountain, NC 28086	do.	Cleveland.
Olivine:			
AIMCOR	Route 2, Box 167-C Green Mountain, NC 28740	do.	Jackson 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.[4]	Box 48 Aurora, NC 27806	Open pit mine and plant	Beaufort.
Pyrophyllite:			
Piedmont Minerals Co., Div. of Resco Products Inc.[5]	Box 7247 Greensboro, NC 27407	Open pit mine and plant	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.[6]	Box 698 Lillington, NC 27546	Pits	Anson and Harnett.
W. R. Bonsal Co.[6]	Box 38 Lilesville, NC 28091	do.	Anson.
B. V. Hedrick Gravel and Sand Co.[6]	Box 8 Lilesville, NC 28091	do.	Buncombe.

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	do.	Various.
Nello L. Teer Co.	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	Box 608 Denton, NC 27339	do.	Davidson, Montgomery, and Stokes.
The NC Granite Co.	Box 988 Mt. Airy, NC 27030	do.	Cabarrus and Surry.

[1]Also mica.
[2]Also feldspar.
[3]Also clay.
[4]Also byproduct gypsum.
[5]Also sericite.
[6]Also industrial sand.

NORTH DAKOTA

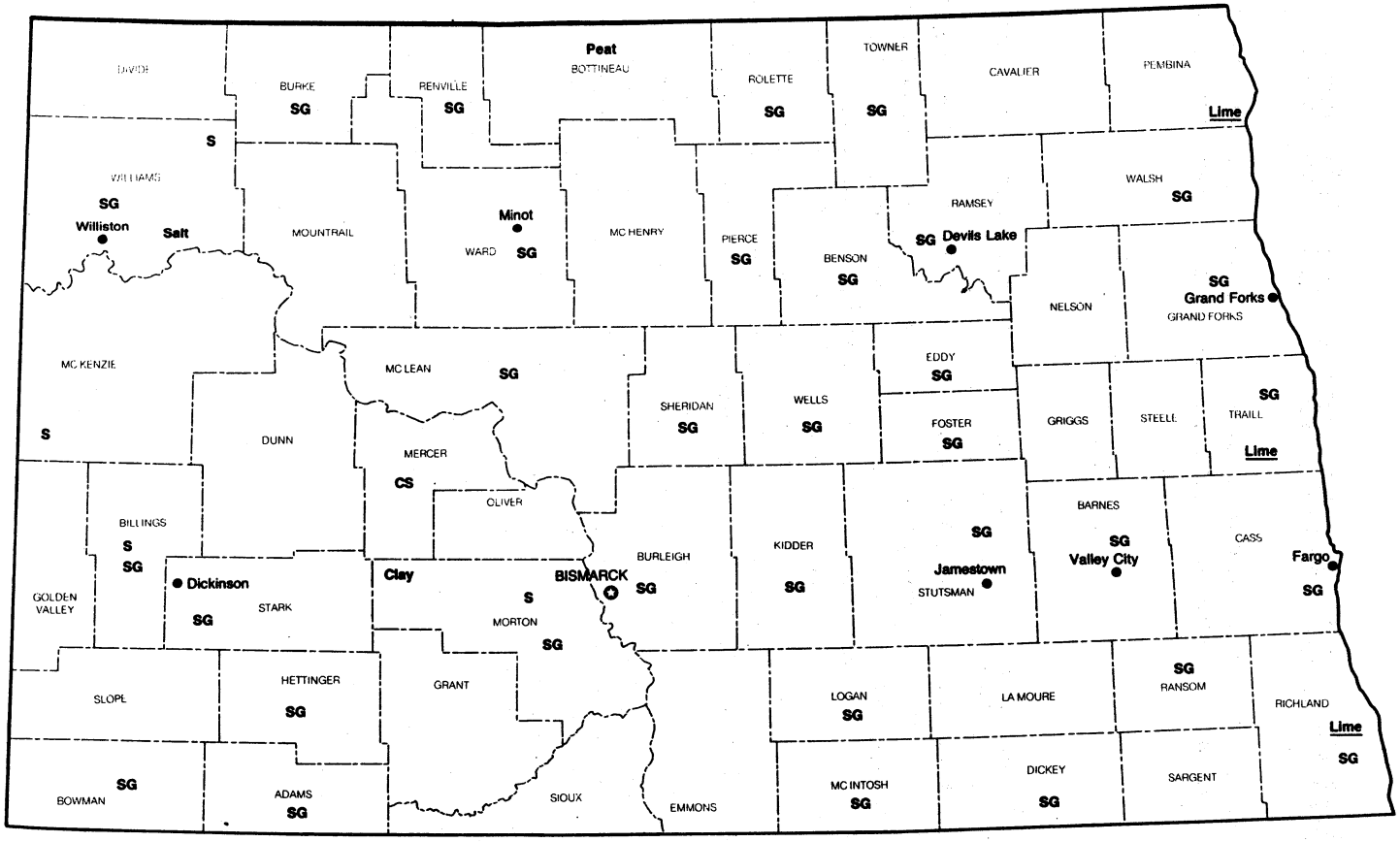
LEGEND

- State boundary
- County boundary
- Capital
- City

MINERAL SYMBOLS

Clay	Clay
CS	Crushed Stone
Lime	Lime plant
Peat	Peat
S	Sulfur
Salt	Salt
SG	Sand and Gravel

Principal Mineral-Producing Localities



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 James R. Boyle[1]

The value of North Dakota's nonfuel mineral industry in 1990 was $26.6 million, an increase over that of 1989 and the first increase in 3 years. The State ranked 48th nationally in nonfuel mineral production, accounting for slightly less than 1% of the Nation's total mineral value for the year.

TRENDS AND DEVELOPMENT

The increase in value over that reported in 1989 was due to a greater demand for sand and gravel and stone, the principal construction minerals produced in the State. However, much of the aggregate used in highway construction in North Dakota was obtained from out-of-State sources.

U.S. Department of Commerce data indicated that 1,512 permits for residential housing units were authorized in 1990, a decrease of 698 below that of 1989. Nonresidential construction value, $105.2 million, increased $12.7 million over that of 1989. State road contracts were valued at $104 million, a slight increase over the 1989 level.

Nonfuel mining employment remained at 350 jobs in 1990, the same level as that of 1988 and 1989. The State's total unemployment rate dropped to 3.9% from the 4.3% in 1989. Mining employment, including the fuel and nonfuel extractive industries, increased 6.2% to 4,300 jobs.[2]

The North Dakota State Soil Conservation Committee reported 29 surface mining operators with 87 pits affecting 398 acres in the State in 1990. The pits ranged in size from 0.1 of an acre to 30 acres. Minerals mined included 3.5 million cubic yards of sand and gravel, scoria, clay, and stone with the removal of 693,000 cubic yards of overburden.[3]

LEGISLATION AND GOVERNMENT PROGRAMS

In 1988, the North Dakota Public Service Commission revised the State's surface mining and reclamation regulations to conform to Federal regulations. These were implemented in 1990.

The Energy and Mineral Research Center (EMRC) of the University of North Dakota at Grand Forks continued investigation into North Dakota's mineral and energy resources. Research was directed toward better methods for using the mineral resources and also for uses for the wastes developed when the resources are processed. EMRC, funded by the Federal Government and private-sector contracts and grants, was composed of three institutes: (1) the Mining and Mineral Resources Research Institute (MMRRI), (2) the Fuels and Process Chemistry Research Institute, and (3) the Combustion and Environmental Systems Research Institute. The MMRRI received a $138,000 grant from the U.S. Bureau of Mines to assist in research activities.

The North Dakota Geological Survey, Bismarck, completed a paleontological display for the North Dakota Heritage Center and helped place a 100-foot-long petrified log on the State Capitol grounds. The Survey continued to add to its drill core library in Grand Forks and to build

TABLE 1
NONFUEL MINERAL PRODUCTION IN NORTH DAKOTA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	76,918	$147	47,903	W	50,485	W
Gemstones		NA	2	NA	$10	NA	$10
Lime	thousand short tons	108	7,094	107	5,439	82	4,623
Sand and gravel (construction)	do.	3,772	8,079	e3,600	e8,100	7,644	17,219
Stone (crushed)	short tons	W	W	—	—	e1,000	e4,600
Combined value of other industrial minerals and values indicated by symbol W		XX	3,485	XX	111	XX	116
Total		XX	18,807	XX	13,660	XX	26,568

eEstimated. 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).

a new book library in the Bismarck offices. When the Survey moved from Grand Forks in 1989, the library shared with the geology department remained in Grand Forks.

The Survey worked in an advisory capacity with the State Health Department on a plan to dispose of incinerator ash in an abandoned coal mine near Minot.

North Dakota received $4.6 million in Federal royalties for minerals produced on Federal lands within State borders. The money represents the State's share of bonuses, rents, and royalties collected by the Department of the Interior's Minerals Management Service.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Five industrial minerals were mined or manufactured in North Dakota in 1990. Sand and gravel continued as the leading commodity, both in value and tonnage.

Clays.—Hebron Brick Co. mined common clay for brick and tile manufacture from two pits near Hebron in Morton County. The company's Hebron plant had an annual capacity of approximately 20 million brick. D. H. Blatner & Sons also mined clay in McLean County. Reported clay production increased from 48,000 to 50,000 metric tons; value was confidential but showed a modest increase.

Lime.—Two companies, American Crystal Sugar Co. and Minn-Dak Farmers Cooperative, produced quicklime for use in sugar beet refining. American Crystal operated plants in Pembina and Traill Counties, and Minn-Dak operated a plant in Richland County. Both companies used limestone obtained from out-of-State suppliers in the lime manufacturing process. Output and value decreased 23.4% and 15.0%, respectively.

Peat.—Peat Products Co. continued as the State's only peat producer. The company harvested reed-sedge peat from a bog in Bottineau County in the northern part of the State. Peat was sold in both bulk and bag; production and value remained at the 1989 levels.

Salt.—There has been no reported salt production in the State since mid-1988 when International Salt Co., a subsidiary of Akzo NV, a Dutch chemical company, purchased Diamond Crystal Salt Co. The purchase included Diamond Crystal's salt operation in Williams County. Following the purchase, the North Dakota operation was closed.

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 1988 and 1990 and estimates for 1989.

In 1990, the production of construction sand and gravel totaled 7.6 million short tons valued at $17 million. This was a dramatic increase of 4 million short tons and $9.1 million over that estimated in 1989. The average value per ton, $2.25, was the same as the figure reported by the sand and gravel industry in 1989.

Construction sand and gravel production was reported by 55 companies operating 167 pits in 38 of the State's counties. The five leading counties, Ward, Sheridan, Dunn, McLean, and Stark, accounted for more than 47% of the production. Major end use, as reported by industry, was road base with almost 39%, while unspecified tonnage amounted to slightly more than 50%. Approximately 33% of the sand and gravel was shipped by truck.

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 1988 and 1990 and actual data for 1989.

Locally, scoria, formed when naturally burning coal beds baked overlying shale strata, was mined and used for road surfacing material. Estimated production was 1,000 short tons valued at almost $5 million.

Sulfur (Recovered).—Elemental sulfur was recovered during natural gas processing at five plants in Billings, McKenzie, and Williams Counties in the western part of North Dakota. Sulfur was also recovered at a petroleum refinery in Morton County in the southern part of the State. Sulfur output, 109,521 metric tons valued at $6.4 million, was 10.6% higher than that reported in 1989; unit value decreased 10.9%.

Other Industrial Minerals.—Dimension stone was shipped into the State by several companies and marketed for cemetery monument and architectural purposes. Exfoliated vermiculite was shipped to Robinson Insulation Co.'s plant at Minot. The vermiculite was exfoliated at the company's plant in Great Falls, MT. Sales were for insulation applications.

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[1]Former State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has more than 30 years of mineral-related industry and government experience. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

[2]North Dakota Labor Market Advisor. Job Service North Dakota. V. 7, No. 2, Feb. 1991, pp. 14-19.

[3]North Dakota State Soil Conservation Committee. Surface Mining Report 1990, 9 pp.

TABLE 2

NORTH DAKOTA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	W	W	$5.51
Plaster and gunite sands	W	W	5.05
Concrete products (blocks, bricks, pipe, decorative, etc.)	W	W	2.22
Asphaltic concrete aggregates and other bituminous mixtures	309	$1,147	3.71
Road base and coverings[1]	2,957	5,001	1.69
Fill	144	243	1.69
Snow and ice control	3	11	3.67
Railroad ballast	W	W	4.00
Other	400	2,142	5.36
Unspecified:[2]			
Actual	1,366	3,132	2.29
Estimated	2,463	5,545	2.25
Total[3] or average	7,644	17,219	2.25

W Withheld to avoid disclosing company proprietary data; included with "Other."

[1]Includes road and other stabilization (cement).

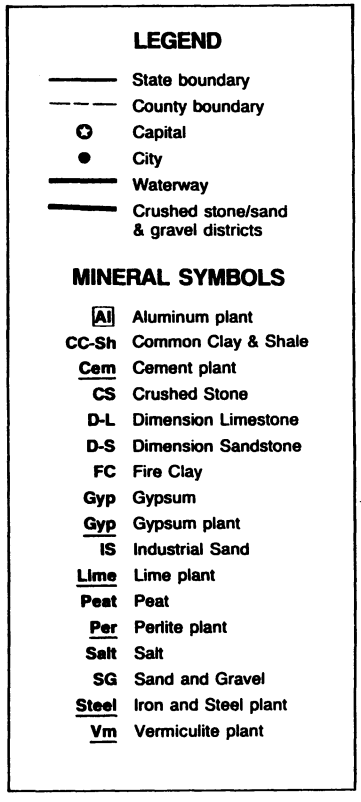
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.

[3]Data may not add to totals shown because of independent rounding.

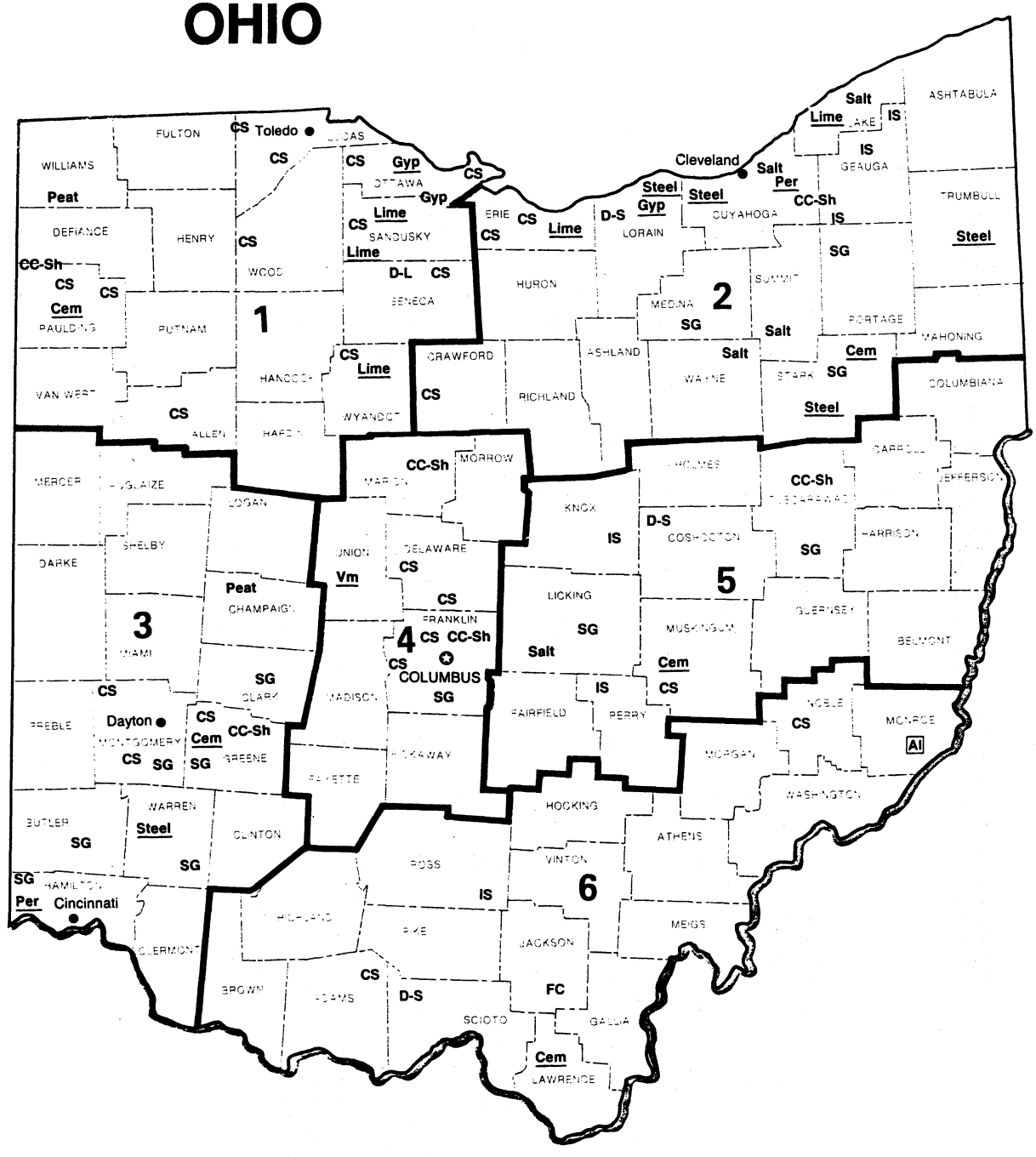
TABLE 3
PRINCIPAL PRODUCERS

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 Co-op.	Wahpeton, ND 58075	do.	Richland.
Peat:			
Peat Products Co.	821 4th St. Bismarck, ND 58501	Bog	Bottineau.
Sand and gravel (construction, 1988):			
Bradshaw Gravel Supply	Box 1676 Grand Forks, ND 58206	Pits and plants	Grand Forks, Rolette, Walsh.
Lake Sand & Gravel Co.	Box 236 Lidgerwood, ND 58053	Pits	Richland.
Schriock Construction Inc.	3009 South Broadway Minot, ND 58701	Pit and plant	Various.
Soper Bros. Construction Co.	Box 791 Devils Lake, ND 58301	Pits	Ramsey.
Susag Sand & Gravel Inc.	Box 23 Harvey, ND 58341	do.	Pierce, Wells, Williams.
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.

OHIO



Principal Mineral-Producing Localities



THE MINERAL INDUSTRY OF OHIO

By L. J. Prosser, Jr.[1]

The value of nonfuel mineral production in Ohio in 1990 was about $729 million. Output and value of most of the commodities produced in the State were about the same as that of the previous year. Demand for industrial minerals used in construction remained strong for the fourth year in a row.

As the decade of the 1990's began, Ohio's position as a significant producer of industrial minerals was evident from sustained production of these commodities during the past 4 years. Each year since 1988, Ohio has produced in excess of 90 million tons of construction aggregates. The State has remained among the Nation's top five producers of clays, lime, salt, and sand and gravel.

Ohio remained the Nation's 2d leading producer of steel and ranked 10th in coal production. Enactment of Federal Clean Air legislation was expected to adversely affect output of high-sulfur coal mined in Ohio in future years.

EMPLOYMENT

Employment trends in mining and construction continued in opposite directions again in 1990. For the sixth consecutive year the number of workers in mining dropped. In 1990, about 17,000 were employed in mining in Ohio, a decline of 1,000 from that of 1989 and almost 11,000 from that of 1984. In contrast, employment in construction was at an alltime high of 199,000 in 1990, an increase of 2,000 workers from that of 1989. The State had employed about 135,000 construction workers in 1984.[2]

Enactment of amendments to the Federal Clean Air Act in 1990 that required the reduction of sulfur dioxide emissions was expected to further erode employment in Ohio's mining sector.

LEGISLATION AND GOVERNMENT PROGRAMS

In the Ohio Legislature, House bill 804 was enacted establishing the Ohio Environmental Education Fund effective October 1, 1990. A maximum of $1.5 million annually was provided through the legislation for environmental education projects. Persons regulated by the Ohio Environmental Protection Agency (OEPA) were eligible for grants for education seminars on pollution prevention, waste minimization, and the State's environmental regulations and standards.

House bill 925 was introduced requiring stricter regulations for hazardous waste, deep-well, injection sites. Among the provisions in the bill were authorization for rules on seismic monitoring around

TABLE 1
NONFUEL MINERAL PRODUCTION IN OHIO[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	129	$11,140	128	$11,233	124	$10,880
Portland	do.	1,424	70,816	1,446	73,230	1,426	72,883
Clays	metric tons	3,365,164	14,423	3,519,668	14,983	2,546,151	13,334
Gemstones		NA	10	NA	18	NA	W
Lime	thousand short tons	2,065	87,431	1,888	94,157	1,884	92,817
Peat	do.	W	W	8	182	12	182
Salt	do.	3,795	115,860	W	W	W	W
Sand and gravel:							
Construction	do.	46,104	156,318	e44,400	e148,700	44,552	165,394
Industrial	do.	1,361	23,441	1,394	24,662	1,349	24,205
Stone:							
Crushed	do.	e48,000	e252,000	46,426	183,190	e48,400	e190,900
Dimension	short tons	e38,300	e3,137	59,923	3,455	e61,783	e3,468
Combined value of other industrial minerals and values indicated by symbol W		XX	2,676	XX	145,346	XX	154,777
Total		XX	737,252	XX	699,156	XX	728,840

eEstimated. 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).

injection wells, annual licensing for all injection-well operations, and public hearings on every new permit or renewal permit for hazardous waste cases. This bill was expected to be acted on during the 1991 legislative session.

Throughout the year, investigations involving toxic waste and pollution were prevalent. A trend toward stricter regulation and more aggressive enforcement in all areas of Ohio's environmental protection system continued, according to a report by the State Environmental Law Compliance Center of Government Institutes Inc. One indication of the growth in environmental matters was the increase in employment at the OEPA. In 1990, OEPA employed more than 1,000 workers, an increase of about 400 employees since 1987. Also during the year, the U.S. Environmental Protection Agency (EPA) and the Department of Energy agreed to pay $1 billion to clean up radioactive waste at a closed uranium processing plant. The OEPA and EPA were monitoring cleanup work at the 1,000-acre plant site about 20 miles northwest of Cincinnati.

The Ohio Division of Geological Survey (DGS), Department of Natural Resources, was the primary State agency involved in mineral resource and research investigations. The 1990 DGS Report on Ohio Mineral Industries listed 217 active coal mines and 487 industrial mineral operators. These figures showed 15 and 94 more operations, respectively, than those in 1989.[3] In 1990, the mining permits from the Division of Reclamation were used to obtain information on companies that was lacking in the DGS's records.

The DGS received a $388,946 grant from the Department of Energy for a 2-year study of the hydrocarbon potential of Rose Run sandstone in eastern Ohio. The Rose Run study was part of a joint project with the Pennsylvania and West Virginia Geological Surveys to address the long-term research needs of the oil and gas industry in the Appalachian Basin.

Also in 1990, the DGS published a report on a 5,370-foot-deep core hole completed in 1989 in Warren County.[4] The report included drilling information, description of seismic methods, and description of a new stratigraphic unit, the Middle Run Formation.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

In 1990, 4 of the 12 nonfuel minerals produced in Ohio accounted for about 73% of the total value as given in table 1. Output of crushed stone and sand and gravel accounted for 26% and 23% of the State's value, respectively. Lime production contributed 13% to the total and cement 11%. The largest change in output among these four commodities was a 4% increase in crushed stone, a reflection of the stable conditions in the State's industrial minerals industry.

Cement.—In 1990, four companies produced portland cement in Ohio, and output remained at the 1.4-million-short-ton level for the third consecutive year. Carlow Group Companies sold its cement plant in Stark County to Essroc Materials Inc., a subsidiary of Societe des Ciments Francais, of France. Carlow continued to operate the Midwest Portland Cement Co. in Muskingum County.

Lime.—Ohio was the Nation's second leading producer of lime, accounting for about 11% of U.S. production. Martin Marietta Corp.'s Woodville plant in Sandusky County and LTV Steel Co. Inc.'s Grand River plant in Lake County again were among the top 10 lime-producing plants in the Nation.

The steel industry consumed more than one-half of the 1.9 million tons of lime produced in the State. Demand for lime used to reduce sulfur dioxide emissions from coal-fired electric utility plants was expected to increase because of enactment of amendments to the Federal Clean Air Act late in 1990.

Ohio Lime Co. applied to the OEPA for a permit to burn used oil at its Millersville and Woodville plants. The firm, after 3 years, has abandoned plans to burn solvent-derived hazardous waste at the plants primarily because of local resident opposition.

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 1988 and 1990 and estimates for 1989.

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.

Production of almost 45 million short tons of construction sand and gravel was the fourth highest total in the United States. Hamilton, Franklin, Portage, and Butler were the leading counties in output. District 3, which included Butler and Hamilton Counties, accounted for about 40% of the State's total production.

In 1990, the average price per ton of sand and gravel was $3.71, an increase of 0.36 cents from that of 1989. Concrete, a mixture of sand and gravel and cement, used in highway and homebuilding, was the leading use for this commodity.

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 1988 and 1990 and actual data for 1989.

During the past 4 years, Ohio has produced an average of almost 49 million tons of stone per year. In 1990, the State ranked 11th nationally in output of crushed stone.

Other Industrial Minerals.—The mineral commodities discussed below collectively accounted for about 27% of the value of Ohio nonfuel mineral production as given in table 1. Ohio ranked among the leading States in the Nation in production of many of these commodities.

Masonry cement was produced at three of the State's four cement plants. Despite

a 28% drop in production, Ohio remained the Nation's top producer of common clay. Ohio also ranked second in output of fire clay. Ohio was 1 of 20 States in which crude gypsum was mined in the United States. The operation was in Ottawa County, and the gypsum was used in wallboard manufacture. Peat was mined by four companies with operations in Champaign, Portage, and Williams Counties. Nationally, Ohio ranked 11th in output of this commodity. Output of salt from two underground mines and three brine operations placed Ohio fourth in the United States in salt production. Industrial sand was produced at seven pits by six companies, with Ohio ranking sixth in the Nation in output. The State also ranked sixth in production of dimension stone.

Metals

No metals were mined in Ohio in1990. Information on processed and manufactured metals is presented in this section.

Manufacturing accounted for about 22% of the workers in Ohio's total labor force. In 1990, the primary and fabricated metal industries employed about 228,000 workers of the State's 1.1 million manufacturing employees.[5]

During the year, a project was underway aimed at reusing mineral waste products, as well as developing technology to lower the use of raw materials used in manufacturing. Norfolk Southern Corp. announced in November a proposal to construct a $30 million plant to produce charcoal-type briquettes from a mixture of municipal waste and low-volatile coal ash. In addition to the manufacture of briquettes, aluminum and ferrous metals would be reclaimed and recycled, and a byproduct material compatible for use in surface coal mine reclamation work produced.

Aluminum.—Ohio ranked sixth nationally in production of primary aluminum. The State's only producer, Ormet Corp., temporarily closed a 41,000-ton-per-year potline from March until September. In June, Ormet and the unionized labor force agreed to a 3-year contract.

Eltech Research Corp. received about $750,000 from the U.S. Department of Energy to develop a more energy-efficient way to manufacture aluminum. The company was conducting experiments with ceramic anodes, which were expected to last up to three times longer than the carbon anodes currently used.

Beryllium.—In October, Brush Wellman Inc. was awarded a $26 million contract for delivery of 91,000 pounds of vacuum, hot-pressed beryllium billets.[6] Billet fabrication and testing and metallurgical processing was scheduled for the firm's plant in Elmore. Brush Wellman refined the ore at its Delta, UT, extraction plant; some of the ore was obtained from the strategic minerals stockpile. The contract was let by the Defense Logistics Agency of the Department of Defense.

Iron and Steel.—Production of steel increased slightly in 1990 to about 16.8 million short tons compared with 16.4 million tons in 1989.[6] Ohio produced about 17% of the Nation's steel during the year and remained the second leading producer.

Developments in Ohio's steel industry in 1990 included another joint venture between United States and Japanese steelmakers. USX Corp. and Kobe Steel Ltd. of Tokyo began construction of a $200 million steel galvanizing plant in Putnam County. The venture was named AZTEC Coating Co., referring to the all zinc galvanizing technology employed at the operation. The plant was designed with a capacity of 600,000 tons per year and was expected to be in production late in 1992.

Warren Consolidated Industries, which purchased steelmaking facilities in Warren from LTV Steel Co. Inc. in 1988, began installation of a continuous slab caster. The firm secured $180 million in financing for the caster, which was expected to be in operation by August of 1991.

Titanium.—RMI Titanium Co. continued operation of titanium materials plants, producing sponge at Ashtabula and ingot at Niles. SMC Chemicals Inc., a subsidiary of Hanson Industries USA, manufactured titanium dioxide pigments at a 111,000-metric-ton-capacity plant in Ashtabula.

In November, RMI announced it would indefinitely delay construction of a titanium tetrachloride plant in Ashtabula. Instead, RMI signed a multiyear agreement with SMC Chemicals for supply of titanium tetrachloride used at RMI's existing sponge plant. Titanium tetrachloride is used to make titanium sponge.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related government experience and has covered the mineral activities in Ohio for 5 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson, editorial assistant.

[2]Ohio Labor Market Information. Labor Market Review, Columbus, OH, Jan. 1991, p. 3.

[3]Weisgarber, S. L. 1990 Report on Ohio Mineral Industries. Dep. Nat. Resour., Div. Geol. Surv., 142 pp.

[4]Shrake, D. L., E. MacSwinford, and L. H. Wickstrom, et al. Ohio Div. of Geol. Surv. Inf. Circ. No. 56, 11 pp.

[5]Ohio Labor Market Information. Labor Market Review, Columbus, OH, Jan. 1991, p. 5.

[6]Brush Wellman News Release. Brush Wellman Inc., 1200 Hanna Bldg., Cleveland Oh 44115, Oct. 1, 1990.

[7]American Iron & Steel Institute. Annual Report, July 1991, p. 66.

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

Use	1989		1990	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Steel, basic oxygen	1,016,540	$50,035	991,566	$50,927
Other[1]	871,671	44,122	892,252	41,890
Total	1,888,211	94,157	1,883,818	92,817

[1]Includes, agriculture, alklies, calcium carbide and cyanamide, electric steel, finishing lime, glass magnesia from sea water or brine, mason's lime, metallurgy, open hearth steel, other chemical and industrial, other environmental, refractory, sewage treatment, soil stabilization, sugar refining, sulfur removal, and water purification.

TABLE 3
OHIO: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	11,424	$38,807	$3.40
Plaster and gunite sands	234	1,334	5.70
Concrete products (blocks, bricks, pipe, decorative, etc.)	1,247	4,951	3.97
Asphaltic concrete aggregates and other bituminous mixtures	5,573	18,898	3.39
Road base and coverings[1]	7,008	28,732	4.10
Fill	4,903	13,710	2.80
Snow and ice control	238	861	3.62
Railroad ballast	W	W	2.80
Other[2]	628	2,710	4.31
Unspecified:[3]			
Actual	9,277	40,939	4.41
Estimated	4,019	14,453	3.60
Total[4] or average	44,552	165,394	3.71

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes road and other stabilization (cement).
[2]Includes roofing granules and 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.

TABLE 4

OHIO: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, BY DISTRICT AND USE

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	733	$2,645	3,843	$13,681	3,945	$12,992	510	$2,038
Plaster and gunite sands	W	W	W	W	137	906	W	W
Concrete products (blocks, bricks, etc.)	—	—	233	917	575	2,359	110	475
Asphaltic concrete aggregates and other bituminous mixtures	W	W	1,360	5,365	1,490	4,621	W	W
Road base and coverings[1]	429	1,851	823	3,796	3,268	13,070	713	2,774
Fill	262	462	783	2,824	2,847	6,563	706	2,993
Snow and ice control	W	W	45	165	54	176	W	W
Railroad ballast	—	—	—	—	W	W	—	—
Other miscellaneous[2]	395	1,342	351	1,740	155	502	384	1,318
Unspecified:[3]								
Actual	—	—	1,239	5,038	4,498	20,071	2,940	12,937
Estimated	—	—	1,601	6,077	1,356	4,120	599	2,651
Total[4]	1,819	6,300	10,279	39,605	18,325	65,380	5,962	25,186

	District 5		District 6	
	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	1,348	$4,446	1,044	$3,005
Plaster and gunite sands	W	W	—	—
Concrete products (blocks, bricks, etc.)	94	282	235	919
Asphaltic concrete aggregates and other bituminous mixtures	1,521	4,694	636	2,424
Road base and coverings[1]	755	2,748	1,020	4,492
Fill	182	510	122	357
Snow and ice control	75	269	W	W
Railroad ballast	—	—	—	
Other miscellaneous[2]	66	260	6	20
Unspecified:[3]				
Actual	599	2,894	—	—
Estimated	130	437	332	1,168
Total[4]	4,771	16,538	3,396	12,386

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes road and other stabilization (cement).
[2]Includes roofing granules and 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.

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.	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	Pits	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.	1515 South Industrial St. Rittman, OH 44270	Underground mine, wells, and plants	Lake and Wayne.
Sand and gravel:			
Construction:			

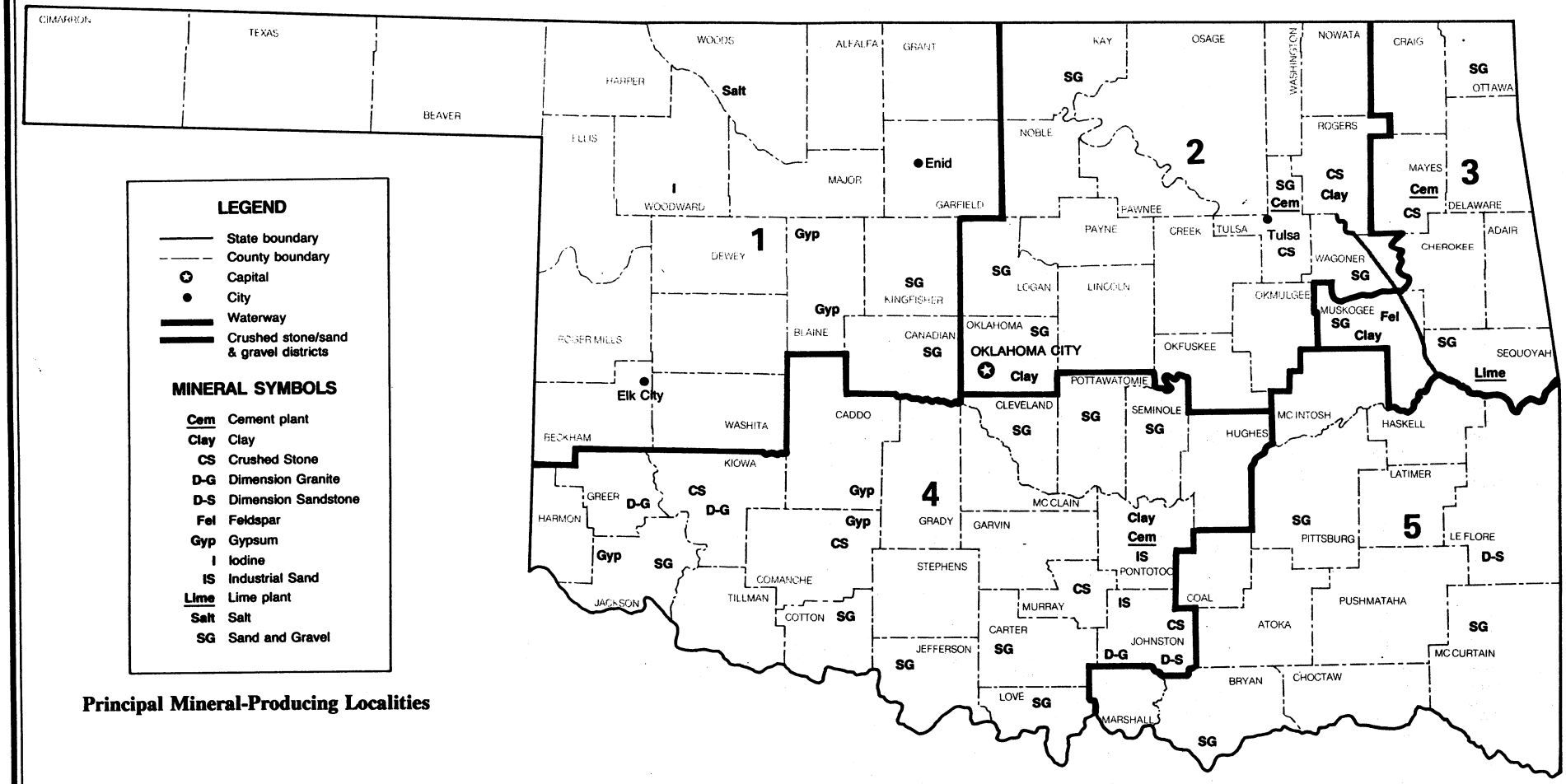
See footnotes at end of table.

TABLE 5-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Construction—Continued			
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.	2728 Hamilton-Cleves Rd. Box 277 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	Clark, Darke, Delaware, Fayette, Franklin, Greene, Montgomery, Warren.
Beazer East Inc.	436 7th Ave. Pittsburgh, PA 15219	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.
Stoneco Inc.	1345 Ford St., Box 29A Maumee, OH 43537	Quarries and plants	Lucas, Mercer, Ottawa, Paulding, Van Wert, 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	do.	Scioto.

[1]Also dimension stone.
[2]Also common clay and shale.
[3]Also crushed stone.
[4]Also sand and gravel.
[5]Also fire clay.

OKLAHOMA



LEGEND

- State boundary
- County boundary
- Capital
- City
- Waterway
- 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

Principal Mineral-Producing Localities

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 Doss H. White, Jr.,[1] and Robert H. Arndt[2]

The State's nonfuel mineral production in 1990 was valued at $260.2 million, an increase of $41.2 million over that reported to the U.S. Bureau of Mines by the State's mineral producers in 1989. The 1990 mineral value reversed a 4-year trend of declining demand and established a new State record. The previous record mineral value, $251.6 million, was produced in 1985. The reversal was due primarily to the increased sales of cement (54%), iodine (28%), and crushed stone (9%). The value of these three commodities exceeded that reported in 1989 by $35.1 million. The State continued to rank 35th in total mineral value. Oklahoma was the only State with iodine production.

TRENDS AND DEVELOPMENTS

The decade of the 1980's was a period of transition for the State's mineral industry. During this period, the value of Oklahoma's nonfuel mineral output totaled almost $2.4 billion. The past 10 years saw a dramatic change in the composition of Oklahoma's work force; mining and construction employment declined during the decade while employment in other sectors rose.

Although the State was faced with a downturn in most sectors of the economy due to the nationwide recession, strong oil revenues during the second half of the year helped Oklahoma forestall a downturn in the overall business index.[3]

Developments during 1990 included plans for a new gypsum mine, controversy over two new quarries, and the Internal Revenue Service (IRS) seizure of Frankoma Pottery. Creta Gypsum Inc. of Olustee filed the required permits with State agencies to develop a surface mine in a gypsum deposit in Jackson County. Two limestone mining companies, Allied Mining Corp., Stillwell, and Brazil Creek Minerals, Fort Smith, received the necessary permits to

TABLE 1
NONFUEL MINERAL PRODUCTION IN OKLAHOMA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland)	thousand short tons	1,432	$42,131	1,236	$39,360	1,544	$60,457
Clays	metric tons	684,067	1,803	565,956	1,619	631,302	3,156
Gemstones		NA	18	NA	W	NA	W
Gypsum (crude)	thousand short tons	2,173	13,393	2,523	14,369	2,184	11,154
Iodine (crude)	kilograms	1,015,210	W	1,505,714	23,947	1,972,849	30,486
Sand and gravel:							
Construction	thousand short tons	9,273	22,654	e8,500	e20,000	9,235	21,993
Industrial	do.	1,268	17,381	1,216	18,310	1,258	22,984
Stone:							
Crushed[2]	do.	e26,300	e92,000	23,598	81,969	e25,300	e89,500
Dimension	short tons	e7,746	e785	8,290	762	e8,138	e684
Tripoli	metric tons	W	W	W	W	18,801	155
Combined value of cement (masonry), feldspar, lime, salt (1988, 1990), stone (crushed dolomite, [1988], crushed granite [1989-90]), and values indicated by indicated by symbol W		XX	29,972	XX	18,695	XX	19,608
Total		XX	220,137	XX	219,031	XX	260,177

eEstimated. 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 stones; kind and value included 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.

develop limestone quarries near the community of Gore. A citizens group, Save the Lower Illinois Inc., was formed to attempt to have the permits revoked. The group was concerned over possible noise, dust, blasting, and increased truck traffic and road damage associated with the two mineral extraction operations.

In April, the IRS took control of the internationally renowned Frankoma Pottery because of a tax issue. A few weeks later, the pottery reopened under Federal bankruptcy court protection. The pottery's financial problems dated from 1983, when a fire closed the firm for a year. Key sales personnel left the firm and it lost many customers; the pottery has faced financial problems since reopening.

EMPLOYMENT

Mining employment for the first 6 months of 1990, including workers in the petroleum and natural gas extraction industries, averaged 44,400. This was an increase of 4% over the same period in 1989.

REGULATORY ISSUES

During the year, the Governor appointed a task force to investigate and recommend remedial actions, if necessary, concerning the State's environmental regulatory agencies. The task force found that the regulatory agencies were fragmented and recommended that they be consolidated. Legislation was introduced to consolidate a number of agencies, including the Department of Mines, but the bill died in the 1990 Appropriations Subcommittee in the Oklahoma House of Representatives.

LEGISLATION AND GOVERNMENT PROGRAMS

The 1990 Oklahoma Legislature passed and the Governor signed Senate bill 263, which defined and regulated brine production but will not impact brine output. Brine production development, operation, and cleanup (in association with solution gases extracted from the same brine field), were not, heretofore, controlled by statute. For many years, iodine has been recovered from brines pumped from subsurface wells. Oklahoma brines are the Nation's only domestic source of iodine.

The Oklahoma Mining Commission formed a committee to study the proposed amendments to the Federal Clean Air Act and the effects of the amendments on the Oklahoma coal industry. A position paper was developed as a result of the study, and the paper was distributed to the Governor, the Oklahoma congressional delegation, and interested State legislators.[4]

Scientists at the Bureau's Intermountain Field Operations Center, Denver, CO, reviewed the joint public notice involving the U.S. Army Corps of Engineers and the Oklahoma Water Resources Board regarding an application to reclaim two abandoned coal mines near Oologah. The review determined that there would be no impact to mineral resources and/or production facilities.

The former U.S. Bureau of Mines helium plant in Boise City was deeded to the town of Keys, the city of Boise City, and Cimarron County. For many years, the facility extracted helium from natural gas. Helium extraction was terminated in 1981, and the plant closed in 1985.

FUELS

Oklahoma's fuel mineral output added an important dimension to the State's total mineral production. Coal production totaled 1,636,760 short tons, a decrease of 132,000 short tons below that of 1989. Coal output was valued at $49.9 million, based on an average value of $30.50 per ton.

The production of crude oil, 103.5 million barrels, fell from the 108.2 million barrels reported in 1989. The average price of crude per barrel was $22.99, up from the $18.27 in 1989. Production of condensate also fell from 9.5 million barrels in 1989 to 8.8 million barrels in 1990. The price per barrel, however, rose from $18.17 in 1989 to $22.91 in 1990. Gas output, both natural and casing head, increased slightly; 2.2 trillion cubic feet were produced in 1989, and 2.3 trillion cubic feet were produced in 1990. The price per thousand cubic feet rose from $1.51 to $1.57.[5]

Construction of three major natural gas pipelines was underway. The lines will transport gas from the Arkoma Basin to States to the north.[6]

Public Service Co. of Oklahoma (PSO) awarded Peabody Coal Co. and Patch Coal Co. contracts to supply PSO with Oklahoma coal during 1990. The contracts, totaling $8 million, call for delivery of 216,000 short tons of coal to fuel two of the utilities' electric generating plants near Oologah. The utility also burns Wyoming coal.

REVIEW BY NONFUEL MINERAL COMMODITY

Industrial Minerals

Oklahoma mineral operations produced 16 different industrial minerals in 1990. The three leading commodities, crushed stone, cement, and iodine, accounted for 69% of the State's total mineral value.

Cement.—Oklahoma ranked 15th among the portland cement-producing States and 20th in masonry cement production; cement ranked second in value among the industrial mineral commodities produced in-State. Portland cement sales, 1.5 million short tons valued at $60.4 million, accounted for 23% of Oklahoma's 1990 mineral value. Output and value increased 300,000 short tons and $21 million, respectively, over that reported by the State's cement producers in 1989. The sharp increase in value was partially due to an increase in the demand for oil well drilling cement. Masonry cement output increased 5%; value, however, declined 4% below the 1989 levels.

Oklahoma's cement industry, Blue Circle Inc, Tulsa; Ideal Basic Industries Inc., Ada; and Lonestar Industries Inc., Pryor, produced clinker at seven kilns. Blue Circle and Lonestar operated five dry-process kilns, and Ideal operated two

wet-process units. All three companies produced both portland and masonry cements.

Clays.—Oklahoma's clay industry, 10 companies operating 11 mines, ranked 18th among the 36 clay-producing States. Common clay was the only clay type produced; 631,000 metric tons valued at $3.2 million exceeded the 1989 level by 65,000 metric tons and $15.4 million. The three major clay-producing counties, Oklahoma, Pontotoc, and Rogers, accounted for approximately 65% of the total production. The principal end uses were in portland cement manufacture (45%), common brick manufacture (43%), concrete block (6%), structural concrete (4%), and face brick (2%). Other uses included highway resurfacing and pottery manufacture.

Feldspar.—APAC Arkansas Inc. produced and marketed a feldspar-silica concentrate that was sold to the glass and ceramics industries. Arcola Sand and Gravel Inc., an APAC subsidiary, dredged a feldspathic sand from the Arkansas River near Muskogee. 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 before shipment.

Gypsum.—Oklahoma ranked second among the 20 gypsum-producing States. Output, 2.2 million short tons, and value, $11.2 million, were slightly lower than in 1989. The effects of the recession, which slowed construction, had a negative impact on demand for gypsum products for the construction industry.

Four companies produced gypsum from mines in the Blaine, Caddo, and Comanche contiguous counties area, and one firm produced gypsum from a mine in Jackson County. Much of the output was from the Nescatunga Gypsum Member of the Blaine Formation. Calcined gypsum was produced by the companies in Comanche and Jackson Counties.

Iodine.—Oklahoma was the only State with iodine production. Three companies produced approximately 50% of the domestic requirements. Other countries importing iodine into the United States included, in descending order of import tonnage, Chile, Japan, Belgium, United Kingdom, and Canada. Oklahoma's annual iodine production capacity was approximately 8% of the world total. Iodine output in 1990, almost 2 million kilograms valued at $30.5 million, exceeded the 1989 production by 467,000 kilograms. Iodine value in 1990 was $6.6 million higher than in 1989.

The State's iodine industry, IoChem Corp., at Vici in Dewey County; North American Brine Resources with plants at Dover and Hennessey in Kingfisher County; and Woodward Iodine Corp. at Woodward in Woodward County, produced brines from the Morrison Formation 7,500 to 10,000 feet beneath the surface. All three companies used the blowing-out process to produce iodine ranging from 95% to 99.8%-plus purity.

IoChem sold its iodine to Schering AG, Federal Republic of Germany, for use in radiopaque media. The other companies sold their iodine for use in animal feed supplements, catalysts, inks and colorants, pharmaceuticals, photographic equipment, sanitary and industrial disinfectants, and stabilizers. Sales were also for use in high-purity metals, motor fuels, iodized salt, lubricants, cloud seeding, and medical research.

Lime.—Oklahoma ranked 21st among the 32 lime-producing States. Although several firms had announced plans to construct lime plants in anticipation of an expanding market for lime in coal-fired powerplant scrubbers, only one firm, St. Clair Lime Co., produced lime in 1990. The company, established in 1943, operated a plant and an underground mine in the St. Clair Lime Formation. The current mine and plant began operations in 1966. Lime output and value increased 2% and 5%, respectively.

Salt.—Cargill Inc. produced an evaporative salt from an operation at Freedom, OK. Brine pumped from multiple wells provided a feedstock for the 200,000-short-ton annual capacity solar evaporative facility. Salt production, curtailed in 1989 due to problems with the evaporative ponds, resumed late in 1990.

Sand and Gravel.—Both construction and industrial sand and gravel were mined in Oklahoma during 1990. The output and value of both types increased slightly above the 1989 level.

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 1988 and 1990 and estimates for 1989.

Oklahoma construction sand and gravel statistics are compiled by geographical districts depicted in the State map. Table 3 presents end-use statistics for Oklahoma's five districts.

One hundred fifteen companies reported sand and gravel extraction from 161 mines in 50 counties. The five leading counties, Kingfisher, Love, Muskogee, Oklahoma, and Tulsa, accounted for 21% of the production. Stationary processing plants were operated by 72 of the companies, 10 companies operated portable facilities, and 59 companies reported no processing equipment. End uses were unreported on 2.2 million short tons. Reported uses included concrete aggregate (41%), fill (19%), road base and cover (17%), asphaltic concrete (6%), and concrete products (0.7%).

Industrial.—Three companies operated four mines in Johnston, Muskogee, and Pontotoc Counties to produce 1.3 million short tons of sand valued at $23 million. This was an increase in output of 42,000 short tons; value rose $4.7 million. Almost 57% of the industrial sand produced came from Johnston County.

Sales were to the following industries: glass containers, flat glass, and foundries. Unit value ranged from a high of $183.97

for ground fillers to $10.20 for roofing granules.

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 1988 and 1990 and actual data for 1989.

Crushed.—The estimated crushed stone production in 1990 increased approximately 1.7 million tons, and value increased $7.5 million because of a rise in unit price of several stone products.

In 1989, the last year with a complete stone canvass, 39 companies produced stone from 63 quarries in 33 counties. Stone types quarried included limestone and dolomite (94%) and sandstone (2%). The remainder was granite and traprock.

Limestone and dolomite were quarried and crushed by 33 firms operating 57 quarries/crushing facilities in 1989. Production, 22,058,051 short tons, was valued at $74.7 million. The three leading counties, Johnston, Murray, and Rogers, accounted for 41% of the production. The major end uses, as reported by the producers, were for cement manufacture (withheld), concrete aggregate (20%), crusher run fill (14%), graded road base (13%), and fine screenings utilization (8%).

In 1989, crushed sandstone was produced by three companies operating three quarries. Output totaled almost 585,000 short tons valued at $2 million. Production was reported from Haskell and McIntosh Counties. The five top end uses or production categories were (1) crusher run fill, (2) concrete aggregate, (3) bituminous aggregate, (4) fine screenings, and (5) riprap and jetty stone.

Granite and traprock, in 1989, were mined and crushed by three companies with three quarries in Johnston and Murray Counties. Major granite end uses were (1) railroad ballast, (2) concrete aggregate, and (3) concrete stone sand; major traprock sales were for (1) railroad ballast, (2) fine screenings, and (3) bituminous aggregate.

Dimension.—Six firms quarried dimension granite and sandstone. The granite operations were in Greer, Kiowa, and Johnston Counties. Sandstone was quarried in Le Flore County. The estimated production and value declined 52 short tons and $78,000, respectively.

Tripoli.—Four States, Oklahoma, Arkansas, Illinois, and Pennsylvania, produced tripoli, a microcrystalline silica used primarily in abrasive applications. The Oklahoma deposits, in Ottawa County, were mined by American Tripoli Co. Output and value declined below that reported by the company in 1989. Sales were to the toothpaste-tooth polishing compound and the metal and jewelry polishing compound manufacturers.

Other Industrial Minerals.—Several crude or semifinished industrial mineral commodities, not listed on table 1, were imported into the State and processed into higher value products.

Barite was shipped into the Elk City plant of Old Soldiers Ltd. and ground for petroleum industry applications. Slag, produced as a byproduct in the steelmaking process at the State's one steel producer, Sheffield Steel Corp., was sold for aggregate applications. Dimension stone, primarily marble and granite, was shipped from other States and finished into monuments and into shapes for construction uses. Sulfuric acid was a byproduct of the Zinc Corp. of America'S smelter at Bartlesville.

Crude vermiculite was shipped to the plant from mines in South Carolina. Output and value were relatively unchanged from those of 1989. Principal sales were for use in concrete aggregate and soil conditioners.

Metals

Cadmium and Zinc.—The Zinc Corp. of America'S 60,000-metric-ton-per-year slab zinc smelter processed leached zinc electrolyte to precipitate cadmium. The cadmium was filtered, briquetted, and further processed to produce a commercial-grade cadmium ball anode. Fabricated thin-filmed cadmium was used for several industrial applications, including photodetector and transparent conductor manufacture and in cadmium battery fabrication.

Gallium.—Eagle-Pitcher Industries Inc., Quapaw, recovered and refined gallium from primary and secondary source materials.

Germanium.—Eagle-Pitcher processed zinc smelter residues at its Quapaw plant to recover primary germanium. The Ottawa County plant, with a 30,000-kilograms-of-germanium-per-year capacity, produced germanium tetrachloride and dioxide, along with polycrystalline and single-crystal germanium metal. Much of the facility's output was used in infrared systems and fiber optics.

Steel.—Sheffield Steel Corp. operated a two-furnace, 400,000- short-ton capacity minimill in Sun Springs. The plant produced reinforcing bar and fence posts.

Uranium.—GA Technologies Inc. (formerly General Atomics) operated a uranium processing plant at Gore. The Gore subsidiary, the Sequoya Fuels Corp., produced uranium hexafluoride and uranium tetrafluoride. During the year, water samples with high-uranium concentrations were discovered when storage tanks were excavated. There was no indication that offsite water had been affected.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 30 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 IV, Oklahoma Geological Survey, Norman, OK.

[3]Southwestern States at a Glance. Update, No. 2, 1991, p. 63.

[4]Oklahoma Department of Mines. Mining News. Mar. 1990, p. 1.

[5]Oklahoma Corporation Commission, Oil and Gas Division, Statistical Department. Liquids and Gas Runs by Counties. 1990.

[6]The Kiplinger Texas Letter. Apr. 20, 1990.

TABLE 2

OKLAHOMA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	2,948	$6,555	$2.22
Plaster and gunite sands	49	137	2.80
Concrete products (blocks, bricks, pipe, decorative, etc.)	50	311	6.22
Asphaltic concrete aggregates and other bituminous mixtures	403	699	1.73
Road base and coverings	1,203	2,675	2.22
Fill	1,267	1,805	1.42
Snow and ice control	39	81	2.08
Other[1]	199	388	1.95
Unspecified:[2]			
Actual	1,525	4,978	3.26
Estimated	1,552	4,364	2.81
Total or average	9,235	21,993	2.38

[1]Includes filtration.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 3

OKLAHOMA: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	149	470	1,734	3,544	517	884
Plaster and gunite sands	W	W	37	91	—	—
Concrete products (blocks, bricks, etc.)	—	—	10	60	W	W
Asphaltic concrete aggregates and other bituminous mixtures	W	W	185	301	136	205
Road base and coverings	551	1,087	W	W	W	W
Fill	60	126	904	1,211	6	14
Snow and ice control	—	—	W	W	W	W
Other miscellaneous[1]	37	100	178	324	200	626
Unspecified:						
Actual	548	1,756	323	774	—	—
Estimated	91	445	676	1,615	179	472
Total[2]	1,436	3,985	4,047	7,920	1,039	2,201

Use	District 4		District 5	
	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	547	1,657	—	—
Plaster and gunite sands	W	W		—
Concrete products (blocks, bricks, etc.)	W	W	—	—
Asphaltic concrete aggregates and other bituminous mixtures	W	W	29	65
Road base and coverings	378	793	107	271
Fill	253	407	44	47
Snow and ice control	—	—	—	—
Other miscellaneous[1]	94	367	—	—
Unspecified:				
Actual	655	2,447	—	—
Estimated	399	935	207	897
Total[2]	2,326	6,607	387	1,280

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes filtration.
Data may not add to totals shown because of independent rounding.

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Blue Circle Inc., a subsidiary of Blue Circle Industries Ltd.[1 2]	One Parkway Center 1850 Parkway Place Suite 1000 Marietta, GA 30067	Quarry and plant	Rogers.
Ideal Basic Industries Inc., Ideal Cement Co.[1 2]	Box 8789 Denver, CO 80201	do.	Pontotoc.
Lone Star Industries Inc.[1 2]	300 First Stamford Place Box 120014 Stamford, CT 06912-0014	do.	Mayes.
Clays:			
Acme Brick Co., a subsidiary of Justin Industries Inc.	Box 24012 Oklahoma City, OK 73124	Pits and plants	Oklahoma.
Chandler Materials Co.	5805 East 15th St. Tulsa, OK 74102	Pit and plant	Do.
Commercial Brick Corp.	Box 1382 Wewoka, OK 74884	do.	Seminole.
Oklahoma Brick Corp., a subsidiary of Merry Companies	Box 75368 4300 NW 10th St. Oklahoma City, OK 73127	do.	Canadian and Muskogee.
Feldspar:			
Arkhola Sand and Gravel Co., a division of APAC-Arkansas Inc., a subsidiary of Ashland Oil Co.[2 3]	Box 1401 Muskogee, OK 74401	Dredge and plant	Muskogee.
Gallium and germanium:			
Eagle-Picher Industries Inc.	Box 737 Quapaw, OK 74363	Refinery	Ottawa.
Gypsum:			
Harrison Gypsum Co. Inc.	Box 69, Route 4 Lindsay, OK 73052	Quarry	Caddo.
Heartland Cement Co.	Box 428 Independence, KS 67301	do.	Blaine.
Republic Gypsum Co.	Drawer C Duke, OK 73532	Quarry and plant	Jackson.
Temple-Inland Forest Products Corp.	Box 1270 West Memphis, AR 72303	do.	Comanche.
United States Gypsum Co., a subsidiary of USG Corp.	Box 187 Southard, OK 73770	do.	Blaine.
Iodine:			
Iochem Corp.	6520 N. Western Suite 200 Oklahoma City, OK 73116	Brine field and plant	Woodward.
North American Brine Resources	c/o Beard Oil Co. 2000 Classen Center Bldg. Oklahoma City, OK 73106	Oilfield brines and plant	Kingfisher.
Woodward Iodine Corp., a subsidiary of Asahi Glass Co. Ltd. and Ise Chemical Co.	Box 1245 Woodward, OK 73801	Brine field and plant	Woodward.
Lime:			
St. Clair Lime Co.	Box 894 Oklahoma City, OK 73101	Mine and plant	Sequoyah.
Pumice (volcanic ash):			
Axtell Mining Corp.	Box 92 Gate, OK 73844	Open pit	Beaver.

See footnotes at end of table.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Salt:			
Cargill Inc.	Box 167 Freedom, OK 73842	Solar evaporation	Woods.
Sand and gravel:			
Construction:			
Boorhem-Fields Inc.[2]	8144 Walnut Hill Lane Suite 297 Lock Box #9 Dallas, TX 75231	Quarries	Bryan.
The Dolese Co.[2]	Box 677 Oklahoma City, OK 73101	Pits and plants	Canadian, Kingfisher, Logan, Oklahoma.
Gainesville Sand & Gravel Co.	Thackerville, OK 73459	Pit and plant	Love.
Lemon Haskell Construction Co. of General Materials Co. Inc.	Box 75608 Oklahoma City, OK 73147	Pits and plant	Cleveland.
Industrial:			
UNIMIN Corp.	258 Elm St. New Canaan, CT 06840	Pit and plant	Pontotoc.
U.S. Silica Co.	Box 187 Berkeley Spring, WV 25411	Pits and plant	Johnston.
Stone:			
Crushed:			
Amis Materials Co.	Box 417 Atoka, OK 74525	Quarry	Atoka.
Anchor Stone Co. & Tulsa Rock Co., subsidiaries of Anchor Industries	3300 North Mingo Valley Expressway Tulsa, OK 74116	do.	Rogers and Tulsa.
Bellco Materials Inc.[3]	Box 466 Nowata, OK 74048	Quarries	Nowata, Rogers, Washington.
Material Producers Inc.	Box 577 Norman, OK 73070	Quarry	Murray.
McNabb Stone Co., a division of McNabb Coal Co. Inc.	Drawer C Catoosa, OK 74015	Quarries	Rogers and Wagoner.
Meridian Aggregates Co., a subsidiary of Burlington Northern Railroad	Box 86 Mill Creek, OK 74856	Quarry	Johnston.
The Quapaw Co.	Box 72 Drumright, OK 74030	Quarries	Creek and Pawnee.
Sooner Rock & Sand Co., a subsidiary of Hallett Construction Co.	Box 1549 Norman, OK 73070	Quarry	Murray.
Standard Industries, a division of APAC-Oklahoma Inc.	Box 580670 Tulsa, OK 74158	Quarries	Cherokee, Kay, Mayes,Tulsa.
Dimension:			
Bodie L. Anderson Quarries Inc.	Box 106 Mill Creek, OK 74856	Quarry	Johnston.
Miller Stone Co.	Route 1 Hackett, AR 72937	Quarry	Le Flore.
Pontotoc Stone Co.	1434 NW 30th St. Oklahoma City, OK 73118	do.	Johnston.
Willis-Oklahoma Red Granite Inc.	Box 867 Granite, OK 73547	do.	Greer.

See footnotes at end of table.

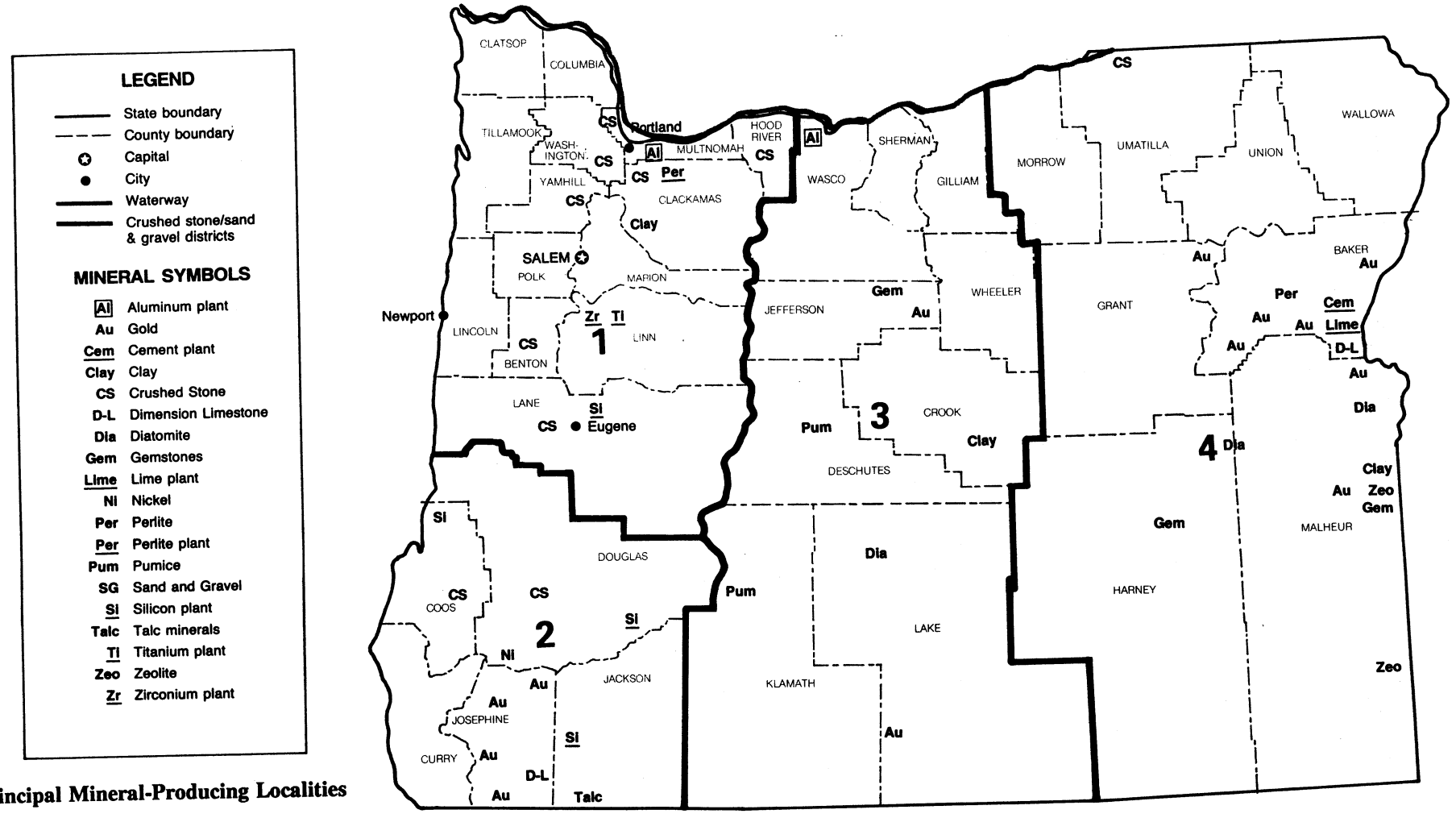
TABLE 4—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Tripoli:			
American Tripoli Co.	Box 489 Seneca, MO 64865	Mines	Ottawa.
Zinc:			
Zinc Corp. of America, a division of Horsehead Industries Inc.[4]	Box 579 Bartlesville, OK 74005	Electrolytic refinery	Washington.

[1]Also clays.
[2]Also stone.
[3]Also sand and gravel.
[4]Also sulfuric acid; copper, lead, and silver residues; and cadium balls.

OREGON



Principal Mineral-Producing Localities

THE MINERAL INDUSTRY OF OREGON

By Rodney J. Minarik[1]

The value of nonfuel mineral production in Oregon in 1990 rose to $237.4 million, an increase of more than 26% from that of 1989, according to the U.S. Bureau of Mines. Gains in the production value of portland cement, nto
44nickel, construction sand and gravel, and crushed stone were largely responsible for the increase. Industrial minerals accounted for the bulk of the State's total nonfuel mineral production value. The State ranked 36th in the Nation in that value compared with 37th in 1989. Oregon was the Nation's sole producer of emery and nickel. The State ranked first nationally in the quantity of pumice produced, third in diatomite production, and was a significant producer of processed natural zeolites.

TRENDS AND DEVELOPMENTS

Construction materials—portland cement, construction sand and gravel, and crushed stone—continued to be the most valuable minerals produced, accounting for the bulk of the State's total mineral production value. The combined value of the three commodities increased by almost 13% from that of 1989. Nickel and gold were the only metals produced in significant quantity; a minor amount of byproduct silver was reported. Nickel had the largest reported increase in both absolute value and percentage gain of all Oregon minerals, a result of the first full year of production at Glenbrook Nickel Co.'s newly reactivated plant near Riddle, Douglas County. Many mining companies that initiated or expanded exploration programs in reaction to the news of Atlas Corp.'s Grassy Mountain project, especially those companies working in the southeastern area of the State, spent a large part of the year evaluating and assessing their data.

EMPLOYMENT

According to the Oregon Employment Division, Department of Human Resources, the State's 1990 mining and quarrying employment was 1,600 workers, an increase from the revised benchmark figure of 1,500 workers reported for 1989. Reflecting the continued strength of the State's aluminum reduction industry, employment in the nonferrous metals sector increased to 5,500 workers from 5,300 in 1989. Blast furnace and iron and steel foundry employment rose to 5,700 workers in 1990, an increase of 100 over that of 1989. Weekly earnings for primary metals industry workers averaged $507 for a 40.3-hour workweek.

REGULATORY ISSUES

Ash Grove Cement West Inc. was seeking to avoid the need for a conditional use permit to burn shredded tires as fuel at its cement plant at Durkee, Baker County. The Oregon Department of Environmental Quality had issued a permit, but the decision was later overturned by the State Land Use Board of Appeals. Opponents argued that Ash Grove's stacks may spew toxic chemicals if the company was allowed to burn shredded tires. Ash Grove claimed that burning shredded tires as fuel would conserve fossil fuels, aid in the disposal of 2 million tires discarded annually in Oregon, and keep the company competitive in the marketplace. A vote

TABLE 1
NONFUEL MINERAL PRODUCTION IN OREGON[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	225,001	$1,049	210,893	$875	223,452	$1,390
Gemstones		NA	894	NA	1,304	NA	1,683
Nickel (content of ores and concentrates)	short tons	—	—	382	r4,662	4,080	W
Sand and gravel (construction)	thousand short tons	14,880	52,657	e14,400	e49,700	15,785	60,928
Stone (crushed)	do.	e22,200	e77,600	218,407	281,204	e 218,000	e 286,600
Talc and pyrophyllite	metric tons	W	W	204	18	105	10
Combined value of cement, diatomite, emery (1989-90), gold, lime, pumice, silver, stone (crushed dolomite and quartzite, 1989), value indicated by symbol W		XX	45,988	XX	r49,965	XX	86,795
Total		XX	178,188	XX	187,728	XX	237,406

e Estimated. r Revised. 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 stones; kind and value included with "Combined value" data.

by Baker County residents in 1989 prohibited Ash Grove from firing its kilns with industrial waste, including commercial solvents, degreasers, and paints.

EXPLORATION ACTIVITIES

Exploration in Oregon in 1990 may best be described as evaluation and assessment. Although there were requests for new exploration permits, many mining companies that initiated or expanded exploration programs during the past 2 years, especially those companies working in the southeastern area of the State, spent a large part of the year taking a more in-depth look at properties they already controlled. Several properties exchanged hands, and the year saw a number of negotiations to create partnerships and joint ventures.

Atlas Corp. completed an economic feasibility study and prepared a plan of operation for its Grassy Mountain gold property, south of Vale in Malheur County. The company continued environmental monitoring and definition drilling and anticipated that the permitting and development would be completed in early 1993. The operating plan includes development of an underground mine with a flotation mill and two open pits using heap-leach cyanidation. Mine life was projected to be at least 8 years. Silver also will be recovered as part of the gold-extraction process.

Chevron Resources Co. and Horizon Gold Shares Inc. continued exploratory drilling and began collection of baseline data on its Hope Butte gold project in northern Malheur County. Chevron drilled its Jessie Page (Quartz Mountain) property near Vale and granted MK Gold of Boise, ID, a 40% interest in the project. The company leased the Mahogany property in the Mahogany Mountains from Manville and drilled.

In an effort to earn 51% interest in the project, Billiton Exploration Inc. funded a drilling program on Ican Minerals Ltd.'s Racey gold property near Malheur City in northern Malheur County. Billiton agreed to an exploration and development program on the adjacent Shasta Gold property with the joint venture of Earth Search Sciences Inc., Beaver Resources, and GSR Goldsearch Resources, thus enlarging the total project area.

ASARCO Incorporated and Manville Corp. explored the Katey claims, American Copper and Nickel Co. drilled its prospect in Harper Basin, and both Echo Bay Exploration Inc. and Atlas conducted exploration in the Tub Mountain area. Malheur Mining Co. continued evaluation of its Kerby-East Ridge prospect near Farewell Bend, including a drilling program, bulk sampling, metallurgical testing, and environmental monitoring. In the Stockade area, Phelps Dodge Mining Co. drilled and sampled near Crowley and BHP-Utah International drilled on Stockade Mountain.

In Baker County, Simplot Resources Inc. opened a new drift at its Bourne Project in the Cracker Creek Mining District near Sumpter. A drilling program was being planned. Manville drilled and bulk sampled its Record-Grouse Creek prospects southeast of Unity. Formation Capital Corp. combined the Stalter, Pioneer, Golden West, and Wray Mine properties to form its Mammoth Property in Grant County. The prospect has both gold-copper and gold-silver targets. During the year, the company opened workings, trenched, sampled soils, and mapped. In Jefferson County, Bond Gold Exploration Co. drilled and mapped its Red Jacket prospect.

In Lake County, Wavecrest Resources Inc., a subsidiary of Quartz Mountain Gold Corp., announced a development schedule for its Quartz Mountain gold prospect, 33 miles west of Lakeview. The property contains the Crone Hill and Quartz Butte deposits and associated underground feeder veins. Exploration and development work, including extensive environmental studies, progressed under the direction of Pegasus Gold Inc., operating partner of both the Quartz Mountain property and the nearby Angel Camp deposit. The low-grade 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 Resources Corp. completed a drilling program at its Bornite copper-gold-silver project in the Cascade Mountains about 45 miles east of Salem in the North Santiam Mining District, Marion County. The company opened a project office in Mill City and was in the process of preparing mining permit application for the U.S. Forest Service and Oregon authorities. Plexus acquired the property from Cyprus Minerals Exploration Co. in 1989. The company also initiated geological and geophysical testing for satellite ore bodies.

Cominco American Resources Ltd. acquired an option on Savanna Resources Ltd's Turner Albright copper-zinc-gold property, sited near O'Brien, Josephine County. Cominco American can earn a 50% interest by completing an exploration and development program. Earlier in the year, Aur Resources decided not to exercise its rights to a similar option. Also in Josephine County, Cambiex USA Inc. and Dragon's Gold began a drilling and drifting program at the Martha Mine in the Greenback district.

LEGISLATION AND GOVERNMENT PROGRAMS

Federal and State government and private industry officials joined together to launch the "Oregon Metals Initiative," a $2 million research program to aid development of Oregon's metals industry. The initiative was being supported by $1 million in funding from the U.S. Bureau of Mines; $500,000 from Oregon's Strategic Reserve Fund, which is financed by the State Lottery; and $500,000 from the metals industry. The first round of research projects was to be carried out by Oregon State University and the Oregon Graduate Institute. Goals of the program are to find solutions to technical problems in processing, increase Oregon's pool of research talent, and improve the industry's long-term competitive position.

Significant developments in a number of

areas were achieved at the U.S. Bureau of Mines Albany Research Center during the past year. Two of the most notable were the development of technology to clean up our Nation's water and the joining of advanced materials.

One of the most promising developments in the maintenance and cleanup of our Nation's drinking and industrial water supplies is the liquid emulsion membrane (LEM) technology developed at the Albany Center. The technical soundness of this concept was proven in the laboratory and is now ready for scale-up to a precommercial demonstration unit. The most recent success of the LEM method was the removal of extremely high levels of contaminants from acid mine drainage waters emanating from the Berkeley Pit in Butte, MT.

Advanced intermetallics research continued at the Albany Center. This work stressed compounds that can be synthesized from domestically available resources. One necessary attribute for this class of materials is the availability of technologically sound joining techniques. As a group, intermetallics are quite hard, tough, and brittle, thus necessitating novel and better ways to put together useful compounds. One high-yield way to do this has been Albany Center's development and refinement of capacitive discharge welding (CDW) techniques. This method of joining intermetallics has emerged as one of the most successful to date for these advanced materials.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Cement.—Cement production in Oregon increased by more than 4% in volume and by 12% in value from that of 1989. The State's only cement producer, Ash Grove Cement West Inc., operated a cement plant and limestone quarry near Durkee, Baker County. The plant, the first dry-process cement plant in the Pacific Northwest 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 portland cement produced in the State was used by ready-mixed companies (82%); concrete product manufactures (9%); highway contractors (5%); and other contractors, building materials dealers, miscellaneous customers, and government agencies (4%). While debate continued on whether or not Ash Grove would be able to burn shredded tires as fuel, the Durkee plant was fueled almost exclusively by natural gas. All production from the Durkee operation leaves the plant in bulk by truck or rail.

Clays.—Total clay production in Oregon increased by 6% in quantity and almost 59% in value from that of 1989. Two types of clay were produced— bentonite and common clay.

Bentonite production about doubled in both quantity and value from that of 1989. According to the Bureau's survey, three companies in two counties accounted for Oregon's bentonite production. Central Oregon Bentonite Co. and Evergreen Bentonite Inc. ranked first and second in the State in both quantity and value produced. The two companies produced bentonite from adjoining properties on Camp Creek, 40 miles southeast of Prineville, Crook County. Teague Mineral Products Co., south of Adrian, Malheur County, was the State's third ranked producer of bentonite clay. Teague's premium-grade sodium bentonite was mined from deposits in northern Malheur County. The material was sold as a soil sealant for waste disposal sites, ditches, and ponds, for drilling mud, and as sealant for abandoned drill holes.

Common clay production in Oregon remained essentially the same in both quantity and value as that in 1989. Common clay, used chiefly in bricks and cement, was mined by three companies in Baker, Jackson, Klamath, Lane, and Multnomah Counties. Ash Grove Cement was the State's leading common clay producer.

Diatomite.—Oregon's diatomite production remained essentially the same in quantity and dropped more than 2% in value from that of 1989; the State again ranked fourth nationally for diatomite production. Diatomite was mined by Eagle-Picher Industries from Miocene lake sediments at a surface operation in the Juntura Basin, along the Malheur-Harney County line. The company trucked the material 70 miles to its Celatom diatomite processing facility west of Vale, Malheur County. The plant product was used for filter aids in water and food processing and for pharmaceuticals.

Oil-Dri Production Co. operated both an open pit and processing facility in Christmas Valley, Lake County. The diatomite was used as an oil absorbant and was packaged and sold under several brand names as pet litter.

Emery.—Oregon was the only State to report emery production in 1990. Oregon Emery Co. of Halsey produced emery from a deposit in eastern Linn County. The material was crushed and screened to specific particle shapes and size ranges and was used primarily in skid-resistant and hardened surfaces such as industrial floors, ramps, and traffic ways and on steel-bridge decking.

Gemstones.—The value of Oregon's gem stone production increased by 29% from that reported in 1989. Although not actually a rock, 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 gem stone production value.

Sunstone, a variety of feldspar, is Oregon's official gem stone. The production of sunstone occurred at three areas in Lake and Harney Counties. Opal also contributed significantly to Oregon's gem stone production value. Other gem stones produced that the State is well known for include various picture and scenic jaspers, agates, and petrified wood.

Lime.—Lime production decreased by almost 5% in quantity but increased by 7% in value from that of 1989. Quicklime accounted for the bulk of Oregon's production, almost 84% of the total lime produced in 1990. Ash Grove Cement at Portland, Multnomah County, sold both quicklime and all of the State's hydrated lime. The company produced hydrated lime at a kiln it operated in Portland. High-calcium limestone was barged in from Ash Grove's quarry on Texada Island near Vancouver, British Columbia, and used as the plant's feedstock. Production was consumed by local steel, chemical, and paper industry markets.

Amalgamated Sugar Co. at Nyssa, Malheur County, purchased high-purity crushed limestone from Ash Grove's Durkee pit, Baker County, for use as "sugar rock" feedstock at its plant in Nyssa. Amalgamated Sugar calcined the limestone to produce quicklime and used it in the processing of beet sugar.

Perlite.—The quantity of expanded perlite produced in Oregon and the value of the product were unchanged from those of 1989. Supreme Perlite Co. manufactured expanded perlite at its plant in Portland, Multnomah County. Some of the raw perlite used as feed came from the company's mine on Dooley Mountain, Baker County. Expanded perlite was used in the production of cryogenic, horticultural, masonry, and construction products.

Pumice.—Oregon pumice production again ranked first nationally for tonnage produced. Production increased by 6% in quantity and 3% in value from that of 1989. Cascade Pumice Co. and Central Oregon Pumice Co. produced pumice from surface mines and operated crushing and screening plants in the Bend area, Deschutes County. 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, and for horticultural purposes.

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 1988 and 1990 and estimates for 1989.

Construction sand and gravel production reported in Oregon increased by almost 10% in quantity and almost 23% in value from that estimated for 1989, and 6% in quantity and almost 16% in value from that surveyed in 1988. 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 78% of the surveyed output. Production was reported in 26 of the State's 36 counties. Columbia, Lane, Marion, and Multnomah were among the leading sand-and-gravel-producing counties.

Major uses were for road base and coverings (27%), and concrete aggregates, including concrete sand (23%). Table 3 presents end-use data for construction sand and gravel produced 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.—CooSand Corp. produced silica sand 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 most 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 (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 1988 and 1990 and actual data for 1989.

Although estimated stone production in Oregon dropped more than 2% in quantity from what was reported in 1989, the estimated value of Oregon crushed stone output rose by almost 7%. Baker, Benton, Lane, Multnomah, and Washington were among the State's leadingcrushed-stone-producing-counties. Reflecting the predominantly volcanic nature of the State's geology, the bulk of Oregon's crushed stone was traprock (basalt). Other types of crushed stone produced in Oregon include granite, limestone, sandstone, and volcanic cinder.

Glenbrook Nickel used crushed quartz, from the Quartz Mountain Mine in eastern Douglas County, at its nickel smelting operation at Riddle. Crushed and screened quartz was produced by Bristol Silica and Limestone Co. at its Jackson County quarry near Gold Hill. The material had a variety of uses, including filter beds, poultry grit, sandblasting, and decorative stone. Campman Calcite Co. closed its Jones Marble limestone operation near Williams, Josephine County.

Talc (Soapstone).—Talc production dropped by almost 47% in quantity and almost 56% in value from that of 1989. 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 principle 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 Products Co. mined clinoptilolite from deposits in the Succor Creek Formation in Malheur County. Although many Oregon zeolite deposits have been documented, Teague Mineral was the only company to commercially mine a natural zeolite product in Oregon in 1990. 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 treatments.

Metals

Aluminum.—Primary aluminum production in Oregon increased 2% in quantity, but value dropped by 14%, the result of a significant drop in prices. Aluminum prices, which averaged $1.10 per pound in 1988 and $0.88 per pound in 1989, dropped to $0.74 per pound in 1990.

In spite of the price drop, Reynolds Metals Co. operated its Troutdale smelter at close to its 121,000-metric-ton-per-year rated ingot capacity. The Multnomah County plant processed imported alumina from Australia and Jamaica. Northwest Aluminum Co. also continued to operate its tolling smelter at The Dalles in Wasco County at close to its annual rated ingot capacity. The 82,000- metric-ton-per-year plant obtained all its alumina from Australia. The company operated the smelter under a lease-purchase agreement signed in 1986 with Martin Marietta Corp.

Copper.—Formosa Exploration Inc., a subsidiary of Formosa Resources Corp. of British Columbia, received an operating permit for its Silver Peak Project, a gold-containing massive copper-zinc sulfide ore body, about 7 miles south of Riddle in Douglas County. Underground development was started, construction began on the mill buildings and tailings pond, and essential mill equipment was in place. Several thousand tons of ore reportedly have been stockpiled. Studies continued on the gold and silver contained in the sulfide ore. A letter of intent has been signed that provides for copper and zinc concentrates to be hauled to Vancouver, WA, and sent to a smelter in Japan for further processing.

Columbium, Hafnium, Tantalum, Titanium, and Zirconium.—Teledyne Wah Chang Albany Corp. (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. Columbium pentoxide, high-purity ferrocolumbium, nickel columbium, and columbium metal were among the products produced.

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. Hafnium metal, a byproduct of TWCA's zirconium production, was produced in the form of 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. After completing construction of 2 additional reduction furnaces in 1990, making a total of 10, OREMET's titanium plant at Albany, Linn County, had a rated capacity of 6,800 metric tons per year. According to a company official, the on-site magnesium plant was substantially expanded to support the additional titanium sponge output. Both OREMET and TWCA produced titanium ingot at their Oregon plants in 1990; TWCA's ingot was used in-house.

Gold.—Reported gold production dropped by almost one-half in both quantity and value from that reported in 1989. Known gold production came mainly from small placer mines in southwestern and northeastern parts of the State. The Bonnanza Mine, a placer gold operation on Pine Creek near Halfway, Baker County, was the State's largest producer. The mine is operated on a seasonal basis, ideally April through November. Reclamation work was done along with production; the northern part of the site has been reclaimed.

The Oregon Department of Geology and Mineral Industries reported additional placer production on Sucker Creek, Josephine Creek, and in the Galice area in Josephine County; on Deer Creek, Elk Creek, and in Rye Valley in Baker County; in the Mormon Basin near the Baker County-Malheur County line; and on Big Creek in Grant County.

As in previous years, only a small amount, less than one-half metric ton, of silver production was reported in 1990.

Nickel.—The Glenbrook Nickel Co. nickel smelter near Riddle, Douglas County, had its first full year of production after being reactivated in 1989 as a joint venture of Cominco American Resources and USA Investments. The plant processed the screened low-grade laterite stockpile that was left at the site when Hanna Mining Co. closed the Nickel Mountain Mine and smelter in 1987. Glenbrook Nickel began to mine fine-grained ore from waste dumps and abandoned settling ponds in an effort to improve size mix of the furnace feed. The company was developing plans to obtain additional ore by reopening the Nickel Mountain Mine and mining high-grade pods and/or importing ore from offshore resources, possibly New Caledonia or Indonesia.

Silicon Metal and Ferrosilicon.—Dow Corning Corp. produced silicon metal at

its facility in Springfield, Lane County. All of 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 10,000 short tons of silicon metal annually. The Bonneville Power Authority supplied the plant's electric power, and all raw materials were obtained domestically.

Glenbrook Nickel ceased on-site ferrosilicon production at its Riddle operation and began to purchase the material on the open market. Ferrosilicon is used by Glenbrook Nickel in the production of ferronickel.

Steel.—Cascade Steel Rolling Mills Inc., operators of a minimill in McMinville, Yamhill County, continued construction of a new melt shop. The plant, capable of producing more than 600,000 tons annually, was being built by Danieli S.p.A., an Italian equipment manufacturer. The increased billet production is expected to correct a raw steel shortfall at the McMinville plant, allow the company 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., a Portland-based steelplate and pipe producer, purchased and reopened California Steel Industries's plate mill at Fontana, CA. The mill was part of the defunct Kaiser Steel Corp. operation that was later bought by California Steel in 1984. Oregon Steel announced it has been awarded a number of contracts for pipe production from its Fontana mill and a pipe mill the company owns in Napa, CA. Oregon Steel's Portland plant supplied the Fontana mill with slab and the Napa mill with plate.

[1]State Mineral Officer, U.S. Bureau of Mines, Spokane, WA. He has 16 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.

TABLE 2
OREGON: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,669	$14,207	$3.87
Plaster and gunite sands	19	113	5.95
Concrete products (blocks, bricks, pipe, decorative, etc.)	9	45	5.00
Asphaltic concrete aggregates and other bituminous mixtures	2,377	10,902	4.59
Road base and coverings	4,183	16,100	3.85
Fill	434	1,245	2.87
Snow and ice control	93	499	5.37
Railroad ballast	W	W	4.80
Other[1]	1,014	3,215	3.17
Unspecified:[2]			
Actual	2,379	9,586	4.03
Estimated	1,609	5,017	3.12
Total[3] or average	15,785	60,928	3.86

W Withheld to avoid disclosing company proprietary data; included with "Other."
[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.

TABLE 3

OREGON: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, BY DISTRICT AND USE[1]

(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[2]	2,871	11,175	657	2,346	4	24	164	821
Asphaltic concrete aggregates and other bituminous mixtures	1,822	8,644	441	1,759	W	W	W	W
Road base and coverings	3080	12,065	655	2,335	23	92	424	1,608
Fill	115	221	121	296	—	—	197	729
Snow and ice control	55	311	11	41	—	—	27	147
Railroad ballast	W	W	—	—	—	—	—	—
Other miscellaneous[3]	611	1,457	400	1,720	43	129	75	407
Unspecified:[4]								
Actual	2,325	9,377	—	—	—	—	45	176
Estimate	1,434	4,361	175	656	—	—	—	—
Total[5]	12,312	47,611	2,461	9,152	70	245	932	3,888

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."

[1]Excludes 8,780 short tons valued at $32,662 not reported by county.

[2]Includes plaster and gunite sands.

[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.

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.
Reynolds Metals Co.	5100 NE Sundial Rd. Troutdale, OR 97060	do.	Multnomah.
Cement:			
Ash Grove Cement West Inc.[1]	5550 SW Macadam Ave. Suite 300 Portland, OR 97201	Plants and quarries	Baker.
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	Surface mine	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.	5550 SW Macadam Ave. Suite 300 Portland, OR 97201	Plant	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	5 NW Greenwood Ave. Bend, OR 97701	Pit	Do.
Sand and gravel (construction):			
Lone Star Northwest Aggregates	3510 SW Bond St. Portland, OR 97201	Pit	Columbia.
Morse Brothers Inc.	Box 7 Lebanon, OR 97355	Pits	Benton, Linn, and Marion.
River Bend Sand & Gravel Co.	Box 12095 Salem, OR 97309	Pit	Marion.
Ross Island Sand & Gravel Co.	4315 SE McLaughlin 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.

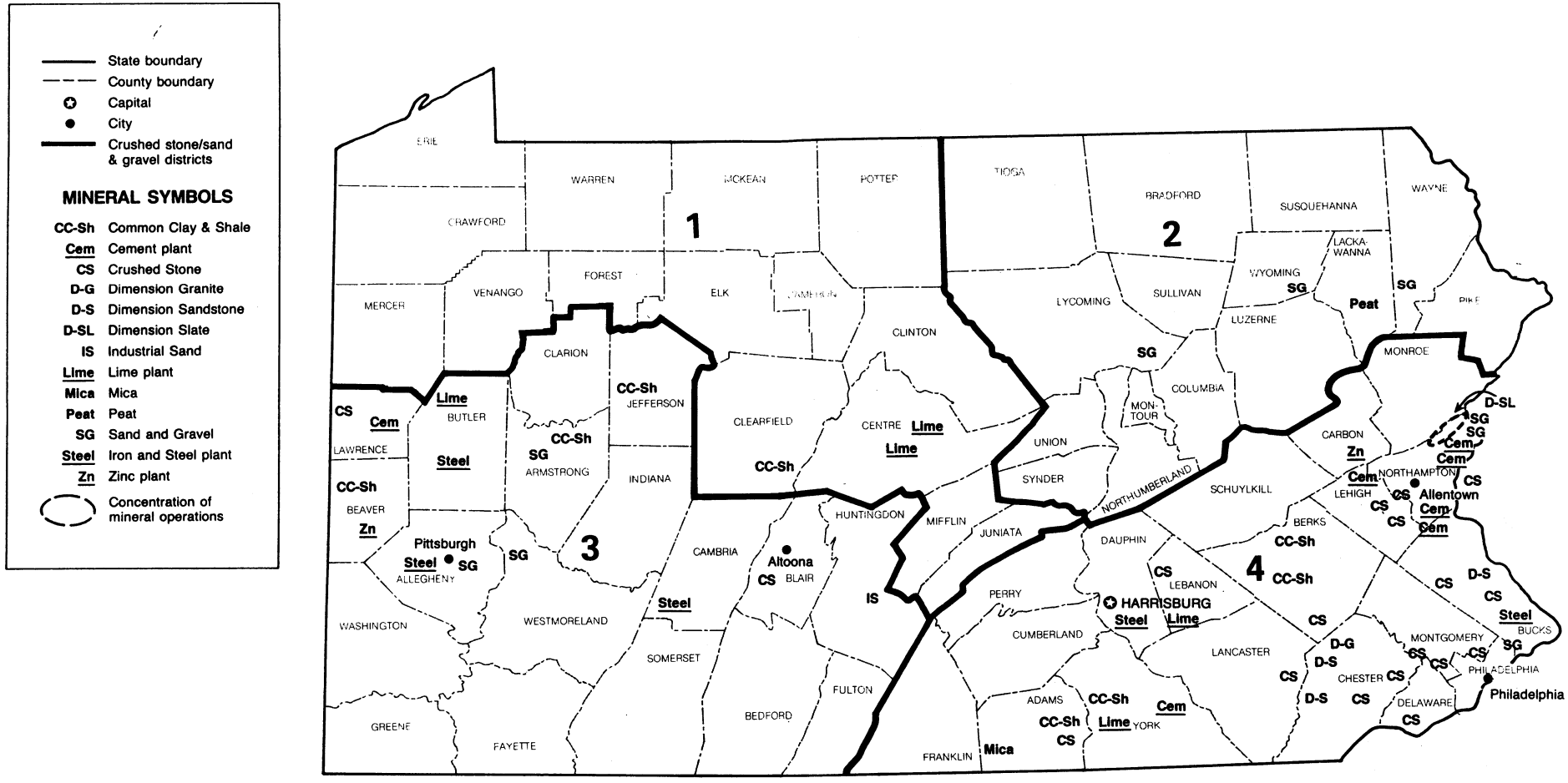
See footnotes at end of table.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Zeolite:			
Teague Mineral Products Co.[2]	Box 35-C, Route 2 Adrian, OR 97901	Surface mine and plant	Malheur.
Zirconium:			
Teledyne Wah Chang Albany[3]	1600 NE Old Salem Rd. Albany, OR 97321	Plant	Linn.

[1]Also clays, pumicite, and crushed stone.
[2]Also bentonite.
[3]Also columbium, hafnium, tantalum, and vanadium.

PENNSYLVANIA



Principal Mineral-Producing Localities

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 was more than $1 billion for the fourth consecutive year. The State's industrial minerals producers again benefited from strong demand by the construction industry. Output of steel and coal increased slightly, and Pennsylvania remained the Nation's third and fourth leading producer of these commodities, respectively.

Pennsylvania also retained its position as the number one producer of crushed stone in the United States. Nationally, the State ranked 12th in value of nonfuel mineral production, accounting for about 3% of the U.S. total.

EMPLOYMENT

In 1990, Pennsylvania employed 27,000 workers in mining and 88,000 workers in primary metals, a decline of 1,000 workers in mining and about 4,000 in metals compared with those of 1989.[3]

In 1990, employment in the construction industry also decreased compared to that of 1989, by 5% to 232,000 workers.

LEGISLATION AND GOVERNMENT PROGRAMS

Commemoration of the 20th anniversary of Earth Day in April coincided with the introduction of legislation on environmental protection. Senate bill 814 provided for a $5 million remining fund for use in mining coal from previously abandoned mines. Three bills were introduced relating to wetlands protection that would create programs for the State to purchase wetlands, provide compensation if a court finds an owner has lost property because of wetlands designation, and streamline the wetlands permitting process. All these bills were carried over for action in the 1991 legislative session.

The Pennsylvania Coal Association published a booklet titled "1990 Pennsylvania Coal Data--A Summary of

TABLE 1
NONFUEL MINERAL PRODUCTION IN PENNSYLVANIA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	391	$28,713	349	$26,473	303	$22,594
Portland	do.	6,309	329,634	5,757	301,980	5,621	286,185
Clays[2]	metric tons	1,248,139	5,843	1,049,973	4,936	840,646	2,900
Gemstones		NA	5	NA	5	NA	5
Lime	thousand short tons	1,641	91,214	1,660	92,139	1,626	92,557
Peat	do.	21	736	20	746	18	730
Sand and gravel (construction)	do.	19,826	91,966	e19,500	e94,600	20,883	97,348
Stone:							
Crushed	do.	e104,600	e470,700	r93,123	r455,004	e r95,800	e r502,700
Dimension	short tons	e59,022	e9,584	44,267	10,032	e43,952	e9,898
Combined value of clays (fire, [1990], kaolin), mica (scrap), sand and gravel (industrial), stone (crushed granite, 1989-90), and tripoli.		XX	14,098	XX	14,754	XX	15,125
Total		XX	1,042,493	XX	1,000,669	XX	1,030,042

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

Production, Market, Employment, and Safety Information."[4] In 1990, Pennsylvania produced about 74 million short tons of bituminous coal and 3.5 million tons of anthracite.

The U.S. Bureau of Mines Pittsburgh Research Center continued research programs directed at improving health, safety, and productivity in the mining industries and conserving environmental resources. Mine-scale research was conducted under controlled conditions at facilities, including the Experimental Mine, the Safety Research Coal Mine, the Mine Equipment Test Facility, the Wire Rope Laboratory, and the Lake Lynn Laboratory. Details on the research work at the Center were published in Program of Research 1991.[5]

The Pennsylvania Bureau of Topographic and Geologic Survey was the primary State agency involved in mineral resources investigations. In 1990, the Survey published reports on the ground water resources of Pike County, coal resources of Cambria and Blair Counties, and Fossil Collecting in the Pittsburgh area.[6] The survey also continued resource studies aimed at identifying high-purity carbonates as well as evaluating mica, silica, and talc resources for use as mineral fillers.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

In 1990, 4 of the 12 nonfuel minerals produced in Pennsylvania accounted for about 95% of the total value as given in table 1. Output of crushed stone and portland cement accounted for 49% and 28% of the State's value, respectively. Construction sand and gravel and lime each contributed 9%. The combined output of sand and gravel and crushed stone increased by 4%. Production of lime and portland cement declined slightly.

Cement.—Production of portland cement declined for the third year in a row. Pennsylvania was the Nation's fourth leading producer of portland cement; the State had ranked third in output in 1989.

During the year, Carlow Group Companies sold its cement plant in Bessemer to Societe des Ciments Francais of France. Ciments Francais already owned cement plants in Coplay and Nazareth and operated as Essorock Materials Inc.

An issue in Pennsylvania's, as well as the Nation's, cement industry was the burning of waste products for use as fuel at cement plants.

Kosmos Cement Co. received permission from Allegheny County officials in December to burn hazardous waste material at its Neville Island plant near Pittsburgh. In eastern Pennsylvania, Keystone Cement Co. sought permission from the State Department of Environmental Resources (DER) to expand the quantity and type of waste it burns. Keystone has burned an average of about 8.5 million gallons of waste annually, mostly flammable solvents, during the past 14 years. Lafarge Corp., at its Whitehall plant, applied to the DER for permission to burn scrap automobile tires as tire-derived fuel. All three of these actions were pending at yearend.

At all three of these cement plants, citizen groups have been formed to oppose the use or expansion of waste burning. Cement company officials claimed the burning of waste provided a significant cost savings for the energy intensive manufacture of cement and was necessary to remain competitive in the global marketplace.

Lime.—For the third successive year, Pennsylvania produced more than 1.6 million short tons of lime. The State also remained the Nation's third leading producer of lime.

Corson Lime Co., Montgomery County, was denied permission to build a conveyor belt over a 1½-mile stretch of roadway in 1989. In 1990, Corson redesigned the project so as to construct the conveyor belt under the roadway. The $3 million project, expected to be completed in the spring of 1991, will allow the company to transport limestone to its lime plant without the use of haulage trucks. The conveyor system has the capacity to move 8,000 tons of stone per day from quarry to plant.

Another of the State's lime producers, Bellefonte Lime Co., Centre County, filed an appeal in county court after local government officials rejected the company's application for a permit to mine limestone on a 170-acre site in Benner and Patton Townships. Permission for the new quarry was sought because only an estimated 3 years of limestone reserves remain at the company's quarry in Pleasant Gap. At yearend, the matter remained pending in court.

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 1988 and 1990 and estimates for 1989.

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 sand and gravel in Pennsylvania exceeded 20 million short tons for the first time since 1979. Sand and gravel was produced in 39 of the State's 67 counties. Armstrong, Beaver, Bradford, Crawford, and Luzerne were the leading producing counties. Statewide, 113 companies operated 154 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 1988 and 1990 and actual data for 1989.

In each of the past 4 years, Pennsylvania has led the Nation in output of crushed stone, with annual production averaging 97.7 million short tons. As Pennsylvania's crushed stone industry produced these record tonnages, the opening and expansion of quarries remained a controversial issue in many

towns and communities. Generally, citizens claimed that developments in the stone industry would cause noise, dust, and increased traffic, thus degrading the quality of life and potentially lowering the value of their homes and property. At the same time, the general public expects new and well maintained roads for which crushed stone is needed.

A quarry controversy in West Rockhill Township, Montgomery County, was finally settled after 21 years. The Pennsylvania Supreme Court ordered West Rockhill officials to issue Mignatti Construction Co. permission to open a quarry on an 81-acre site in the township.

However, as one dispute ended, others continued. In Bucks County, Durham Township officials adopted new zoning ordinances to restrict quarry development. In Berks County, Union Township officials sought to restrict quarrying to 25 acres of a 162-acre site that had been purchased by a stone producer. In Upper Merion Township, residents claimed quarry blasting had caused damage to their homes. State DER officials maintained the blasting and vibrations from the operation were below State limits. The residents subsequently have requested the DER and State government to adopt more stringent regulations.

These quarry controversies, along with others, remained pending at yearend. Conflicts between residents and developers were expected to continue until long-term land use planning decisions at the local government level can be reconciled.

Other Industrial Minerals.—The following mineral commodities collectively accounted for about 5% of the value of Pennsylvania's nonfuel mineral production as given in table 1.

Masonry cement was produced at 10 plants in Pennsylvania in 1990. Output dropped to about 300,000 short tons, a decline of about 25% since 1988. The State again ranked third nationally in output of masonry cement. Common clay and shale used in brick manufacture was produced at 24 pits. Berks and York Counties led the State in output. Small quantities of fire clay and kaolin were also mined in Pennsylvania. Scrap mica was produced near Fairfield, Adams County, and sold primarily as a filler. Peat was produced in four counties in the State, with most of the output coming from Lackawanna and Monroe Counties. Industrial sand used in the manufacture of glass containers was mined in Huntingdon County. Bluestone, slate, sandstone, and diabase were quarried for dimension stone products. The bluestone industry in Susquehanna County sought changes in the State's bonding and reclamation regulations. The bluestone producers wanted an exemption to the regulations for operations producing less than 1,000 tons per year. Tripoli or rottenstone was produced by one company in Northumberland County and sold for use as a mild abrasive for polishing compounds and as a filler material.

Mineral commodities processed in Pennsylvania included those that were imported, shipped from domestic sources outside the State, or manufactured into higher value end products. Commodities surveyed by the U.S. Bureau of Mines were iodine, iron oxide materials, expanded perlite, sulfur (recovered), sulfuric acid, and exfoliated vermiculite. The combined value of these commodities was about $39 million. Synthetic graphite was manufactured by four companies at four plants.

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.

Iron and Steel.—Steel production increased slightly to about 12 million short tons, according to data published in the Pennsylvania Business Survey by The Pennsylvania State University. Highlighting the year for the State's steel industry was the beginning of construction of a new continuous caster by USX Corp. Installation of the continuous caster was part of an agreement by USX and the United Steelworkers Union that was settled in 1987. The caster was expected to have a capacity of 2.6 million tons per year.

In other developments, J&L Specialty Products Corp. became a subsidiary of Ugine ACG of France. J&L Specialty purchased its operations from LTV Corp. in 1986. A closed seamless tube operation once owned by Babcock & Wilcox Co. in Beaver County was purchased for $130 million by NS Group Inc. of Kentucky. The sale was completed in November, and initial plans were for limited operation. At peak operation, the facilities were used to produce about 180,000 tons of seamless tubular products annually.

Zinc.—Zinc Corp. of America (ZCA) operated a primary electrothermic smelter at Monaca. Horsehead Resource Development Co. (HRD), a company affiliated with ZCA, recovered crude zinc calcine from electric arc furnace dust, a waste material from steelmaking, at a plant in Palmerton.

Late in the year, ZCA announced plans for a joint venture with Mitsui Mining & Smelting Co. to produce zinc dust products. These zinc dust products would be used as an alternative material for mercury in the manufacture of alkaline batteries.

HRD began a $40 million expansion project at its Palmerton operations. The firm, during the 2-year project, expected to add two new kilns and increase capacity to process the electric arc furnace dust from 335,000 short tons to 520,000 tons per year.[7]

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related industry and government experience and has covered the mineral activities in Pennsylvania for 8 years. Assistance in the preparation of the chapter was given by Sally 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 Admin., The Pennsylvania State Univ., University Park, PA Feb. 1990, p. 4.

[4]Pennsylvania Coal Data 1990. PA Coal Association, 212 North 3rd St., Suite 102 Harrisburg, PA 17101, Nov. 1990, 24 pp.

[5]Pittsburgh Research Center Program of Research, FY 1991, 99 pp.

[6]Pensylvania Geology. Bureau of Topographic and Geologic Survey. V. 21, No. 6, Oct. 1990, 16 pp.

[7]Northeast Pennsylvania Business Journal. Palmerton Firm Corners Market in Recycling Zinc. Dallas, PA pp. 3-5.

TABLE 2

PENNSYLVANIA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	6,718	$34,767	$5.18
Plaster and gunite sands	239	1,745	7.30
Concrete products (blocks, bricks, pipe, decorative, etc.)	497	2,911	5.86
Asphaltic concrete aggregates and other bituminous mixtures	2,426	13,153	5.42
Road base and coverings[1]	5,189	19,633	3.79
Fill	599	2,277	3.80
Snow and ice control	195	911	4.67
Other[2]	682	2,753	4.04
Unspecified:[3]			
Actual	1,973	8,977	4.55
Estimated	2,366	10,222	4.32
Total[4] or average	20,883	97,348	4.66

[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules and 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.

TABLE 3

PENNSYLVANIA: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, BY DISTRICT AND USE[1]

(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)	1,940	8,371	1,443	7,806	1,462	7,601	1,873	10,989
Plaster and gunite sands	W	W	40	336	W	W	172	1,250
Concrete products (blocks, bricks, etc.)	155	667	117	842	132	747	93	654
Asphaltic concrete aggregates and other bituminous mixtures	462	2,578	828	4,107	917	4,565	219	1,903
Road base and coverings[2]	1,053	3,700	1,058	5,755	2,463	6,586	616	3,592
Fill	203	606	248	1,075	70	221	77	375
Snow and ice control	109	415	55	333	15	59	16	103
Other miscellaneous[3]	315	1,005	93	548	136	710	166	647
Unspecified:[4]								
Actual	248	669	19	120	1,078	5,382	477	206
Estimated	595	2,750	961	3,602	301	1,120	508	2,750
Total[5]	5,080	20,762	4,861	24,525	6,573	26,990	4,217	24,331

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Excludes 151,785 short tons valued at $739,193 not reported by county.
[2]Includes road and other stabilization (cement and lime).
[3]Includes roofing granules and 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.

TABLE 4

PENNSYLVANIA: LIME SOLD OR USED BY PRODUCERS, BY USE

Use	1989		1990	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Agriculture	16,530	$1,109	12,425	$739
Acid water neutilization	56,704	2,706	83,044	4,518
Paper and pulp	26,371	1,230	45,662	2,244
Steel:				
Basic oxygen	450,862	22,737	350,718	19,878
Electric	220,397	10,813	193,022	9,619
Sewage treatment	109,852	4,109	46,390	2,476
Water purification	54,657	2,562	38,829	2,394
Other[1]	724,863	46,873	855,489	50,689
Total	1,660,236	92,139	1,625,579	92,557

[1]Includes glass, industrial solid waste, ladle desulfurization, open hearth steel, ore concentration, other chemical and industrial, other metallurgy, petroleum refining, refractory, road stabilization, sugar refining, sulfur removal, tanning, and wire drawing.

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.
Essorock Materials Inc.	Drawer 32 Nazareth, PA 18064	Plant and quarries	Lehigh and Northampton.
LaFarge Corp.	5160 Main St. Whitehall, PA 18052	Plant	Lehigh.
Hercules Cement Co.	Center St. Stockertown, PA 18083	Plant and quarry	Northampton.
Lone Star Industries Inc.	Wood & Prospect Sts. Box 270 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.
Fire:			
The Brockway Clay Co.	Box C Brockway, PA 15824	Pit	Jefferson.
Kaolin:			
Narvon Products Corp.	900 East 8th Ave., Suite 200 King of Prussia, PA 19406	Pit and plant	Lancaster.
Lime:			
J. E. Baker Co.	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.[1]	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.	525 William Penn Place Pittsburgh, PA 15219	Plant	Butler.
Peat:			
Hyponex Corp.	2013 South Anthony Blvd. Fort Wayne, IN 46803	Bog and plant	Monroe.
Lake Benton Soil Products Inc.	Rural Delivery 1 Dalton, PA 18414	Bog	Lackawanna.
Sand and gravel:			
Construction:			
A. Barletta & Sons	Box 40 Hazelton, PA 18201	Pits and plant	Luzerne.
Davison Sand & Gravel Co.	400 Industrial Blvd. New Kensington, PA 15068	Dredge and pits	Armstrong and Westmoreland.

See footnotes at end of table.

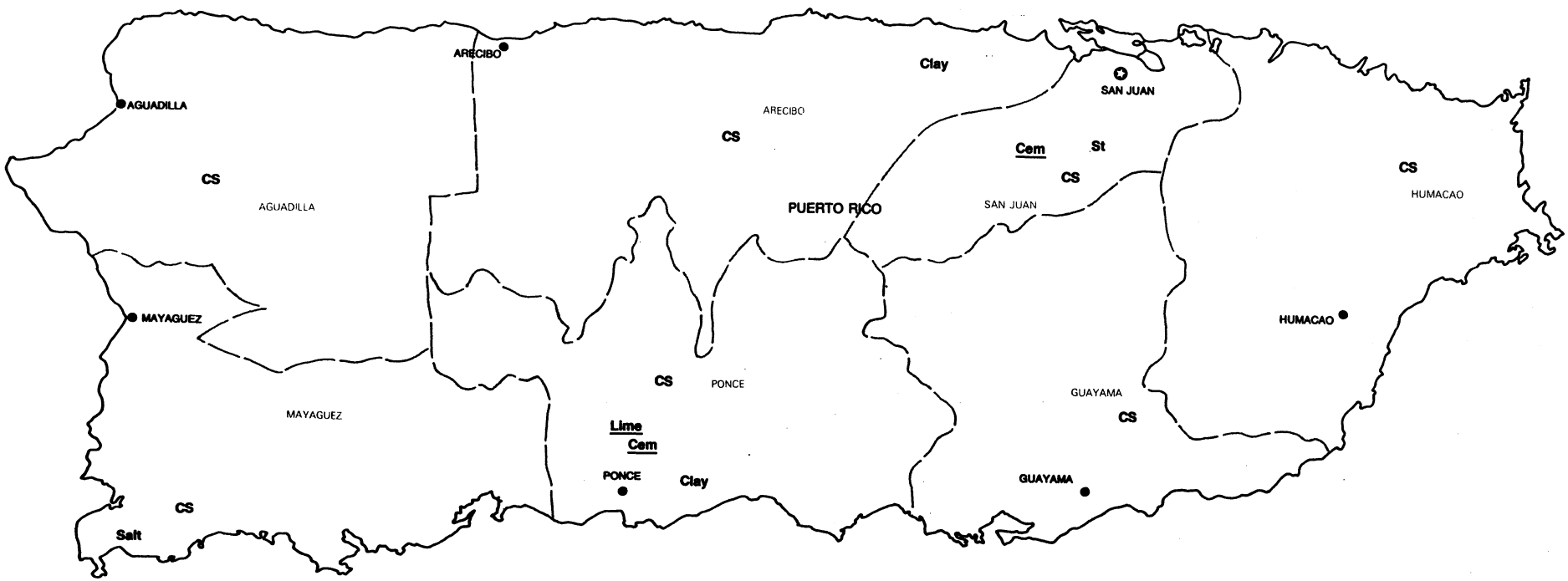
TABLE 5—Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Construction—Continued			
Dravo Basic Materials Co.	4800 Grand Ave. Pittsburgh, PA 15225	Dredge, pit, plant	Allegheny and Beaver.
Eastern Industries Inc.[1]	Rural Delivery 3, Box 150 Center Valley, PA 18034	Pits and plant	Bradford and Northampton.
Glacial Sand & Gravel Co. Inc.	Box 1022 Kittanning, PA 16201	Dredge and plant	Armstrong.
Hasbrouck Sand & Gravel Inc.	Rural Delivery 4 Titusville, PA 16354	Pit and plant	Crawford.
Warner Co.	699 Bristol Pike Morrisville, PA 19067	do.	Bucks.
Wyoming Sand & Stone Co.	R.D. 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.
Stone:			
Crushed:			
Beazer East Inc.[2]	436 7th Ave. Pittsburgh, PA 15219	Quarries and plants	Centre, Chester, Clinton, Columbia, Delaware, Lycoming, Monroe, Montour, Tioga, Wayne, York.
Eureka Stone Quarry Inc.	Lower State & Pickerton Sts. Chalfont, PA 18914	do.	Bucks, Lackawanna, Monroe, Pike.
Glasgow Inc.	Box 248 Glenside, PA 19038	do.	Chester and Montgomery.
New Enterprise Stone & Lime Co. Inc.	Rural Delivery 3 New Enterprise, PA 16664	do.	Adams, Bedford, Blair, Centre, Cumberland, Franklin, Huntingdon, Lancaster, Somerset.
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 stone.
[2]Also sand and gravel.

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

THE MINERAL INDUSTRY 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 Ramon M. Alonso[2]

THE COMMONWEALTH OF PUERTO RICO

The value of nonfuel mineral commodities reported by the U.S. Bureau of Mines in 1990 was $126.3 million. This figure does not include two commodities reported in 1989, clay and crushed stone. The Commonwealth's leading commodity, cement, increased 8.6% over the 1989 value. This increase was primarily the result of approximately $1.5 billion of financial aid given Puerto Rico by the Federal Government in late 1989 and the first half of 1990 to help the island repair the damage caused by Hurricane Hugo.

Trends and Developments

Puerto Rico was one of four disaster areas created as a result of Hugo. The other three, Virgin Islands, South Carolina, and North Carolina, received significantly less aid given directly to families affected by the storm. This resulted because a much larger number of people poor enough to qualify for Federal family and housing grants were victims of the storm in Puerto Rico than in the other three areas. According to the Department of Social Services in San Juan, 62% of the Puerto Rican population lives below the poverty level and receives some type of welfare or other Federal assistance. The per capita income in Puerto Rico was $5,157, and more than 280,000 people applied for grant money following the hurricane. Puerto Rico received $576.3 million in family and housing grants compared to $99 million for the Virgin Islands and $102.6 million for South and North Carolina combined.

Overall, total aid, which amounted to $2.6 billion, was much more equitably distributed. This aid included public assistance for roads, bridges, and buildings; loans from the Small Business Administration and the Department of Agriculture; flood insurance payments; and other Federal funding. Total aid payments amounted to $881 million for Puerto Rico, $609 million for the Virgin Islands, and $1.1 billion for the Carolinas.

The aforementioned payments were part of a total of $7.7 billion that the Federal Government injected into Puerto Rico in

TABLE 1
NONFUEL MINERAL[1] PRODUCTION IN THE COMMONWEALTH OF PUERTO RICO

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland)	thousand short tons	1,397	$113,966	1,374	$112,318	1,486	$122,027
Clays	metric tons	148,218	365	136,873	311	W	W
Lime	thousand short tons	25	3,802	26	3,800	29	3,483
Salt	do.	40	900	—	—	—	—
Sand and gravel (industrial)	do.	31	624	30	600	55	825
Stone (crushed)	do.	e9,350	e47,400	8,389	46,648	NA	NA
Total[2]		XX	167,057	XX	163,677	XX	126,335

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.

fiscal 1990. This was more than the foreign aid granted to any country in the world and more than was received by 16 States in the Union.

Puerto Rico's mineral production is almost entirely dependent upon the Commonwealth's construction industry. Construction projects scheduled for the first quarter of 1990 made industry experts optimistic about 1990's prospects. In March, a bid was let for a $100 million Old San Juan waterfront restoration project. Groundbreaking for the $25 million multipurpose Centro Europa Project in Santurce also occurred in March. However, the optimism waned later in the year when a $1.2 billion resort in Isabela, Costa Isabela, originally scheduled to break ground in October, was delayed to 1992. The project was to be financed largely by Japanese investors.

By midyear, most of the Hugo relief funds had been distributed, and construction slowed dramatically. As the year progressed, the recession on the U.S. mainland and the Iraq invasion of Kuwait created uncertainty in the industry. This caused a further slowdown of the economy and resulted in further decreases in mineral production.

Senate bill 244, a bill to grant a referendum on the political status of Puerto Rico, was being debated by the U.S. Senate Energy and Natural Resources Committee at yearend. Uncertainty over the economic effects of the plebiscite, if it is held, has restrained companies from making new or expanded investments in Puerto Rico.

Section 936 of the U.S. Internal Revenue Code, established by the U.S. Federal Taxes Act of 1976 and 1986, permits U.S. manufacturers to repatriate profits from Puerto Rico free of U.S. Federal tax. Section 936 has become a flexible mechanism for economic development, not only in Puerto Rico, but throughout the Caribbean. The profit-to-sales ratio, after tax, reported in Puerto Rico is five times higher than the average for mainland U.S. manufacturers. More than 500 mainland U.S. corporations and almost 100 foreign companies with subsidiary manufacturing and service operations in Puerto Rico receive combined profits totaling approximately $4 billion per year, according to Puerto Rico Treasury Department data.

The construction industry still faced old problems that plagued it prior to 1990. Many water-treatment plants belonging to the Puerto Rico Aqueduct and Sewer Authority (PRASA) were still the subject of Federal bans with new hookups denied to them. Additionally, up to 22 different public agencies were involved in the permitting process. A one-step permitting process initiated in 1990 was not working. Industry officials[3] complained that officials in district offices did not have the authority to make decisions, and the office in San Juan was open only 1 day a week. Instead of alleviating the problem, the new procedure added an additional step in the process.

Water pollution and waste were also issues causing concern. In March, the overflow of sewer lines in Condado prompted the U.S. Environmental Protection Agency (EPA) to instruct PRASA to rehabilitate the sanitary systems or face a ban on any more sanitary and water hookups in the area. In May, EPA gave PRASA until January 1, 1993, to make the necessary improvements. At yearend, new regulations scheduled to become effective in September 1991 had not been issued by EPA. The new regulations were to set standards for new municipal solid waste landfills.

Other issues that impacted Puerto Rico included wetlands (see discussion in Regulatory Affairs section) and privatization of public works. In June, the Puerto Rico Department of Transportation and Public Works (PRDTPW) let a contract for the construction of Puerto Rico's first privatized road project. The $400 million project entails development of a toll-road system in northern Puerto Rico. PRDTPW also selected a consulting firm for a proposed $250 million privatized project in southern Puerto Rico. An additional $160 million of roadway and bridge construction projects were underway in 1990. The Puerto Rico Highway Authority proposed an investment, including privatized projects, of approximately $1 billion for its 5-year construction program beginning in 1990.

In April, Puerto Rico's second largest cement company sold 30% of its shares to the American subsidiary of Ciments Francais, the world's fourth largest cement manufacturer. The Commonwealth Oil Refining Co. (Corco) emerged from Chapter 11 bankruptcy protection in 1990.

Employment

U.S. Mine Safety and Health Administration (MSHA) statistics[4] showed 2,044 workers employed at 108 mineral extracting or processing operations in Puerto Rico at the end of 1990. This represents an increase over 1989 employment of 83 workers (4.2%) employed at 7 fewer operations. Approximately 35% of the workers, 715, were employed by the island's 2 cement manufacturing facilities. Puerto Rico ranked ahead of 16 States in the number of worker-hours worked in the mining industry in 1990.

Regulatory Issues

Puerto Rico is one of the most densely populated and urbanized countries in the world, with a population of 3.3 million and an area of 3,435 square miles, roughly two-thirds the size of Connecticut. The situation is complicated by the large amount of wetlands on the island. The EPA established a no-net-loss of wetlands policy in February. The Engineers and Surveyors Association insisted the policy could not apply to Puerto Rico because of the island's great need for housing and considerable space limitations.

An adequate supply of potable water and sewage and solid waste disposal facilities are other problems exacerbated by the Commonwealth's high population density.

Browning Ferris Industries' (BFI) regional landfill in Ponce was the only landfill operating in compliance with new Environmental Quality Board (EQB)

regulations in 1990. BFI announced plans to open a solid waste landfill on a 315-acre tract in Guaynabo in May. The project was still in the permitting stage as of yearend. Public opposition to the project was responsible for part of the delay in obtaining the permit. BFI had planned to have the $70 million facility operational by late 1991.

Environmental Developmental Corp. also proposed a landfill for Guaynabo. A preliminary Environmental Impact Statement was submitted to the Puerto Rico Planning Board in May. Local residents opposed the project.

Nine sites in Puerto Rico are on EPA's Superfund or National Priority List (NPL). One site has been cleaned; of the remaining eight sites, one was being cleaned and the remaining seven were in various stages of remedial investigation or feasibility studies. Approximately 180 additional sites, 12 of which were added in 1990, have been reported to EPA as potential hazardous waste sites and were included on its Wastelan Preremedial List.[5]

Modular Incineration Systems (MIS) began the permitting process for a hazardous waste incineration plant on property owned by Corco in Penuelas in June. Among objectives of MIS would be the cleanup of the Corco facility. Industries in the vicinity of Corco were facing a possible $100 million hazardous waste cleanup mandated by EPA late in 1989. Permit applications were pending at yearend.

The recycling industry experienced unprecedented growth in Puerto Rico in 1990; however, it did not have significant impact on the individual consumer because of the absence of curbside recycling programs. Equipment and collection services for a variety of solid waste components were offered by a number of firms. BFI, the island's leading commercial landfill operator, and the Solid Waste Management Authority initiated a recycling program that they predict will result in recycling 25% of Puerto Rico's solid waste by 1995. Reynolds Aluminum Recycling Co., a subsidiary of Reynolds Metals Co., has been recycling aluminum cans in Puerto Rico for almost 15 years. Much of the glass collected for recycling was used by Owens-Illinois at its Vega Alta glass-bottle manufacturing plant. In contrast, there were no recycling plants for paper although two firms collected paper to send to the mainland for recycling.

Exploration Activities

Mineral resources in Puerto Rico were being assessed by the U.S. Geological Survey (USGS) in cooperation with investigators from the Department of Geology, University of Puerto Rico in Mayaquez, and the Puerto Rico Department of Natural Resources (DNR). The USGS completed the classification of more than 200 mineral occurrences. Nickel is known in laterite deposits, copper and gold are in porphyry deposits, iron and copper are in skarns, gold is in placers and epithermal deposits, phosphate is derived from guano in caves, and bauxite is present in karst terranes. Clay, limestone, and glass sand are presently being extracted, and past production of gold, manganese, and iron has been documented. Mineral resources, including minerals, metals, nonmetals, and construction materials, were assessed both onshore and offshore. Geochemical data available for Puerto Rico have been derived mainly from a regional stream-sediment sampling program, although data from soil and rock samples were also used. The most intense sampling was done in the central one-third of the island, where porphyry copper systems have been discovered. Information for the offshore area came partly from approximately 2,000 sediment samples from the insular shelf. Data from these samples have been used to map surficial sediment types, and in conjunction with seismic-profile data, to estimate offshore sand and gravel resources.

The assessment will be published[6] in folio format, with text and plates describing the results of studies of geology, geochemistry, mineral occurrences, and a mineral resource analysis. Maps will be available in digital format. This assessment is part of the National Mineral Resources Assessment Program and will aid the government of Puerto Rico and the mining community in land use planning, revisions of tax codes and commercial law, investment planning, and mineral exploration. It is scheduled to be completed in 1992 and will incorporate all available geologic information for Puerto Rico, some of which has never been published, in a readily understood format.

Plans to develop potentially viable metallic mineral deposits have been frustrated by lack of investment, poor infrastructure, uncertainty over the island's status, and the unwillingness of DNR to negotiate mineral leases. Cominco American Resources Inc.'s proposed exploration program continued to be stymied by political infighting, and the company appeared to have partially lost interest in the project in 1990.

A Commonwealth House of Representatives report prepared by the House's Natural Resources and Environmental Quality Commission recommended modification of the Law of Mines to strictly define the role of government in expropriating land for the purpose of exploitation of valuable mineral deposits. The report was prepared as a result of political opposition to a Memorandum of Understanding (MOU) that proposed to grant Cominco rights related to mineral deposits in several areas of Puerto Rico. The MOU was endorsed by five members of Governor Rafael Hernandez Colon's cabinet in December 1988.

Legislation and Government Programs

The USGS Center for Inter-American Mineral Resource Investigations (CIMRI) participated in the USGS project to assess the mineral resources in Puerto Rico. CIMRI was established to encourage the study and collection of data on nonfuel mineral resources in the Americas and the Caribbean. CIMRI personnel coordinate and participate in cooperative mineral resource investigations, mineral resource

exchange, training, and research in Latin America.

In 1990, the Caribbean-936 program granted, through the Government Development Bank for Puerto Rico, $180 million in loans in the Caribbean region. The loans were guaranteed by two Federal agencies, the Overseas Private Investment Corp. and the Agency for International Development.

Fuels

The rise in oil prices resulting from Iraq's invasion of Kuwait was especially felt in Puerto Rico, which is dependent upon imported oil for 98% of its energy needs. In order to reduce this dependency, Puerto Rico Electric Power Authority (PREPA) proposed to build, in coordination with the private sector, a 300-megawatt coal-burning plant in Mayaquez. The $450 million plant would be built by Cogentrix of Charlotte, NC, which planned to sell the energy to PREPA and steam to tuna canneries in the Mayaguez area. The project was opposed by Mayaguez political leaders, as well as environmentalists. Plans to build a similar plant in 1982 were dropped by PREPA because of a drop in demand for energy.[7]

PREPA also conducted talks with Marine Gas Transport, a company that supplies natural gas to Trinidad and Tobago. Other sources of energy do not appear feasible. PREPA canceled plans for additional exploratory oil drilling after a $3 million, 10,000-foot attempt near Toa Baja failed in 1989. A prototype windmill had been experimented with on Culebra, a small island off Puerto Rico's eastern coast, but did not make an impact because of difficulties in coupling it to the island's electrical system. Puerto Rico lacks rivers large enough to develop significant hydroelectric plants, and nuclear energy has been ruled out because of the island's earthquake-prone location and radioactive waste disposal problems.

Westinghouse's project to build a waste-to-energy plant in suburban San Juan appeared to be hopelessly mired in Puerto Rico's permitting process. PREPA and the municipality of San Juan reached a preliminary accord in May regarding the planned purchase by the utility of electric power to be produced by the garbage-burning plant. Plans call for the plant to be completed in 1992 at a projected cost of $89 million. The plant would burn up to 1,000 tons of municipal garbage daily to provide electricity for 10,000 homes while relieving San Juan's dangerously congested landfill.

Corco emerged from Chapter 11 bankruptcy protection in February 1990 after a settlement was reached with the company's outstanding creditors and stockholders who were owed more than $100 million. The Texas-based company first filed for Chapter 11 protection in 1978, then emerged in 1982, only to fall back again in 1984 because of insufficient financial resources. Corco was originally founded in 1955 to take advantage of a loophole in the U.S. law that allowed it to import low-priced foreign crude oil to compete with high domestic-oil prices on the mainland. The advantage was lost in 1972 when the Arab oil embargo skyrocketed the price of foreign oil. Despite its emergence, Corco lacks the financial reserve to reopen the refinery, which would require a minimum investment of $130 million to install a new catalytic cracker. Instead, it planned to become a middleman in the oil industry.

Review by Nonfuel Mineral Commodities

Industrial Minerals.—Mineral extraction represents less than 1% of Puerto Rico's gross national product (GNP). Industrial mineral production fared much better than the GNP average during the first half of 1990 as a result of construction to repair damage from Hurricane Hugo. However, during the second half of 1990, industrial mineral production fell to levels lower than that of the previous year as Hugo funding ran out and the economy faltered.

Cement.—Puerto Rico's two cement companies, Puerto Rican Cement Co. (PRC) and San Juan Cement Co. (SJC), sold a combined 19 million sacks of cement in the first half of 1990, but only 12.6 million sacks during the second half.[8] However, the total of 31.6 million sacks represents a 8.6% increase over the 29.1 million sacks sold in 1989. Gross 1990 sales were $81,993,050 for PRC and $52,506,000 for SJC.[9] Both companies were in the midst of $40 million-plus expansions that were expected to be completed by mid-1991.

SJC sold 30% of its shares to a division of the North American subsidiary of Ciments Francais, the fourth largest cement producer in the world. Essroc Materials Inc., a subsidiary of New Jersey-based Essroc Corp., purchased the shares at an estimated price of about $15 million and has the option to purchase additional shares at prices subject to negotiation. Ciments Francais, headquartered in Paris, France, had annual sales exceeding $2 billion in 1989, of which Essroc Corp. contributed $500 million. SJC had assets of roughly $80 million and controlled approximately 40% of Puerto Rico's cement market. Its plant and quarry are on a 236-acre tract in Dorado. The plant has the capacity to produce 18 million sacks per year and employs 324 workers.

Clays.—The only clay production reported to the Bureau in 1990 was common clay used in the manufacture of cement. According to Bureau policy, both the value and quantity of clay production were withheld as proprietary company data. The totals were not included in table 1 because clay was the only commodity on which data were withheld.

Graphite (Synthetic).—Union Carbide discontinued the production of synthetic graphite at its plant at Yabucoa in 1990. The plant had operated at reduced capacity since 1987.

Sand and Gravel.—Owing to very poor response to its canvass forms, the Bureau no longer compiles production data for construction sand and gravel mined in Puerto Rico.

Construction.—MSHA inspected 39 construction sand and gravel operations in Puerto Rico in 1990.

Industrial.—Owens-Illinois (O-I) signed a contract with Quibell Corp. of Roanoke, VA, to produce 100,000 cases of slightly tinted green bottles per month. Quibell began distributing bottled water in 1989 to take advantage of a steadily growing market estimated to exceed $2 billion annually in the United States alone. Quibell marketed in 25 States and Puerto Rico in 1990. O-I also began manufacturing intravenous (IV) bottles for Baxter Health Care Corp.'s manufacturing plants in Puerto Rico. In 1990, exports accounted for only 15% of O-I's total production, but the company hoped for rapid expansion of exports over the next few years. Since 1988, more than one-half of O-I's project proposals have been geared to foreign export business opportunities.

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 1988 and 1990 and actual data for 1989.

Crushed.—The Bureau did not estimate crushed-stone production in Puerto Rico in 1990. MSHA inspected 55 crushed stone operations in Puerto Rico in 1990, 36 of which were limestone quarries. This was the same number of operations reported by the Bureau in 1989.

Dimension.—Although no dimension stone production was reported to the Bureau in 1990, MSHA records show that three operations were inspected in 1990. Marble was quarried at two of the operations, and the rock type at the third was unspecified. Most of the dimension stone produced in Puerto Rico was classified as rubblestone and used as riprap to repair and maintain breakwaters and jetties.

Other Industrial Minerals.—Two industrial minerals are manufactured in Puerto Rico, and a third is recovered as a byproduct of oil refining. Chemical-grade lime was produced by PRC at its Ponce plant. Although production increased 11.5% to 29,000 short tons, the value of lime produced decreased 8.3% from that of 1989 to $3.5 million. The lime was used primarily for water purification and by the construction industry. Salt, evaporated from seawater, was produced by two companies in southwestern Mayaguez. Although the quantity of salt imported through the Port of San Juan decreased from 39,000 short tons in 1989 to 16,000 tons in 1990, the value increased from $355,000 to $368,000 during the same period. Elemental sulfur was recovered by the Sun Oil Co. Inc. at its Yabucoa Oil Refinery.

Construction of the filler-grade calcium carbonate and talc plant in Guanica that was announced in 1989 and scheduled to go into production by mid-1990 was never built. The Venezuelan-backed company formed to build the plant was disbanded, and the proposed operation was canceled.

Peat moss imports through the Port of San Juan increased from 96 short tons valued at $26,000 in 1989 to 497,000 tons valued at $109,000 in 1990. The growth in imports can be attributed to the use of horticultural material to landscape houses rebuilt as a result of Hurricane Hugo.

Metals.—As was noted in the Exploration Activities and Government and Legislative Programs sections, Puerto Rico has potentially economic porphyry copper and gold deposits that have not been developed. Several metal products are produced in Puerto Rico from imported or locally recycled metals. Aluminum is extruded to manufacture contours in the form of tubes, channels, and angles by Alruss Extrusion and Finishing Corp. and Aluminum Extrusion Corp. (Alumex). Alumex produces 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 1990, imports from Europe and Asia increased significantly. Bayamon Steel Processors Inc. announced in March plans to build a 48-inch hot-dip line to produce 14- to 26-gauge sheet steel. Bayamon planned to utilize 70% of the line's 70,000- to 75,000-short-ton-per-year capacity in-house to replace material it currently imports from the United States, Europe, and South America. Bayamon planned to export the excess to Florida and Santa Domingo.

THE COMMONWEALTH OF THE NORTHERN MARIANAS

Sixteen islands with a total area of 164 square miles comprise the Commonwealth of the Northern Marianas. A 17th island, Guam, is the southernmost island of the Mariana island chain but is not part of the Commonwealth. Although the Northern Marianas theoretically has equal status with the Nation's only other Commonwealth, Puerto Rico, the U.S. Department of the Interior plays a much larger role in its administration.

The only mineral production on the islands was crushed stone for the local construction industry. The Northern Marianas have a surprisingly well-developed road network that is a legacy of World War II. The network consists of almost 200 miles of roads, about 75 miles of which is primary and secondary and the rest scenic and village roads.

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 only nonenergy mineral commodity produced in the Virgin Islands in 1990 was crushed stone.

Trends and Developments

The U.S. Bureau of Mines did not estimate crushed stone production for the Virgin Islands in 1990; however, local

sources[10] indicated that demand for crushed stone was at record highs. This resulted in large part from construction done on the islands to repair damage caused by Hurricane Hugo in September 1989. In fiscal year 1990, the Federal Emergency Management Agency committed $332.9 million and other Federal agencies an additional $251.5 million to aid the U.S. Virgin Islands in recovering from the damages caused by the hurricane. Much of the money was delegated to reconstruction activities that required crushed stone.

Review by Nonfuel Mineral Commodities

Industrial Minerals.—Stone.—Crushed stone, the only mineral commodity mined in 1990, was quarried by two companies, Devcon International Corp. on St. Croix and St. Thomas and St. Croix Stone and Sand Co. on St. Croix. 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 was expanded to about 150,000 short tons per year in 1990, the first full year of operation after the plant was overhauled and modernized. All of the stone produced at the quarry is water washed with water that has to be recycled because of a limited supply and the lack of sufficient space for settling ponds. Suspended fines are removed from the recycled water by a Jadair water clarifier that uses a polymer flocculent to settle the suspended solids. These fines were donated to a local landfill to be used as cover material. Crusher fines are recovered by screening for use by the company's ready-mix plant and concrete block plant, which are in the vicinity of the quarry. Devcon imports cement from Colombia and fine sand from Barbuda, a small island about 200 miles east of St. Thomas. The sand supplements the manufactured sand in the manufacture of concrete blocks.

Caribbean Material Supply Co. Inc., a wholly owned Devcon subsidiary, operates the Springfield Quarry near Groveplace on St. Croix. Plant capacity was 150 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 tons per hour.

Other Minerals.—The only other mineral commodities produced in 1990 were alumina and elemental sulfur. Clarendon Ltd., a Swiss-based aluminum trading company, reopened the alumina refinery on St. Croix that was formerly operated by Martin Marietta. The 700,000-short-ton-per-year refinery, which had been idle since 1985, used bauxite imported from Jamaica as its basic raw material. The Virgin Islands Aluminum Corp., the Clarendon subsidiary that operates the refinery, employed 252 hourly and 74 salaried workers.

Elemental sulfur was recovered as a byproduct by Hess Oil Virgin Islands Co., a wholly owned subsidiary of Amerada Hess Corp., at its Christiansted oil refinery on St. Croix. The refinery had a capacity of 600,000 to 700,000 barrels per day.

Although metal mining has not been reported in the U.S. Virgin Islands, recent geochemical testing by the USGS has delineated extensive areas showing anomalous concentrations of antimony, arsenic, barium, bismuth, copper, gold, lead, silver, tellurium, tin, and zinc. The anomalies appear to be structure related because they transect all exposed rock types on the islands.

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 reported in 1990 was construction aggregate from American Samoa and Guam.

Regulatory Issues

Two regulatory issues, which affected not only the United States' possessions but also the rest of the Pacific Island Nations, dominated the environmental news in 1990. First was global warming that many residents fear could cause a rise in sea level that would inundate some islands completely and greatly reduce the land area of many others. Pacific Islanders united with the islands of the Caribbean, the Indian Ocean, and the Mediterranean island of Malta to form the Alliance of Small Island States (AOSIS). AOSIS hoped to ensure that its views would be heard at international conferences on climatic change, such as the Second World Conference on Climate Change held in Geneva, Switzerland, in October 1990 and conferences scheduled for Washington, DC, in 1991 and Brazil in 1992.

The second issue related to the storage and destruction of chemical weapons on Johnston Island. The U.S. Army completed a $150 million high-tech incinerator to destroy the chemicals in 1989, but operations verification testing planned for 1990 was delayed by environmental protesters. Full-scale operation of the facility, originally scheduled for February 1989, has been rescheduled for September 1991. The Army issued a final environmental impact report in July that concluded that hazards from the planned incineration were minimal.

Legislation and Government Programs

President Bush declared American Samoa an emergency area on February 9 after a cyclone heavily damaged parts of the seven-island group. The declaration formalized already ongoing rescue efforts and allowed the Federal Emergency Management Agency to provide financial assistance to help the islands recovery from damage estimated at $2.5 million.

The Minerals Research Institute, funded by the U.S. Bureau of Mines, granted $546,536 to the University of Hawaii for marine geological research in 1990. One

of the projects was directed toward determination of the microtopography of colbalt-rich manganese crust formation on seamounts occurring in the Hawaiian and Johnston Islands area of the U.S. Exclusive Economic Zone. The project supported an in-house Bureau research project, "Beneficiation and Processing of Ocean Floor Minerals," which is being conducted by the Salt Lake City Research Center. Under this project, potentially environmentally acceptable methods have been developed for extracting cobalt, nickel, and manganese from the sea floor crusts.

In December, the Guam Mass Transit Authority (GMTA) announced plans to commission a feasibility study into a proposed $63 million monorail system. GMTA officials indicated that the monorail was the only feasible solution to the island's traffic congestion that has been aggravated by a deteriorating road network and the importation of almost 15,000 vehicles annually.

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 the 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. In 1990, the United States apparently gave up on getting the compact ratified and mandated a return to pre-1980 Federal administration of Palau. A Secretarial Order issued by the U.S. Department of the Interior in October restricted the Palauan government's financial authority and lawmaking powers.

There was no reported mineral production from the Republic of Palau in 1990. Recent investigations[11] by the USGS found epithermal gold mineralization. A typhoon that struck the Palau islands in November inflicted several millions of dollars in damage but caused no fatalities.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 32 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]Caribbean Business (San Juan, PR). Industry Profile—Construction Companies. V. 18, No. 15, Apr. 11, 1990.

[4]U.S. Department of Labor. Mine Inspection Data Analysis System, 4th Quarter 1990. Jan. 2, 1991.

[5]U.S. Environmental Protection Agency. Wastelan Preremedial Report 20 Sorted by State, County, and Site Name. Aug. 3, 1990.

[6]Bawiec, W. J., et al. Mineral-Resource Assessment of Puerto Rico in Seventh Annual V. E. McKelvey Forum on Mineral and Energy Resources. U.S. Geol. Surv. Circ. 1062, 1991, p. 4.

[7]Caribbean Business (San Juan, PR). Power Authority Focuses On Alternate Energy Projects. V. 18, No. 33, Aug. 20, 1990.

[8]———. It's Been a Dry Summer for Puerto Rico's Cement Industry. V. 19, No. 34, Aug. 29, 1991.

[9]———. Puerto Rico's 20 Largest Construction Materials Suppliers. V. 19, No. 20, May 23, 1991.

[10]Pit & Quarry. Caribbean-Island Site Challenges Plant Designers. V. 83, No. 8, Feb. 1991, p. 32.

[11]Rytuba, J. J., et al. Epithermal Gold Mineralization in the Republic of Palau in Third Annual V.E. McKelvey Forum on Mineral and Energy Resources. U.S. Geol. Surv. Circ. 995, 1988, p. 59.

TABLE 2
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
	PUERTO RICO		
Cement:			
Puerto Rican Cement Co.[1]	Box 1349 Ponce, PR 00936	Plant	Ponce.
San Juan Cement Co.[2]	GPO 2888 San Juan, PR 00936	do.	San Juan.
Graphite (synthetic):			
Union Carbide P.R. Inc.	Banco De Ponce Piso 20 Ave. Munoz Rivera 268 Hato Rey, PR 00918	do.	Humacao.
Sand (industrial):			
Owens-Illinois Inc.	Box 387 Vega Alta, PR 00762	Pit and plant	Arecibo.
Stone (crushed):			
Productora De Agregados Inc.	Box 1052 Sabana Seca, PR 00749	Quarry	Do.
Cantera Perez Inc.	Box 789 Humacao, PR 00661	do.	Humacao.
Cantera Dorado Inc.	Box 4217, Bay Gardens Station Bayamon, PR 00620	do.	Arecibo.
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 00840	do.	St. Croix.
	GUAM		
Sulfur:			
Amerada Hess Corp.	1 Hess Plaza Woodbridge, NJ 07095	Plant	St. Croix.
Stone (crushed):			
Guam Government Public Works Dept.	Agana, GU 96910	Quarry	Guam.
Hawaiian Rock Products	Box H Agana, GU 96910	do.	Do.
Perez Brothers Inc.	Box F Agana, GU 96910	do.	Do.

[1]Also lime, clay, crushed stone.
[2]Also clay, crushed stone.

RHODE ISLAND

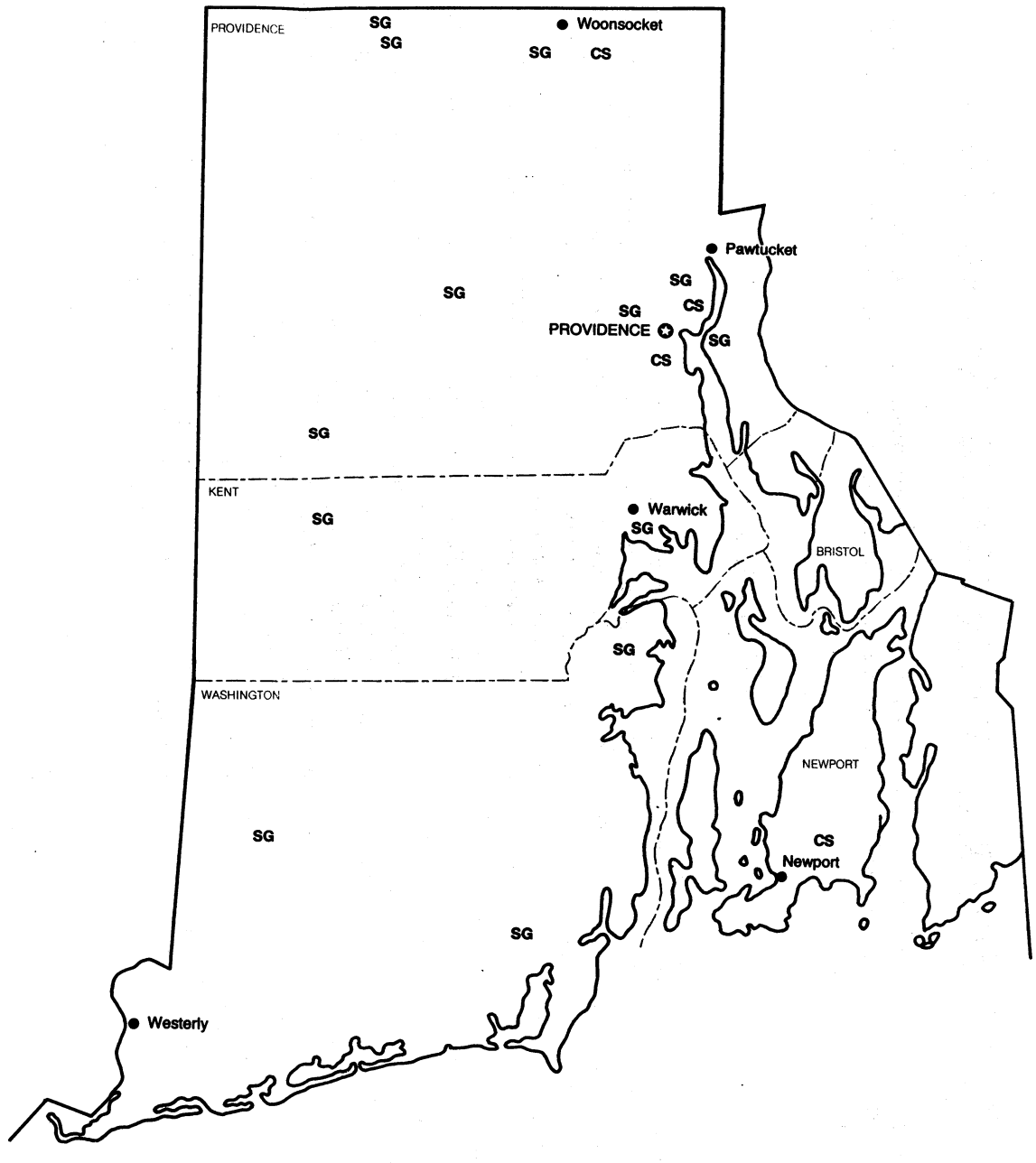
LEGEND

- State boundary
- County boundary
- Capital
- City

MINERAL SYMBOLS

- CS Crushed Stone
- SG Sand and Gravel

Principal Mineral-Producing Localities



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 1990 was $17.8 million, a $6.7 million increase from the 1989 value. Crushed stone and construction sand and gravel continued to account for virtually all of the State's mineral output. Industrial sand output and a small amount of gem stones collected by rockhounds accounted for the remainder. Several mineral-related commodities were also received at the Port of Providence for distribution in Rhode Island and other Northeastern States. Some of the commodities received at the port during the year were petroleum products, cement, steel, and caustic materials. The primary commodity shipped out of the port was iron and steel scrap.

TRENDS AND DEVELOPMENTS

In 1990, Rhode Island's economy, like that of most other New England States, remained depressed. The residential sector was overbuilt, and only a limited amount of commercial and industrial construction was underway. The value of total construction contracts in Rhode Island declined almost 60% from that of 1989. Decreases were reported for all categories of construction. The largest decline in construction contract values occurred in the nonbuilding sector (down 80%), followed by nonresidential (down 65%) and residential (down 31%). Also, because of a lack of State and Federal funds available, highway and infrastructure work, which rely heavily on mineral aggregates, was at a virtual standstill. Because most of the State's mineral output is dependent on construction activity, the declines in building contracts and road construction have left the State's mineral industry in a depressed condition.

EMPLOYMENT

In 1990, the average number of workers[2] employed in the mineral extractive industries in Rhode Island was 150. This included 102 workers in the sand and gravel industry, 29 in the stone industry, and 19 working in mills and preparation plants.

REGULATORY ISSUES

Coventry Sand & Gravel and D'Ambra Construction Co. Inc. applied for permits from the Rhode Island Department of Environmental Management to allow the companies to accept and treat soil contaminated with petroleum products. The contaminated soil would come from areas around underground storage tanks that have leaked and in much smaller quantities from transportation accidents. D'Ambra's proposal is to process up to 180 tons of contaminated soil daily; Coventry Sand & Gravel could process up to 100 tons per hour.

TABLE 1
NONFUEL MINERAL PRODUCTION IN RHODE ISLAND[1]

Mineral	1988		1989		1990	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones	NA	$1	NA	$2	NA	$2
Sand and gravel (construction) thousand short tons	1,853	7,847	e1,100	e3,900	1,969	9,042
Stone (crushed) do.	e1,500	e9,400	21,208	7,170	e 21,600	e8,800
Total[3]	XX	17,248	XX	11,072	XX	17,844

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 which must be concealed to avoid disclosing company proprietary data.

LEGISLATION AND GOVERNMENT PROGRAMS

Legislation (House bill 9198) to formally establish the Rhode Island Geographic Information System (RI GIS) was signed into law. The bill designates the Rhode Island Division of Planning as the lead agency for management of the RI GIS and provides technical support at the University of Rhode Island. One of the goals of the RI GIS is the development of standard map packages to support cities and towns preparing comprehensive land use plans. Information in the RI GIS is to include data on land use, Statewide soils, wetlands, flood plains, archeological sites, open space, and ground water. Because individual towns in Rhode Island usually exercise control of surface mining through zoning ordinances and bylaws, the RI GIS should help local communities in their zoning decisions concerning mining activities and locating solid waste landfill sites.

The Office of the State Geologist, at the University of Rhode Island, continued work on surficial mapping and offshore sand and gravel mapping. Also, a combined Rhode Island-Connecticut bedrock map at the scale 1:250,000 was being prepared, with possible publication by the U.S. Geological Survey (USGS). The new combined two-State map will incorporate data from the recently compiled bedrock geological map of Rhode Island that was completed at a scale of 1:100,000.

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 1988 and 1990 and estimates for 1989.

Construction sand and gravel was the State's leading mineral commodity in terms of value, accounting for one-half of the value of all minerals produced in the State. Output amounted to almost 2 million short tons valued at $9 million. In 1990, 11 companies mined construction sand and gravel from 18 pits in 3 of the State's 5 counties. Leading counties, in order of output, were Providence, Kent, and Washington. Construction sand and gravel was used for concrete aggregate, asphaltic concrete aggregates, road base and coverings, and fill.

In November, the Coventry Town Council unanimously passed an ordinance on soil erosion and sediment control primarily to further regulate sand and gravel pit operators. The ordinance was passed after residents complained about dust and noise from the town's sand and gravel pits. It requires any person or group to notify the town's building official of any plans to disturb land that may "increase the potential for soil erosion." If the town finds the possibility of significant environmental damage, a plan for controlling erosion and sediment must be submitted. The submitted plans must follow certain principles, among them avoiding steep slopes, respecting original boundaries, providing for adequate drainage, planting vegetation or mulch, and restoring areas damaged by construction or development. Before approval of the plan, the applicant must also file a performance bond, the amount determined by the Department of Public Works. The bond can be seized by the town to correct any damage caused by the applicant.

Industrial.—Holliston Sand Co. Inc., Providence County, was the only producer of industrial sand in the State. Most of the sand was used for filtration, blasting, golf course sand, and molding and core.

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 1988 and 1990 and actual data for 1989.

Estimates of the crushed stone produced in the State totaled 1.6 million short tons valued at $8.8 million. In 1989, five companies operated five quarries, four in Providence County and one in Newport County. Limestone was the leading type of stone produced, followed by granite and traprock. Most of the stone was used for road base, filter stone, and bituminous and concrete aggregate.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related experience and has covered the mineral activities in Rhode Island for the past 5 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 establishing during periods (not necessarily continuous) of active operations.

TABLE 2

RHODE ISLAND: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY[1]

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	461	$2,630	$5.70
Plaster and gunite sands	W	W	6.48
Concrete products (blocks, bricks, pipe, decorative, etc.)	W	W	20.00
Asphaltic concrete aggregates and other bituminous mixtures	W	W	4.54
Road base and coverings	266	895	3.36
Fill	116	209	1.80
Snow and ice control	9	96	10.67
Other[1]	201	948	4.72
Unspecified:[2]			
Actual	526	2,536	4.82
Estimated	390	1,729	4.43
Total or average	1,969	[3]9,042	4.59

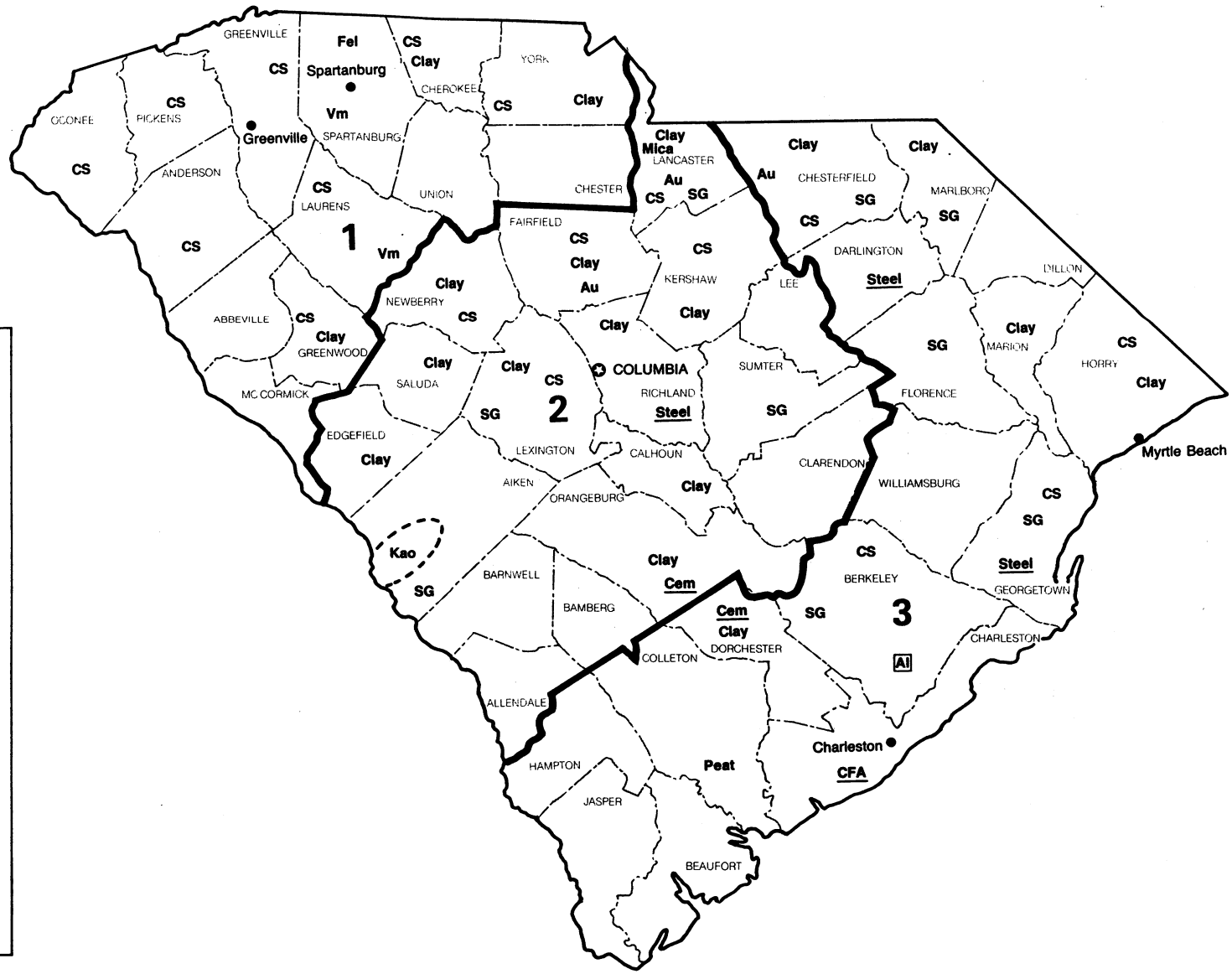
W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes filtration.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.
[3]Data do not add to total shown because of independent rounding.

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Construction:			
Acme Sand & Gravel	100 Armento St. Johnston, RI 02919	Pit	Providence.
A. Cardi Construction Co. Inc.	451 Arnold Rd. Coventry, RI 02816	Pits and plant	Kent.
Material Sand & Stone	RFD 1, Greenville Rd. Woonsocket, RI 02895	Pits	Providence.
Richmond Sand & Gravel Inc.	Box 389 Wyoming, RI 02898	Pit	Washington.
River Sand & Gravel Co. Inc.	101 Ferris St. Pawtucket, RI 02861	Pit	Kent.
South County Sand & Gravel Co.	Box 3725 Peace Dale, RI 02883	Pits	Washington.
Industrial:			
Holliston Sand Co. Inc.	Box 97, 303 Lowland St. Holliston, MA 01746	Pit	Do.
Stone (1989):			
The Conklin Limestone Co.	RFD 1 Lincoln, RI 02865	Quarry	Do.
Forte Bros. Inc.	14 Whipple St. Berkley, RI 02864	do.	Do.
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 Inc.	875 Phoenix Ave. Cranston, RI 02920	do.	Providence.

[1]Also sand and gravel.

SOUTH CAROLINA



LEGEND

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

MINERAL SYMBOLS

Al	Aluminum plant
Au	Gold
Cem	Cement plant
CFA	Chrome Ferroalloy plant
Clay	Clay
CS	Crushed Stone
Fel	Feldspar
Ful	Fuller's earth
Kao	Kaolin
Mica	Mica
Peat	Peat
SG	Sand and Gravel
Steel	Iron and Steel plant
Vm	Vermiculite

Concentration of mineral operations

Principal Mineral-Producing Localities

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] and Norman K. Olson[2]

The value of mineral commodities produced in South Carolina in 1990 increased 5.8% over that of 1989 to an alltime high of $450 million. The State's three leading commodities, cement, crushed stone, and gold, accounted for almost 75% of the total. The State led the Nation in vermiculite production, ranked second in kaolin output, and remained the only gold-producing State in the Eastern United States. Overall, South Carolina's national ranking for the value of all minerals produced improved from 25th in 1988 to 24th. The State also ranked 22d in the value of industrial minerals and 18th in the value of metals.

TRENDS AND DEVELOPMENTS

South Carolina's mineral production increased to a record high in 1989 for the eighth consecutive year. The new record resulted primarily from increases in the State's two leading commodities, crushed stone and cement. Lesser increases occurred in clay and construction sand and gravel. The value of crushed stone grew by 21.3% to an estimated $135.4 million and accounted for 30% of the total value of all minerals produced. The increase in crushed stone production resulted, in part, from South Carolina's 10-year, $13 billion program of transportation improvement. The program, which began in 1989, placed a priority on road construction in rural areas and smaller cities. Cement value increased 10.7% to $109.6 million and accounted for 24% of the total value. Cement replaced gold as the second leading commodity produced in South Carolina.

Although the U.S. Bureau of Mines, because of its policy to protect the proprietary nature of some data, withholds data on the amount and value of gold produced, published reports[3] indicate that more than 220,000 ounces of gold, unchanged from that of 1989, was produced in the State in 1990. South Carolina's fourth gold mine was permitted in August. Construction was well underway at yearend, and production was expected to start early in 1991. Mining operations were temporarily suspended by South Carolina's second

TABLE 1
NONFUEL MINERAL PRODUCTION IN SOUTH CAROLINA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland)	thousand short tons	2,533	$118,670	2,188	$99,083	2,464	$109,644
Clays	metric tons	1,867,829	40,541	1,596,153	39,075	2,062,824	44,486
Gemstones		NA	10	NA	10	NA	10
Sand and gravel:							
Construction	thousand short tons	7,529	20,751	e7,500	e23,300	8,627	24,941
Industrial	do.	859	15,271	842	16,635	844	15,972
Stone:							
Crushed[2]	do.	e23,500	e105,800	24,429	111,656	e26,200	e135,400
Dimension short tons		e353	e31	W	W	W	W
Combined value of cement (masonry), gold, manganiferous ore, mica (scrap), peat, silver, stone (crushed shell), vermiculite, and values indicated by symbol W		XX	56,728	XX	135,538	XX	119,400
Total		XX	357,802	XX	425,297	XX	449,853

eEstimated. 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; kind and value included with "Combined value" figure.

largest gold producer in late October because of the rupture of a tailings dam. The dam failure occurred during a record-setting rainfall spawned by a tropical storm. Mining operations were not expected to resume before spring 1991.

In contrast to its neighboring States, notably North Carolina and Georgia, South Carolina did not appear to experience an inordinate amount of public resentment against mining. Concern was expressed about the use of cyanide in gold operations, especially in the wake of the aforementioned dam failure. However, the number and severity of complaints against proposed or expanded mining operations were relatively few. A Florida company encountered strong public protest when it announced plans[4] to build a manufacturing and waste-treatment complex near Blacksburg, Cherokee County. Another company drew heavy public opposition when it applied for a permit to mine peat in the Carolina Bays area of coastal Horry County.

Crushed stone was imported from Nova Scotia through the Port of Charleston. Presently, this source is marginally competitive in the Southeastern U.S. market. However, because of increased environmental regulation and public opposition to new and enlarged aggregate operations, imports of aggregates from other countries is likely to increase in the future, and according to one marketing specialist,[5] may become as common as the importation of cement.

A cement company in Dorchester County changed ownership for the second time in 3 years. One aluminum company dedicated a new forgings plant in Greenwood County, while a secondary aluminum producer filed for bankruptcy protection under Chapter 11 at its Spartanburg plant. Startup of a new ferroalloy continuous bar mill in Richburg, Chester County, originally scheduled for the fourth quarter of 1990, was delayed until the second quarter of 1991.

EMPLOYMENT

U.S. Department of Labor (DOL) statistics[6] reported an average of 2,100 workers, out of a total of 1,549,000 nonfarm workers, employed in the South Carolina mining industry in 1990. However, DOL's Mine Safety and Health Administration (MSHA) reported[7] an average of 2,909 employees working in surface mining operations and an additional 1,776 employees in mills and preparation plants. The MSHA data appear to more accurately portray mining employment in South Carolina because MSHA physically inspected each mining operation and reported the number of employees as part of the inspection.

Average annual pay for 1990[8] for the mining industry rose to $25,901, an increase of 4.2% over that of1989. Mining was the second highest paying occupation in South Carolina, second only to the transportation, communications, and public utilities industry.

REGULATORY ISSUES

South Carolina ranked 23d nationally for toxic chemicals released into the environment in 1989, according to statistics announced by the U.S. Environmental Protection Agency (EPA) in 1991.[7] Toxic emissions totaled 88.5 million pounds, an increase of 3.8 million pounds over that of 1988. Total releases for the United States were 5.7 billion pounds. A coalition of environmental groups charged that the report exempts 95% of the total emissions.

In South Carolina, more than 400 industries are required to report the amounts of more than 300 chemicals they release. Exempted from the law are mining, farming, electric utilities, hazardous waste recycling, and oil and gas drilling. Also exempted were all Federal facilities, including nuclear weapons plants and military bases.

As of June 30, 1990, there were 22 sites in South Carolina on EPA's National Priority List (NPL), commonly known as Superfund. South Carolina's State Priority List (SPL) contains an additional 84 sites. During fiscal year 1990 ending on June 30, 1990, South Carolina spent $1.6 million from its Hazardous Waste Contingency Fund (HWCF) for response actions at eight SPL sites and one NPL site. Funds for HWCF are generated from fees charged for the disposal of waste. The fees range from $5 per ton for in-State-generated nonhazardous waste to $30 per ton for out-of-State hazardous waste. Revenues available in the HWCF as of June 30, 1990, totaled $15.6 million.

South Carolina remained a net importer of hazardous waste. The State's hazardous waste management operations included a landfill in Sumter County, hazardous waste incinerators in York and Spartanburg Counties, 2 cement plants in Dorchester and Orangeburg Counties that burn hazardous waste for fuel, and 11 chemical recycling facilities.

Legislation to restrict hazardous waste imports that passed in 1989 was not enforced in 1990 until State officials learned the outcome of legal challenges to a similar law passed by the State of Alabama. As of December 31, 1990, a decision on the Alabama law was still pending.

Consolidated Materials (CMI) of Leesburg, FL, announced plans to build a 23,000-ton-per-day garbage incinerator on a 2,200-acre site along the Broad River. The site was the location of the never-completed Cherokee nuclear power station near Blacksburg. The company's plans also called for cement kilns, steel furnaces, a plastics extrusion operation, and a recycling facility.

Reverse vending machines that return a penny for each steel food and beverage can deposited were test marketed in South Carolina beginning in June 1990. USX Corp. and Nationwide Recyclers Inc. provided financial backing for introduction of the machines in the Carolinas. The vending machines are part of a project coordinated by the Steel Can Recycling Institute to develop markets and sources for used steel food and beverage cans.

EXPLORATION ACTIVITIES

Exploration for gold and other metals in South Carolina was concentrated in the Carolina slate belt extending from Chesterfield and Lancaster Counties in north-central South Carolina to Edgefield and McCormick Counties in the central-western part of the State. Four prospecting permits composing 6,990 acres in the Sumter National Forest in Abbeville, Edgefield, McCormick, and Saluda Counties were active during 1990. Minerals listed in the permits include copper, gold, lead, manganese, nickel, silver, and zinc. Permits were issued to Molycorp Inc. (assigned by Newmont Exploration Limited), GCO Minerals Inc., BHP Utah International Inc., and Joseph A. Porter. Other companies reported to have been exploring for gold in South Carolina include Battle Mountain Gold Co., Cominco American Inc., Kennecott, Noranda Inc., Piedmont Mining Corp., Prime Capitol Corp., and Westmont Mining Inc.

Gwalia (U.S.A.) Ltd. completed exploration and applied for a mining permit on 1,600 acres acquired from British Petroleum Minerals Corp. and 450 purchased acres. The property is at Barite Hill in McCormick County.

Piedmont Mining Co. and Corona Corp. reached a preliminary agreement in May 1990 to form a 50-50 joint venture to explore for heavy-mineral sands in the Carolinas.

Kerr-McGee Corp. acquired four leases totaling almost 20,000 acres in the Francis Marion National Forest in Berkeley and Charleston Counties. The leases are for zircon and other heavy minerals.

LEGISLATION AND GOVERNMENT PROGRAMS

On May 7, 1990, new amendments to existing mining legislation went into effect. Important changes included requiring a certificate of exploration and a $2,500 security for exploration activities of less than 2 acres; protection of surface and ground water; protection of cultural and historical resources; a plan for closure of the mine; and when 10 or more people request a public hearing, the request must have technical merit. The new amendments mandated new application fees for all new permits, any significant modification of a permit, and any transfer of a permit. Additionally, the State can assess civil penalties and administrative fees for uncorrected violations.

A bill to impose a severance tax on gold was unanimously defeated by members of the South Carolina House of Representatives on March 21, 1990. The proposed tax was called highly discriminatory because it exempted the first 25,000 ounces of gold production. As a result, only one mining company would have been seriously impacted by the tax.

As of December 31, 1990, 522 active mining permits (3 less than the year previous) were issued to 275 mining companies (13 more than the year previous) and 24 county governments (unchanged from the year previous). There were 29 applications pending (3 more than the year previous) and more than $9.8 million ($1.4 million more than the year previous) in reclamation bonds on file. Of the 69,384 acres permitted (246 less than the year previous), 19,828 (932 more than the year previous) were affected. Not included in the permitted acreage are 4,835 acres (361 more than the year previous) that have been reclaimed. More than 60% of the permits (314) were issued for sand pits and sand-clay fill material.

South Carolina received a $50,000 EPA grant, administered by the Western Governors' Association, to conduct a statutory and regulatory review, a programmatic review, a fiscal review, and to conduct a mined-lands inventory. A $100,000 grant from the same source will be used to compile abstracts concerning precious-metal mines throughout the Nation.

Clemson University received an $86,000 grant from the U.S. Department of Agriculture Cooperative States Research Service to develop a technique to locate and quantify ground water pollution near ponds. Researchers planned to use an electromagnetic terrain conductor to detect leakage from the pond into the soil, thereby reducing costly and time-consuming soil sampling. Although the project was directed toward agricultural ponds, the technique, if successful, should be applicable to mine tailings ponds.

Research at the U.S. Bureau of Mines Tuscaloosa Research Center (TURC) included development of methods to describe and delineate possible environmental problems as well as development and evaluation of methods to mitigate pollution arising from solid or liquid wastes. An example is a monitoring study underway for washdown of a cyanide heap-leaching stack at the Brewer Mine. The decommissioning of heap-leach stacks is a major environmental issue facing the gold mining industry.

TURC also completed a study to monitor and evaluate the runoff from an abandoned waste impoundment at the Haile Gold Mine. The study found that cyanide associated with this tailings site has degraded and stabilized within the impoundment area. This was evidenced by the lack of dissociable cyanide in the tailings samples and very low concentrations of cyanide in the underlying soil. Ground water analyses show no cyanide contamination occurring in the ground water. The naturally low pH and high iron content of the soil and water indicate that the cyanide could have reacted with the iron to form a stable or well-complexed compound. Future studies are planned to validate this hypothesis.

TURC also conducted preliminary studies to mitigate ground water contamination from spent heap-leaching operations utilizing refuse coal to absorb cyanide. Column leach tests were conducted using cyanide leach solutions from Brewer's Haile mining operation. Preliminary results indicate that an underlying material with a high iron-sulfur content could react with the cyanide to form stable compounds. Further studies were being prepared using coal refuse, iron oxide refuse, and pyrite

waste. Successful development of a cyanide absorbent material could result in wastes being utilized as a subbase in leach pads or impoundment structures to prevent the contamination of the ambient water table.

The Intermountain Field Operations Center (IFOC) completed property evaluations of the Brewer and Haile gold mines for the Mineral Availability System. Evaluation of the Ridgeway Mine was in progress at yearend.

W. R. Grace & Co. received the National Association of State Land Reclamationists national award for 1990 for its reclamation efforts at its Enoree, SC, vermiculite mine. The Enoree operation has received 14 awards for mine reclamation and mine safety over the past 10 years. The operation's general manager was named 1990 Miner of the Year by the Mining Association of South Carolina. 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.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Nine industrial minerals were mined in South Carolina in 1990. Four additional industrial mineral commodities were produced from raw materials mined within the State, shipped from other States, or imported. These 13 commodities accounted for approximately 80% of the value of minerals produced in 1990.

Crushed stone retained its position as the most valuable mineral commodity produced in the State, and cement regained its ranking as the second most valuable.

Cement.—Cement production increased 12.5% over that of 1989 to 2,464,000 tons valued at $109.6 million, a 10.7% increase. This represents more than 30% of the value of all industrial minerals produced. Nationally, South Carolina ranked 12th in both the quantity and value among the 38 States producing portland cement. In the production of masonry cement, it ranked sixth in quantity and fifth in value. Two of the three companies that manufactured cement in South Carolina underwent corporate changes in 1990. Beazer PLC sold the cement plant in Harleyville, Dorchester County, that it purchased from Gifford Hill in 1986 to Blue Circle Industries PLC. Santee Portland Cement Co., a subsidiary of Dundee Cement Co. that in turn was owned by Switzerland's Holderbank Financiere Glaris Ltd., became a subsidiary of Holnam Inc. in March. The change occurred when Holderbank merged its three North American subsidiaries, Dundee, Holnam, and Ideal Basic Industries, into Holnam Inc. to create the largest cement-producing company in the United States.

Santee, in Holly Hill, Orangeburg County, had a capacity of 1.1 million tons per year from two wet-process kilns. The plant used hazardous waste, principally dry-cleaning fluids and spent oil and grease from automobile-part washers, to supplement coal as fuel. Blue Circle had an annual capacity of 550,000 tons using one dry kiln. South Carolina's third cement producer, Giant Cement Co., also in Harleyville, is owned by Giant Group Ltd., a holding company formed by the merger of Giant Portland Cement Co. and Keystone Portland Cement Co. in 1985. Its plant had a capacity of 770,000 tons per year from four wet-process kilns. Hazardous waste is used as a supplementary fuel.

Clays.—South Carolina's clay production increased 29% in volume and 13.8% in value over that produced in 1989. Clay production rebounded from a sharp decline in 1989 to slightly surpass record levels set in 1988. All three types of clay produced, common clay, fuller's earth, and kaolin, increased both in volume produced and in value. However, the bulk of the increase resulted from the use of large tonnages of low-value, unprocessed kaolin in a special project.

GSX Services of South Carolina Inc. discontinued the use of fuller's earth as clay baseliner and top clay liner in its hazardous waste landfill operation in Sumter County.

Common Clay and/or Shale.—Common clay decreased 10.7% in quantity produced to 832,000 metric tons and 6.2% in value to $2.1 million. Common clay accounted for almost two-thirds of the volume of clay produced, but only 5% of its value. Common clay was mined by 13 companies from 22 mines in 13 counties.

Common clay was used in the manufacture of portland cement, common brick, face brick, structural tile, and terra cotta. Major producers were Boral Bricks Inc., Lancaster County; Dundee Cement Co., Orangeburg County; Palmetto Brick Co., Marlboro County; Richtex Corp., Richland County; and Southern Brick Co, Greenwood and Saluda Counties.

Kaolin.—South Carolina ranked second nationally in both the volume of kaolin produced and in its value. Although kaolin accounted for only one-third of the volume of clay produced, it derived more than 90% of the value of clay produced. Industrial kaolin was produced by five companies operating seven pits in Aiken County. The companies were Dixie Clay Co., J. M. Huber Corp., Kentucky-Tennessee Clay Co., National Kaolin Products Co., and Southeastern Clay Co. Unprocessed kaolin was mined by Carolina Ceramics Inc. in Richland County, Dixie and National in Aiken County, Guignard Brick Works in Calhoun County, Palmetto Brick Co. in Kershaw County, and Richtex Corp. in Lexington and Richland Counties.

Tables 2 and 3 summarize the kaolin used in South Carolina by kind and end use, respectively.

Mica.—Mica production remained at about the same level that it had in 1989. South Carolina ranked fifth in quantity and fourth in the value of crude mica produced. Seven States produced crude mica in 1990.

Spartan Minerals Corp., Pacolet, Spartanburg County, was one of the Nation's six largest ground mica processors in 1990. Spartan, a subsidiary of FMC Corp., processed dry ground mica for the joint compound and coatings market from byproduct mica supplied by FMC, Lithium Div., from its lithium operations in Bessemer City, NC.

Mineral Mining Corp.'s (MMC) sericite mica mine and grinding plant near Kershaw, Lancaster County, were purchased by Piedmont Mining Co. Inc. of Charlotte, NC. Before the purchase, Mineral Mining Corp. conducted mining operations for Piedmont at its Haile Gold Mine on a contract basis. MMC, renamed Mineral Mining Co. Inc., operates as a wholly owned subsidiary of Piedmont.

Peat.—Peat production in South Carolina also remained virtually unchanged from that of 1989. Nationally, the State ranked 13th in quantity and 12th in value with respect to 22 States producing peat. American Peat and Organics Inc. remained the only company mining peat in South Carolina. Its operation was at Snuggedy Swamp near the Edisto River in Colleton County.

GCO Minerals, a Houston, TX-based subsidiary of International Paper Co., applied to the U.S. Army Corps of Engineers (USCE) for a permit to mine peat from four sites in and around the Carolina Bays, near Myrtle Beach. The mining would affect 433 acres of land controlled by International and is projected to harvest more than 500,000 tons of peat during the 11-year life of the operation.

As was expected, GCO's proposal drew heavy criticism from environmental groups. At yearend, GCO's application was being reviewed by the USCE, the South Carolina Land Resources Commission (LRC), the South Carolina Department of Health and Environmental Control (DHEC), the South Carolina Coastal Council, the State Wildlife and Marine Resources Department, and the South Carolina Water Resources Commission

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 1988 and 1990 and estimates for 1989.

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 use and district in table 5.

The volume of construction sand and gravel increased 15% over that produced in 1989; however, its value increased only 7% over 1989's value. Construction sand and gravel was the fifth most valuable mineral commodity mined in South Carolina with a total of 8.6 million short tons produced at a value of $24.9 million. Forty companies operating 54 pits in 20 counties produced sand and gravel mainly for road base, concrete aggregate, asphalt concrete, and fill. Districts 2 and 3 (see State map) accounted for more than 95% of the State's production.

Major producers were Becker Minerals Co. with five operations in Dorchester, Florence, Marlboro, and Sumter Counties; Palmetto Sand Co. in Dorchester and Orangeburg Counties; Foster Dixiana Sand Inc. in Lexington and Richland Counties; Brewer Sand Co. Inc. in Sumter County; Loveless & Loveless Inc. in Kershaw County; Pageland Sand Co. Inc. in Chesterfield County; and Wilson Brothers Sand Co. Inc. in Laurens and Lexington Counties.

Becker Minerals Inc. began mining on a 700-acre tract adjacent to the Bennettsville city limits in June 1990. Mining on the tract, which was an extension of Becker's current operation, was delayed by protests of local residents and a threatened lawsuit by the Bennettsville City Council.

W. R. Bonsal and Co. suspended its mining operations on the Savannah River floodplain near Beech Island in Aiken County late in the year.

Industrial.—Industrial sand and gravel was produced by five companies in South Carolina. The State's production remained almost static at about 840,000 short tons as it maintained its ranking of 12th nationally in the quantity of industrial sand and gravel mined. South Carolina ranked 10th nationally in the value produced, which dropped 4% below the 1989 value to slightly under $16 million.

Companies producing industrial sand and gravel were Columbia Silica Sand Co., Foster-Dixiana Corp., and U.S. Silica Co. in Lexington County and Unimin Corp. and Whibco Inc. in Kershaw County. Almost 60% of the sand produced was used for making fiberglass and containers and as molding and core sand in the foundry industry.

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 1988 and 1990 and actual data for 1989.

Crushed.—Crushed stone continued, for the second year, to be the most valuable mineral commodity produced in South Carolina. Its estimated value of approximately $135 million represented a 21.3% increase over that of 1989. Crushed stone accounted for almost 38% of South Carolina industrial minerals production and for more than 30% of the total value of all minerals mined. Fifty-five crushed stone quarries, 34 granite and 21 limestone, were permitted by the State of South Carolina on December 31, 1990. This represents an increase of four more, all granite quarries, than were permitted 1 year earlier.

At yearend, Southern Aggregates Co.'s permit application to mine 140 acres adjacent to its existing quarry at Jamestown in Berkeley County was pending approval by the North Carolina Land Reclamation Commission. Approval of the application was vigorously opposed by area residents. In 1987, 45 residents filed lawsuits against Southern Aggregates claiming that

quarrying activity had caused numerous sinkholes to develop on their properties. Settlement of the lawsuits was also pending at yearend.

Dimension.—A significant decrease in the production of dimension stone occurred in 1990. Although six dimension stone quarries operated by four companies were permitted in 1990, only three companies operating four quarries were active. Consequently, in accordance with the Bureau's policy not to published proprietary company information, data on the quantity and value of dimension stone produced in South Carolina was once again withheld in 1990. Granite was the only rock quarried for dimension stone, and only rough monumental stone and rough blocks were produced. Companies holding mining permits were Granite Panelwall Co., a subsidiary of Florida Crushed Stone Co., with three quarries in Lancaster County; Matthews International Corp. with one quarry in Kershaw County; South Carolina Granite Inc., a subsidiary of North Carolina Granite Co., with one quarry in Kershaw County; and Willis Mining Enterprises, with one quarry in Newberry County. Willis did not report any production to the Bureau in 1989 or 1990.

Vermiculite.—South Carolina once again was the leading State in vermiculite production in 1990. Although production increased slightly, value showed an appreciable decrease to continue a downturn that began in 1988. Companies mining vermiculite included Enoree Minerals Corp. in Spartanburg County, and W. R. Grace & Co., Virginia Vermiculite Ltd., and Patterson Vermiculite Co., all in Laurens County. Virginia Vermiculite purchased the Carolina Vermiculite Co. from Strong-Light Products Corp. late in 1989 and renamed it the Carolina Vermiculite Div. of Virginia Vermiculite Ltd.

Grace Specialty Chemicals Co., W. R. Grace & Co.'s vermiculite- producing subsidiary, completed an agreement with ICI Advanced Materials (ICI), U.S.-based subsidiary of ICI PLC of the United Kingdom. According to the agreement, Grace will supply ICI with vermiculite slurry from its Enoree plant under a long-term supply contract. In return, Grace acquired a portion of the vermiculite dispersion technology and marketing activities of ICI.

Laurens County Parks and Recreation Commission agreed to allow W. R. Grace & Co. to mine a 4-acre area in Laurens County Park. Royalties from the mining would allow the county to develop two additional ballfields at the park at a cost estimated between $225,000 and $250,000.

South Carolina ranked second in the quantity of and third in the value of exfoliated vermiculite produced or used. Although there was a significant reduction in the quantity of exfoliated vermiculite sold, its value decreased only slightly. Three of the four companies that mined crude vermiculite also produced exfoliated vermiculite. Grace's exfoliated vermiculite plant at Travelers Rest was inactive during 1990. More than 90% of the exfoliated vermiculite produced in South Carolina was used for block and loose-fill insulation, soil conditioners, and in lightweight-concrete aggregate.

Other Industrial Minerals.—Only three other industrial minerals were mined in South Carolina: gem stones; manganiferous schist; and sericite schist, which is included with clay in table 1. South Carolina was a minor producer of gem stones, ranking 36th of 49 States reporting gem stone production. The manganiferous schist was mined for brick colorant by Boren Brick Co. at Blacksburg and the Ashe Brick Div. of Boral Brick Co. at Van Wyck. The Blacksburg plant discontinued using locally mined manganiferous schist for coloring brick in 1990. Imported manganese shipped in from out-of-State processing plants replaced the manganiferous schist. Apparently the change was made in response to customer complaints about the staining of bricks colored with manganiferous schist. The ground manganese also gives the brick a uniform rather than a speckled tint. Boren maintains stockpiles of manganiferous schist that are reserved for making brick to match previous production.

The sericite schist, used in brick manufacture, was mined by Boral Brick Co. at Van Wyck, Boren at Gaffney, Carolina Ceramics in Kershaw County, and Industrial Minerals Inc. in Cherokee County. Industrial Minerals also ground calcium borate minerals imported from Turkey for sale to fiberglass manufacturers.

Several other industrial minerals were produced or used in South Carolina from materials shipped in from out-of-State. Synthetic graphite was used to make low-modulus cloth and fiber and high-modulus fibers by Amoco Performance Products Inc. in Greenville. High-modulus fibers were also manufactured by BASF Corp., Structural Materials in Rock Hill, York County.

Showa Denco Carbon Inc., a subsidiary of Tokyo-based Showa Denco K.K., started an $11 million expansion program at its plant in Ridgeville, Dorchester County. Showa purchased the 5-year-old plant from Airco Carbon Inc., a subsidiary of the United Kingdom's BOC Ltd., in 1988. The plant makes graphite carbon electrodes used in high-temperature electric arc furnaces. In electric arc furnaces, solid cylinders of graphite weighing from 200 pounds to 2 tons conduct up to 100,000 amperes of electricity into the furnaces. This produces temperatures that reach 14,000° C. Since it took over the plant, Showa has increased its share of the graphite-electrode market from 24% to 30% and decreased its exports from 40% of sales to 30% as a result of focusing on the U.S. market. Sales in 1990 were $63.7 million, up from $61.6 million in 1989. With the expansion, which is expected to be completed by mid-1991, Showa expects to increase production capacity from 30,000 metric tons to 35,000 metric tons annually.

Spartan Mineral Corp., in addition to processing ground mica, produced a feldspar-silica mixture for the glass and pottery market using the same lithium byproduct material.

Westvaco Corp. manufactured organic iodine compounds at the North Charleston, Charleston County, plant. Kaolin from Florida and ball clay from Tennessee and Kentucky were used by the Kohler Manufacturing Co. to produce sanitaryware at its Spartanburg plant. Heckett Div., Harsco Corp., processed steel slag for aggregate from Georgetown Steel Corp.'s minimill in Georgetown. Slag from MacAlloy Corp.'s ferroalloy plant in Charleston was used for aggregate, refractory material, and roofing shingle applications.

Metals

Gold and byproduct silver were the only metals mined in South Carolina in 1989. Gold production decreased, and South Carolina's national ranking in the production of gold dropped from sixth to seventh. Three companies operated gold mines in 1989, and a fourth was under construction and scheduled to begin production in 1991.

Gold.—The U.S. Bureau of Mines withholds data on the amount of gold produced in South Carolina to protect proprietary company data. However, published reports indicate that, in 1990, Kennecott's Ridgeway Mine produced 172,000 ounces at a cash production cost of $174 per ounce ($29,928,000),[9] and Piedmont's Haile Mine produced 22,402 ounces compared with 15,458 ounces produced the previous year.[10] Published production data for Brewer's Jefferson Mine were not available.

Kennecott mined ore selectively from two pits at the Ridgeway Mine and blended it to produce a consistent plant feed. The ground ore was processed through 10 vat leaching tanks and an on-site refinery produced doré bars. Mine tailings were treated with ferrous sulfate to make a stable cyanide compound from the remaining free cyanide.

Planned additions to the processing operations at Ridgeway are expected to increase throughput to 15,000 tons per day, which would make it the largest gold mill in the Western Hemisphere. New equipment scheduled for the expansion included a gyratory crusher to increase efficiency and reduce stress on the primary mill and a second ball mill.

Ore at Brewer's Jefferson Mine has a higher concentration of gold than the Ridgeway Mine, but much lower silver values. The ore is processed on a heap-leach pad and a gravity flow carbon column plant. Brewer produced doré bars containing 90% gold and 10% silver from a small on-site refinery.

Brewer had recently discovered other small deposits approximately 10 miles from the Brewer Mine in Lancaster County. Brewer planned to process the ore in its facilities in Chesterfield County if permits can be obtained for the new sites. Planned production would be 1,500 to 2,000 tons per day, and about 30 to 35 additional people would be employed.

Brewer suspended mining operations on October 28 when heavy rains spawned by a tropical storm ruptured an earthen tailings dam and allowed water containing sodium cyanide to enter the Lynches River. A South Ccarolina Wildlife and Marine Resources Department report on the fish kill resulting from the discharge was being reviewed by DHEC at yearend. Under the State's Pollution Control Act, DHEC has the power to recover damages and assess civil penalties to companies that discharge waste into the environment and cause damage to wildlife. Mining was expected to resume during the spring of 1991 after a new dam had been constructed according to plans approved by the DHEC.

Piedmont Mining Co. Inc. announced[11] the results of a preliminary feasibility study and economic evaluation of the mineral inventory at its Haile Gold Mine near Kershaw, SC. The study indicated that 6.4 million additional tons of proven and probable mineral inventory in four mineralized zones could be mined from several open pits, with an average strip ratio of 3.5:1. The preliminary economic analysis showed that at a milling rate of 3,000 tons per day, gold production could average about 60,000 ounces per year with a mine life of more that 6 years. At a gold price of $400 per ounce, the total pretax cash-flow for the project could be about $45 million after deducting the $15 million capitol cost. Piedmont was examining financing alternatives to develop the potential of the Haile property. These may include a private placement of new equity capital or a joint venture with another mining company.

The proven and probable mineral inventory at the Haile Mine was listed at 14.5 million tons with an average grade of 0.048 ounce of gold containing a total of 700,000 ounces of gold with a cutoff grade of 0.01 ounce per ton in seven mineralized zones.

South Carolina's fourth gold mine is to be operated by Gwalia (U.S.A.), a wholly owned subsidiary of Australia's Gwalia International Ltd. Its mining permit became effective on August 14, 1990, for a mine 3 1/2 miles southeast of McCormick, McCormick County, SC, near the Georgia State line. The mine will be an open pit operation using an asphalt-based heap-leach pad. The company will employ 24 people, with an additional 14 to 18 employed by a contractor who will be responsible for stripping, crushing, and mining operations. Gwalia employees will be responsible for all agglomeration, stacking, and processing operations.

The company anticipated mining 600,000 short tons of ore per year to produce approximately 20,000 troy ounces of gold and 55,000 ounces of silver per year. Total production for the mine has been estimated to be 75,000 ounces of gold and 225,000 ounces of silver, giving the mine a life-span of almost 4 years. An active exploration program may extend the projected mine life. Construction was well underway at yearend, and gold production was expected to begin by mid-1991.

Silver.—Silver was produced as a byproduct at the Ridgeway and Jefferson Mines. The quantity of silver produced almost doubled the amount produced the previous year, primarily as a result of increased silver recovery at the Ridgeway Mine.

Other Metals.—No metals other than gold and silver were mined in South

Carolina. Locally, significant amounts (1.5%) of copper occur in the sulfide ore at the Brewer Mine, but no recovery of copper has been reported. Nonetheless, metals shipped into South Carolina for refining or further processing did play an important role in the mineral economy of the State.

Alumina imported from Australia through the Port of Charleston was processed into primary aluminum by Alumax Inc., Mount Holly, Berkeley County. Alumax is jointly owned by Amax Inc., with a 73% ownership share and a 23% product share, and Clarendon Ltd., with 27% ownership share and a 77% product share. The plant has a nominal production capacity of 181,000 metric tons using two 180-cell potlines with an expansion capability of two additional potlines.

Kaiser Aluminum and Chemical Corp., a subsidiary of Maxxam Inc., officially dedicated its new $12 million aluminum forgings plant in Greenwood, Greenwood County, in April 1990. Construction began late in 1989 on the 112,800-square-foot facility, which can produce 4.7 million pounds of aluminum forgings per year.

Blasius Group Inc., Spartanburg, Spartanburg County, filed for bankruptcy protection under Chapter 11 in February 1990. Falling world prices and declining automotive industry sales forced the action, according to company officials.[12] At the time of the bankruptcy, 50% of the ownership of Blasius, formerly known as Batchelder-Blasius Inc., was held by Charles Batchelder, whose New England secondary aluminum smelter folded several years ago. Negotiations to find an equity partner to buy out Batchelder fell through shortly before the bankruptcy announcement. Blasius had been producing between 4 million and 4.5 million pounds of specification ingot per month.

A significant portion of the Port of Charleston export business in 1990 was related to the exportation of equipment to build and operate the mines, establish mining rail systems, and provide needed materials and components for Chile's copper mining industry. The Port of Charleston also provided import service on most of Chile's copper shipments to at least six major U.S. companies who utilized more than 250,000 tons of Chile's annual copper production.

Companies exporting mining equipment to Chile included Tamper Co. of Columbia, SC, which shipped railroad equipment and maintenance to build Chile's mine railroad system. The American division of Chile's Corporation del Cobre (Codelco) exported mining machinery to and imported copper cathodes and wire from Chile. Southwire Co. of Carrollton, GA, exported copper and precious metals from its newly acquired plant in Gaston, SC, to Venezuela. Southwire completed a purchase agreement with the copper wire rod and scrap recycling facility of AT&T Nassau Metals Corp. in October. Under the agreement, Southwire acquired an 85% share of and management responsibility for the plant, which was renamed Gaston Copper Recycling Corp. The other 15% share is owned by a subsidiary of the Bank of Montreal.

Startup of Teledyne Allvac's new continuous bar mill in Richburg, originally scheduled for the fourth quarter of 1990, was delayed until the second quarter of 1991. Construction of the new plant started in September 1989 and was originally scheduled to be completed by December 1990. The computer-controlled mill with major equipment built by Danieli of Buttrio, Italy, will be housed in a 163,000-square-foot facility. Both titanium and high-temperature nickel alloy, in straight-length bars and rod coils weighing up to 3,000 pounds, will be produced. The titanium and nickel superalloys will be used in the aerospace industry, for biomedical implants, and for the automotive industry.

In 1990, exports, mainly through the Port of Charleston, made up 12% of Allvac's business. Company officials expect that to grow to 25% in the next few years.

Usinor Sacilor agreed in principle to purchase a 50% interest in Georgetown Steel Corp., a Georgetown, SC, minimill. The joint venture will likely give Georgetown the ability to make the highest quality wire rod that is possible from electric furnaces, including tire cord wire, a major market from which it has been excluded.

Georgetown Industries is presently owned by Kuwait's Ministry of Finance (91%) and Georgetown managers and directors (9%). Georgetown Steel, which anticipated $200 million in revenue in 1990, makes up roughly one-third of Georgetown Industries' total sales.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 32 years of 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]State geologist, South Carolina Geological Survey, Columbia, SC.

[3]New York Times National. Striking Gold and Fear in South Carolina. June 3, 1991, p. A-18.

[4]The Miami (FL) Herald. Firm Encounters Foes for Plans in Two States. Dec. 25, 1990.

[5]Mining Engineering. Aggregate Imports: Is It Achievable? V. 46, No. 1, Jan. 1991, p. 145.

[6]U.S. Department of Labor. Employment and Earnings. V. 38, No. 5, May 1991, p. 136.

[7]U.S. Department of Labor. Mine Injuries and Worktime, Quarterly. Jan.-Dec. 1990.

[8]U.S. Department of Labor. News: Average Annual Pay by State and Industry, table 4. 1990.

[9]Mining Journal (London). Galactic at a Loss. Mar. 13, 1991.

[10]New Release, Prime Capitol Corp. (Vancouver). International Viking Resources Inc. May 2, 1990.

[11]Skillings Mining Review. Piedmont Reports Results of Preliminary Feasibility Study. Oct. 6, 1990, p. 4.

[12]American Metals Market. Chapter 11 Bankruptcy Plan Filed by Blasius Group. Feb. 2, 1990.

TABLE 2
SOUTH CAROLINA KAOLIN SOLD OR USED BY PRODUCERS, BY KIND

Kind	1989		1990	
	Metric tons	Value	Metric tons	Value
Air-float	494,563	$35,383,831	497,067	$37,372,439
Unprocessed	165,088	1,087,320	733,994	5,036,470
Total	659,651	336,471,151	1,231,061	42,408,909

TABLE 3
SOUTH CAROLINA KAOLIN SOLD OR USED BY PRODUCERS, BY KIND AND USE

(Metric tons)

Kind and use	1989	1990
Air-float:		
Adhesives	13,084	12,116
Animal feed and pet waste absorbent	3,480	3,491
Ceramics[1]	5,354	6,299
Fertilizers, pesticides and related products	19,053	19,068
Fiberglass	137,754	134,923
Paint	542	W
Paper coating and filling	17,658	17,479
Plastics	8,275	W
Rubber	160,524	148,008
Refractories[2]	8,667	6,900
Other uses[3]	59,161	88,439
Exports[4]	61,009	60,344
Total	494,563	497,067
Unprocessed: Face brick and other uses	165,088	733,994
Grand total[5]	659,651	1,231,061

W Withheld to avoid disclosing company proprietary data.
[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 oils; catalysts (oil refining); chemical manufacturing; ink; medical; sewer pipe; and unknown uses.
[4]Includes ceramics; adhesives; paper filling; pesticides and related products; and rubber.
[5]Data may not add to totals shown because of independent rounding.

TABLE 4

SOUTH CAROLINA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	4,492.00	$14,448.00	$3.22
Plaster and gunite sands	331.00	878.00	2.65
Concrete products (blocks, bricks, pipe, decorative, etc.)	108.00	276.00	2.56
Asphaltic concrete aggregates and other bituminous mixtures	272.00	681.00	2.50
Road base and coverings[1]	462.00	2,157.00	4.67
Fill	948.00	1,195.00	1.26
Snow and ice control	W	W	3.50
Other[2]	64.00	322.00	5.04
Unspecified:[3]			
Actual	1,153.00	3,034.00	2.63
Estimated	797.00	1,951.00	2.45
Total or average	8,627.00	[4]24,941	2.89

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes road and other stabilization (lime).
[2]Includes roofing granules.
[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.

TABLE 5

SOUTH CAROLINA: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	98	279	1,754	6,839	2,640	7,329
Plaster and gunite sands	—	—	W	W	W	W
Concrete products (blocks, bricks, etc.)	W	W	—	—	W	W
Asphaltic concrete aggregates and other bituminous mixtures	—	—	W	W	167	296
Road base and coverings[1]	W	W	W	W	348	1,827
Fill	W	W	W	W	756	953
Snow and ice control	W	W		—	—	—
Other miscellaneous[2]	137	395	557	1,384	220	653
Unspecified:[3]						
Actual	—	—	392	826	761	2,208
Estimated	—	—	51	149	746	1,801
Total[4]	235	675	2,753	9,198	5,639	15,068

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes road and other stabilization (lime).
[2]Includes roofing granules.
[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.

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 Highway 246 S Greenwood, SC 29646	do.	Greenwood.
Cement:			
Blue Circle Industries, PLC (formerly Gifford-Hill Cement Co.)	Box 326 Harleyville, SC 29448	do.	Dorchester.
Giant Cement Co.	Box 218 Harleyville, SC 29448	do.	Do.
Holnam Inc. (formerly Santee Cement Co.)	Box 698 Holly Hill, SC 29059	do.	Orangeburg.
Clays:			
Common clay and shale:			
Palmetto Brick Co.[1]	Box 430 Cheraw, SC 29520	do.	Kershaw and Marlboro.
Richtex Corp.[1]	Box 3307 Columbia, SC 29230	Mine and plant	Lexington and Richland.
Santee Portland Cement Co.	Box 698 Holly Hill, SC 29059	do.	Orangeburg.
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.
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	do.	Chesterfield
Kennecott Ridgeway Mining Co.	Route 2, Box 106 Ridgeway, SC 29130	do	Fairfield
Piedmont Mining Corp.	Box 505 Kershaw, SC 29067	do.	Lancaster
Mica (sericite):			
Mineral Mining Co., a subsidiary of Piedmont Mining Co.	Box 458 Kershaw, SC 29067	do.	Do.
Sand and gravel:			
Augusta Sand & Gravel Co.	Box 472 Clearwater, SC 29822	Pits and plants	Aiken.
Becker Sand & Gravel Co. Inc.	Box 848 Cheraw, SC 29520	do.	Various.
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 the end of table.

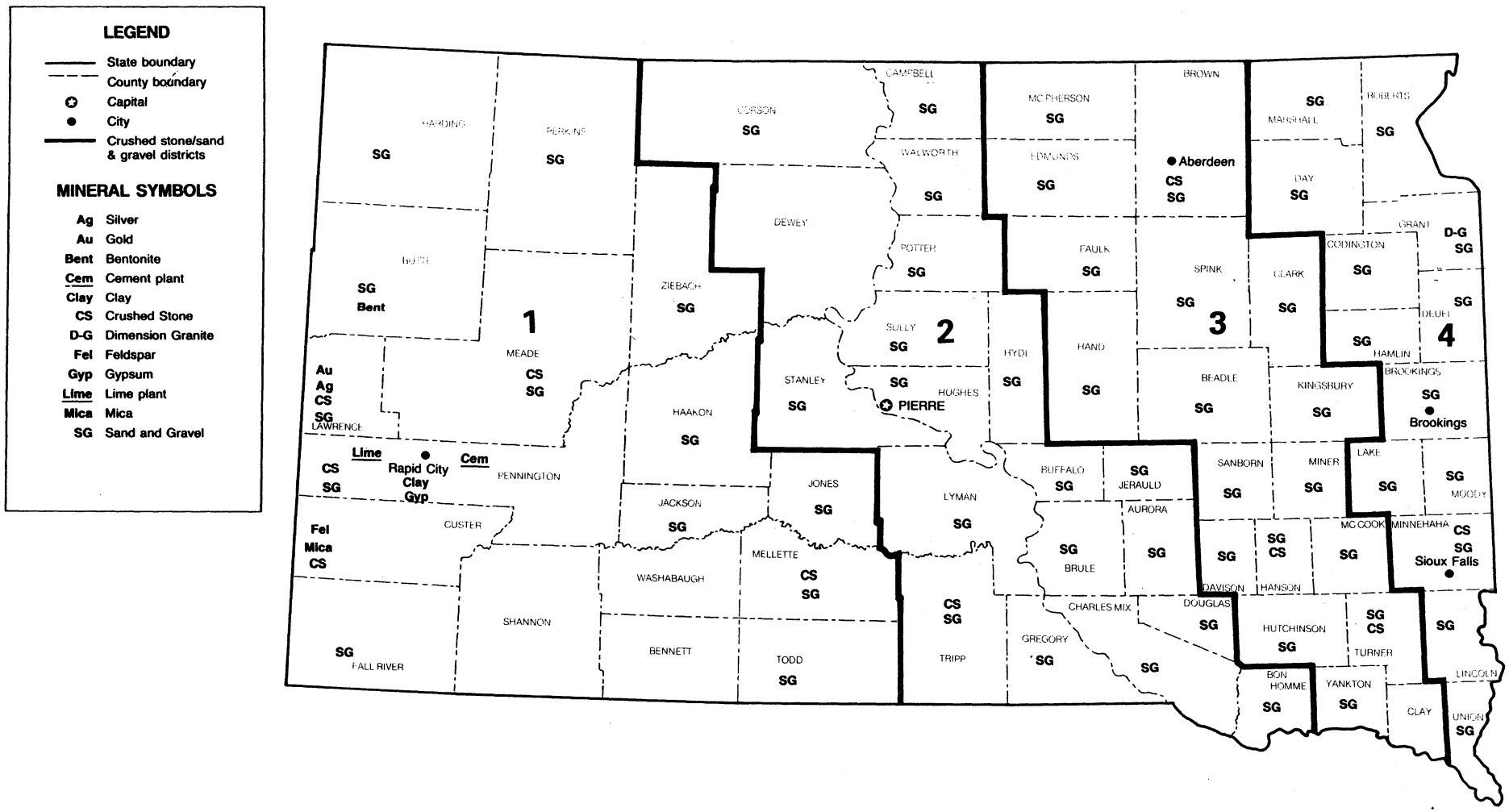
TABLE 6-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone:			
Crushed:			
Martin Marietta Aggregates	Box 30013 Raleigh, NC 27612	do.	Do.
Tarmac America Inc.	Box 34527 Richmond, VA 23234.	do.	Do.
Vulcan Materials Co.	Box 7497 Birmingham, AL 35253	Quarries and plant	Various.
Dimension:			
Granite Panelwall Co., a division of Florida Crushed Stone Co.	Box 898 Elberton, GA 30635	do.	Lancaster.
Matthews International Corp.	Box 606 Kershaw, SC 29067	Quarry	Kershaw.
North Carolina Granite Co.	Box 151 Raleigh, NC 27612	do.	Kershaw.
Vermiculite:			
Carolina Vermiculite Div. of Virginia Vermiculite Ltd.	Box 98 Woodruff, SC 29388	do.	Do.
Enoree Minerals Corp.	Box 289 Lauren, SC 29360	Mines and plant	Spartanburg
W.R. Grace & Co.	Route 1 Enoree, SC 29335	do.	Laurens.
Patterson Vermiculite Co.	Route 1 Enoree, SC 29335	do.	Do.

[1]Also kaolin.

SOUTH DAKOTA



Principal Mineral-Producing Localities

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 James H. Aase[1]

Nonfuel mineral production in South Dakota rose to a record high value of $298 million in 1990, a 5% increase over that of the previous year and 33% above the average for the decade of the 1980's. Advances in both quantity and value were recorded for more than one-half of the commodities produced compared with 1989 figures.

Production came from sites in 62 of the State's 67 counties. Lawrence County was the leading county in terms of value for nonfuel mineral production, contributing more than two-thirds to the State's total.

The State ranked 34th nationwide in value of nonfuel mineral production, contributing about 1% of the U.S. total.

Gold, the principal commodity produced in the metallic sector, accounted for approximately $7 out of every $10 of the State's total nonfuel mineral value and is credited for 80% of the $14 million increase over that of the previous year. Leading the nonmetallic commodities in value was cement, followed by construction sand and gravel and crushed stone. Collectively, these three commodities contributed about 23% of the State's total nonfuel mineral production value.

Among the minerals produced in South Dakota during the year, the quantity of gold produced ranked 4th among 13 States reporting production; silver, 13th of 19; portland cement, 31st of 38; common clay and shale, 32d of 43; lime, 23d of 32; mica, 2d of 7; crushed stone, 34th of 49; dimension stone, 9th of 34; and construction sand and gravel, 31st of 50.

TRENDS AND DEVELOPMENTS

Required environmental controls in place at the State's large-scale surface gold mines allowed mining to occur and, at the same time, maintained adequate environmental protection. No notices of violation were issued during the year for environmental problems.

TABLE 1
NONFUEL MINERAL PRODUCTION IN SOUTH DAKOTA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	4	W	W	W	W	W
Portland	do.	490	W	W	W	W	W
Gemstones		NA	$100	NA	$150	NA	$110
Gold[2]	kilograms	13,981	197,026	16,123	198,318	16,860	209,732
Lead[2]	metric tons	—	—	4	3	—	—
Sand and gravel (construction)	thousand short tons	7,929	18,681	e6,400	e20,800	9,689	23,689
Silver[2]	metric tons	3	552	4	705	6	940
Stone:							
Crushed	thousand short tons	e5,500	e20,600	3,833	14,303	e4,800	e16,800
Dimension	short tons	e43,297	e16,472	54,623	17,738	e50,688	e12,871
Combined value of clays (common), feldspar, gypsum (crude), iron ore, lime, mica (scrap) and values indicated by symbol W		XX	32,288	XX	32,341	XX	34,310
Total		XX	285,719	XX	284,358	XX	298,452

eEstimated. 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]Recoverable content of ores, etc.

Near yearend, the Cumulative Environment Evaluation (CEE) of mining in the Black Hills was completed and taken under review by a Governor-appointed task force. The CEE is part of the State's Centennial Environmental Protection Act. The CEE and the recommendation of the task force will be used as a planning tool by the South Dakota Board of Minerals and Environment when considering new or expanded large-scale gold mining proposals in the Black Hills.

Brohm Mining Corp. continued to supply information to fulfill mine permit requirements for its proposed Gilt Edge Mine expansion project. The expansion includes plans to mine up to 90 million short tons of sulfide ore using conventional milling methods, a 400-acre pit, a 278-acre tailings impoundment, and several waste rock depositories.

In early 1990, Homestake Mining Co. announced that exploration conducted 3 miles north of the Homestake Mine at Lead encountered encouraging gold intercepts in deep drill holes. An exploration drift was begun that will be driven northward 17,000 feet from the 6,800-foot level of the mine to evaluate the intercepts. During the year, the company spent $4.4 million on the project. The underground exploration program was expected to cost a total of $23 million and to be completed within 5 years. The drift also will provide access for underground exploration of the area between the mine and the deep intercepts north of the mine. Surface core drilling also was expected to continue in order to direct the exploration drift toward favorable structures.[2]

Work began during the year on an $8.5 million mill expansion project at the Homestake Mine in order to process additional ores from its Open Cut operation. The project was scheduled for completion in late 1991 and was expected to increase mill capacity by 500 short tons per day. The expansion of the Open Cut operation progressed further as key permits were obtained and relocation plans for public roads, residences, and businesses continued. Mining in the expansion area of the Open Cut was scheduled to begin in 1996.[3]

In 1990, production capacity of Wharf Resources (U.S.A.) Inc.'s mine near Lead was increased to 3 million tons of ore per annum. This was achieved by expanding the capacity of the leach pads, purchasing additional trucks, enhancing crushing capacity, and upgrading collection ponds. Capital expenditures over the 2-year construction period of this expansion project were $10,000,000.[4]

The Golden Reward Mining Co. completed its first full year of operation at its open pit mine and heap-leach facility near Lead. Exploration drilling in conjunction with redesigning pits with steepened slopes resulted in an increase of minable reserves.[5]

Bond Gold-Richmond Hill Inc. completed construction of two additional leach pads at its Richmond Hill Mine, 5 miles northwest of Lead. The additional pads will allow for more than a doubling of capacity to heap-leach gold ore. Exploration activities were concentrated around the mine site with emphasis on the development of minable ore reserves. Two areas were discovered and drilled and are undergoing engineering studies and metallurgical testing to determine their potential as reserves.[6]

In August 1990, Homestake Mining Co. signed a consent decree with the U.S. Environmental Protection Agency (EPA) concerning Whitewood Creek Superfund site. The agreement reached called for Homestake to pay for past EPA response measures, to fund future measures, and for monitoring possible health and environmental risk caused by past discharges of arsenic-bearing tailings material into Whitewood Creek. Homestake is the only mining company still in business of the approximately 60 that, over the past 100 years, used the creek for discharging their tailings. Discharges into the creek were stopped in the late 1970's.

EMPLOYMENT

Employment in the State's mining industry averaged 2,600 workers during the year, a drop of less than 1% compared with that of 1989. Mining production workers' earnings averaged $12.52 per hour, and the average work week was 42.6 hours. Both the earning level and hours worked per week rose slightly above the previous year's level.[7]

No fatal injuries occurred in 1990 at any of South Dakota's underground mines, surface mines, or associated mills and/or operation plants. During the almost 4.5 million employee-hours worked at these facilities, a reported 103 injuries occurred to workers resulting in lost workdays, and an additional 130 injuries occurred with no workdays lost.[8]

REGULATORY ISSUES

The State Board of Minerals and Environment issued three life-of-mine permits in 1990. All three permits were issued to a single operator for sites in Pennington County. The material permitted to be mined was slate.

EXPLORATION ACTIVITIES

Fifteen exploration permits were issued during the year, down slightly from the number issued in 1989. The seven companies receiving the permits indicated precious metals as the primary target, and all were for sites in Lawrence County.

Permits were issued for 1,887 exploration drill tests, 1.5% above the number permitted the previous year. The testing utilized a variety of methods, including rotary, core, and churn drilling.

Although exploration activity remained at approximately the same level as in 1989, it was significantly below the peak levels reached in 1987 and 1988. Ballot measures the past several years by environmental groups, and public concern over mining in the Black Hills, has slowed exploration activities by some companies owing to uncertainties regarding future regulatory requirements or additional moratoriums on mine permitting. Currently, exploration is focused primarily on defining ore boundaries at, and adjacent to, existing mine sites.

LEGISLATION AND GOVERNMENT PROGRAMS

During the 1990 session of the South Dakota Legislature, a bill was enacted into law that was of particular interest to the State's gold mining industry. The legislation, Senate bill 257, contained, in part, measures to impose a moratorium on the issuing of permits for any new large-scale gold and silver mines in the Black Hills prior to January 1, 1992. It limited expansion of existing operations during the moratorium to 200 acres per operator, with mandatory concurrent reclamation of an equal number of acres of previously mined land. The bill also provided for creation of a seven-member Governor-appointed review committee to evaluate and make recommendations about the cumulative environmental evaluation as required under provision of the State's 1989 Environmental Protection Act.

A ballot initiative that would have limited gold and silver mining in the Black Hills to a cumulative 3,100 acres was narrowly defeated in the November general election. Currently, as a result of the 1989 Environmental Protection Act, the State imposed a limit of 3,500 acres until completion of a cumulative environmental evaluation.

The South Dakota Mining and Mineral Resources Research Institute (MMRRI), at South Dakota School of Mines and Technology in Rapid City, received a $145,000 grant from the U.S. Bureau of Mines in 1990. The funding was made available under provision of title III of the Surface Mining Control and Reclamation Act of 1977, Public Law 95-87, as revised. MMRRI has the mission of coordinating and administering training and research in fields of mining, mineral resources, mineral development, and mineral processing, in response to the interest and needs of the State, region, and Nation, with provisions for due regard for the environment.[9]

The South Dakota Geological Survey (SDGS) continued basic research projects involving mineral and water resources of the State during the year. SDGS completed a drilling project to obtain stratigraphic and geochemical data from Cretaceous rocks and Precambrian Sioux quartzite. The project, partially funded by the U.S. Geological Survey, was part of a study to support manganese exploration in the southeastern part of the State. Data developed during the project was being included in an SDGS open file report.

A U.S. Bureau of Mines report entitled "An Appraisal of Selected Mineral Resources of the Black Hills National Forest, South Dakota and Wyoming" was completed during the year. In 1989-90, the U.S. Bureau of Mines appraised selected high resource potential areas containing gold, rare-earth elements, or pegmatite deposits in or near the Black Hills National Forest. The economic feasibility of possible operations and the probability of exploration and development within the next decade were assessed. This mineral land assessment report (MLA-90) is available for consultation at U.S. Bureau of Mines headquarters in Washington, DC, and its field office in Denver, CO.

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Gold and Silver.—The quantity and value of gold and silver produced in the State increased significantly over those of the previous year. In 1990, the quantity of gold produced was at its highest level since 1970. Production of silver, obtained as a coproduct with gold, rose to a record high of the past 70 years. All of the active, major gold operations were within a 7-mile radius of Lead, in Lawrence County. Collectively, all of the gold mining operations processed in excess of 7.5 million short tons of ore from which 542,068 troy ounces of gold and 194,945 troy ounces of silver were recovered as bullion. The average unit prices in 1990 were $386.91 per troy ounce for gold and $4.82 per troy ounce for silver.

Homestake Mining Co. was the State's largest gold producer, accounting for more than two-thirds of the total output. According to company reports,[10] gold production from the Homestake and Open Cut Mines at Lead totaled 388,000 troy ounces, a 1.5% increase over that of 1989. Ore produced from the underground mine was 1,755,000 short tons grading 0.180 ounce of gold per ton; open cut ore amounted to 632,000 short tons grading 0.128 ounce of gold per ton. The combined average head grade of ore milled from the underground and open cut operations was 0.164 ounce of gold per ton, an increase of 3% compared with that of 1989. Mill recovery rate was 95%. Full production cost of the Lead operation in 1990 totaled $311 per ounce, a decrease of $11 per ounce from that of the previous year. Yearend proven and probable reserves of underground ore were pegged at about 20.4 million short tons containing 0.237 ounce of gold per ton. Open cut ore reserves were cited at about 8.6 million short tons containing 0.122 ounce of gold per ton.

Despite a number of startup problems encountered by Golden Reward Mining Co. in both the mining and processing phases of its operation, approximately 1.2 million short tons of ore was mined, crushed, and placed on leach pads, yielding 30,000 ounces of refined gold. Recovery of the precious metal from the ore was 71% of contained gold and 25% of contained silver. Minable reserves of leachable material within the company's 772-acre mine permit area was stated to be 12.5 million short tons averaging 0.042 ounce of gold per ton. The overall stripping ratio was cited as 1.6:1.[11]

At Wharf Resources' open pit heap-leach gold mine 5 miles southwest of Lead, a total of 2.6 million short tons of ore was processed in 1990. The average grade of processed ore was 0.042 ounce of gold per short ton, and the average recovery rate was 73.80%. Gold produced during the year amounted to 80,621 ounces, a 4.7% increase over that of the previous year. Proven and probable reserves of ore within the pit design and mining permit boundary were cited to be 23.7 million short tons. The

grade of the ore reserves was stated as 0.037 ounce of gold per short ton.[12]

Brohm Mining Corp.'s Gilt Edge Mine near Deadwood produced 33,054 ounces of gold and 23,931 ounces of silver during the year. Ore mined from an open pit and processed through its heap-leach facility totaled 1,321,425 short tons in 1990, an increase of 87% compared with the 1989 tonnage. The average grade of the ore processed was 0.042 ounce of gold per short ton. The average recovery of the gold from the ore was 60.6%. Proven and probable reserves of oxide ore were stated at 2.6 million short tons, having a grade of 0.041 ounce of gold per short ton. Sulfide ore reserves were cited as 45.1 million short tons, carrying a grade of 0.040 ounce of gold per short ton.[13]

The Richmond Hill Mine and heap-leach operation, approximately 5 miles northwest of Lead, produced 38,897 ounces of gold and 59,000 ounces of silver during the year. The gold produced was from treatment of 1.16 million short tons of ore having an average mill head grade of 0.033 ounce of gold per short ton. The stripping ratio was 0.67:1. Probable ore reserves were listed as 2.3 million short tons having a grade of 0.05 ounce of gold per short ton.[14]

Iron Ore.—Pete Lien & Sons Inc. produced iron ore from a pit near Nemo. The ore was used by the South Dakota Cement Plant in Rapid City as an ingredient in cement manufacturing.

Industrial Minerals

Cement.—Cement manufactured in South Dakota came exclusively from the State-owned plant in Rapid City. The output consisted of four types of portland cement and a prepared masonry cement, which collectively increased slightly in quantity and value compared with those of the previous year. The increase was attributed to strong sales to ready-mix dealers that more than offset declines to highway contractors for paving projects within the State and in North Dakota. Nearly two-thirds of the portland cement shipments from the plant were handled by truck, with the remainder by rail. Plant shipments were handled principally in bulk form, with only a minor amount shipped in containers. During the year, the South Dakota Cement Plant consumed in excess of 1 million tons of nonfuel mineral raw materials mined in the State in its cement manufacturing.

Clays.—The South Dakota Cement Commission mined common clay from pits in Pennington County and accounted for the total State output during the year. The clays were used exclusively in cement manufacturing. Output decreased 7% in quantity and 13% in value compared with 1989 figures.

Feldspar.—Feldsparproductiondecreased more than one-third in quantity and value compared with that of the previous year. Pacer Corp. was the sole producer during the year, obtaining its output from pegmatite deposits in Custer County. Approximately one-half of the hand-cobbed feldspar produced was used in potterymaking and the remainder in various other uses.

Gemstones.—No commercial gem stone mining operations were reported in South Dakota in 1990. No precise value is known for gem material that rockhounds, mineral collectors, and other hobbyists collected. The value for gem stones indicated in table 1 is an estimated amount.

Gypsum.—Crude gypsum production rose 47% in quantity and 48% in value compared with 1989 figures. Output was from the Lange Mine in Meade County, operated by the South Dakota Cement Commission. The entire output was used in cement manufacturing.

Lime.—The State's entire lime production in 1990 was from the Pete Lien & Sons Inc. plant in Rapid City. Output increased approximately 20% both in quantity and value over that of 1989. Both quicklime and hydrated lime were produced at the facility.

Mica.—Mica production decreased 17% in quantity and 18% in value compared with 1989 figures. Pacer Corp. accounted for the entire State output. Production was from its Brite-X Mine in Custer County and was processed at the company's grinding mill in Custer.

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 annual report contains actual data for 1988 and 1990 and estimates for 1989.

Construction sand and gravel output increased 51% in quantity and 14% in value over that estimated for the previous year. The largest specified use of the sand and gravel consumed during the year was in road bases and coverings. Construction sand and gravel statistics are compiled by geographical districts as shown on the State map. Table 3 presents end-use data for the four districts covering the State. The leader in terms of value of sand and gravel output was Codington County, followed respectively by Hanson County and Dewey County.

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 annual report contains estimates for 1988 and 1990 and actual data for 1989.

Crushed.—Estimated crushed stone output increased 25% in quantity and 17% in value over that recorded in 1989.

Dimension.—Dimension stone production was estimated to have decreased 7% in quantity and 27% in value compared with that reported for the previous year. Near midyear, a joint venture was undertaken between Dakota Granite Co. of Milbank, SD, and Rock of Ages Corp. of Barre Town, VT, resulting in the purchase of inventory, quarrying equipment, and quarries of Field Enterprises, a business that owned the Dakota Mahogany quarry in Milbank and another quarry in

Bellingham, SD. The new business will be called Whetstone Granite Co. Ownership of the company is divided equally between the two principals.

[1]Former State Mineral Officer, U.S. Bureau of Mines, Minneapolis, MN. He has 33 years of experience in mineral-related work in private industry and government. Assistance in the preparation of the report was given by Wanda J. West, editorial assistant.

[2]Homestake Mining Co. (San Francisco, CA). 1990 Annual Report to Stockholders, 40 pp.

[3]Work cited in footnote 2.

[4]Wharf Resources Ltd. (Toronto, Ontario, Canada). 1990 Annual Report to Stockholders, 27 pp.

[5]United Coin Mines Limited (Toronto, Ontario, Canada). Interim Report to Shareholders. July 31, 1991, 14 pp.

[6]LAC Minerals Ltd. (Toronto, Ontario, Canada). 1990 Annual Report to Stockholders, pp. 9-11, 28.

[7]South Dakota Department of Labor. Employment & Earnings Covered by Unemployment Insurance. 1990, p. 4.

[8]U.S. Department of Labor. Mine Injuries and Worktime, Quarterly. 1990, p. 15.

[9]South Dakota School of Mines and Technology (Rapid City, SD). South Dakota Mining and Mineral Resources Research Institute. Annual Status and Final Report. 1991, 136 pp.

[10]Work cited in footnote 2.

[11]Work cited in footnote 5.

[12]Work cited in footnote 4.

[13]MinVen Gold Corporation (Lakewood, CO). 1990 Annual Report to Stockholders, 109 pp.

[14]Work cited in footnote 6.

TABLE 2

SOUTH DAKOTA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY[1]

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	657	$2,875	$4.38
Plaster and gunite sands	5	23	4.60
Concrete products (blocks, bricks, pipe, decorative, etc.)	4	24	6.00
Asphaltic concrete aggregates and other bituminous mixtures	356	1,509	4.24
Road base and coverings[1]	3,554	6,897	1.94
Fill	565	737	1.30
Snow and ice control	37	60	1.62
Other	91	142	1.56
Unspecified:[2]			
Actual	3,777	9,472	2.51
Estimated	644	1,951	3.03
Total[3] or average	9,689	23,689	2.44

[1]Includes road and other stabilization (cement).
[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.

TABLE 3

SOUTH DAKOTA: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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	W	W	—	—	248	816
Plaster and gunite sands	—	—	—	—	—	—	5	23
Concrete products (blocks, bricks, etc.)	—	—	—	—	—	—	4	24
Asphaltic concrete aggregates and other bituminous mixtures	5	29	58	134	148	524	145	822
Road base and coverings[1]	615	104	948	2,087	687	1,176	1,305	2,586
Fill	—	—	59	129	45	78	461	529
Snow and ice control	2	7	(2)	(2)	4	15	30	38
Other miscellaneous[3]	319	1,671	117	430	38	61	25	38
Actual	667	1,622	900	2,132	783	1,785	1,428	3,933
Estimated	205	370	—	—	327	1,400	112	181
Total[4]	1,812	4,747	2,082	4,912	2,032	5,039	3,763	8,991

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes road and other stabilization (cement).
[2]Less than 1/2 unit.
[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.

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 Bond International Gold Inc.[1]	601 West Main St. Lead, SD 57754	Open pit and leach pads	Lawrence.
Brohm Mining Corp., a division of MinVen Gold Corp.[1]	Box 485 start here Deadwood, SD 57732	do.	Do.
Golden Reward Mining Co.[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 & Sons Inc.	Box 440 Rapid City, SD 57709	do.	Lawrence.
Lime:			
Pete Lien & 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 & 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.
Fisher Sand & Gravel Co.	Box 1034 Dickinson, ND 58602	do.	Beadle, Clark, Davison, Hanson, Pennington, Sanborn, Union, Walworth.
Myrl & Roy's Paving Inc.	1300 North Bahnson Sioux Falls, SD 57103	do.	Lincoln and Minnehaha.
Sweetman Construction Inc.	Box 84140 Sioux Falls, SD 57118	do.	Minnehaha and Roberts.
Stone (1989):			
Crushed:			
Limestone:			
Pete Lien & Sons Inc.	Box 440 Rapid City, SD 57709	Quarry and plant	Pennington.

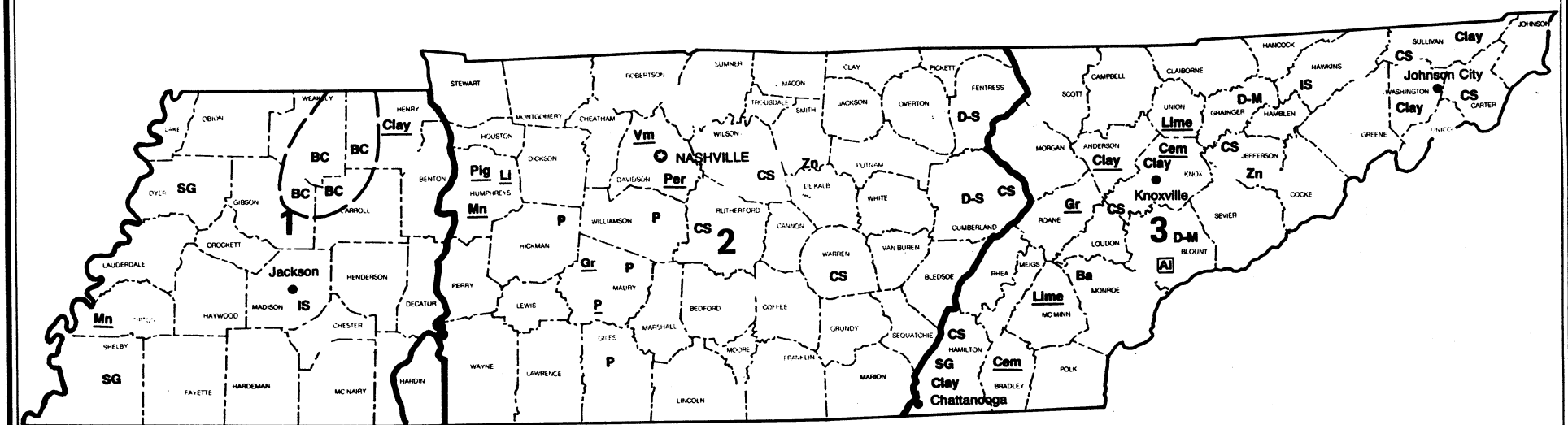
See footnotes at the end of table.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone (1989)—Continued			
Crushed—Continued			
Limestone—Continued			
Northwestern Engineering Co. (Hills Materials Co.)	Box 2320 Rapid City, SD 57709	Quarries and plants	Do.
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 57101	do.	Minnehaha.
Spencer Quarries Inc.	Box 25 Spencer, SD 57374	do.	Hanson.
Sweetman Construction Co.	Box 809 Sioux Falls, SD 57101	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.

TENNESSEE



LEGEND

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

MINERAL SYMBOLS

Al	Aluminum plant
Ba	Barite
BC	Ball Clay
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
D-M	Dimension Marble
D-S	Dimension Sandstone
Gr	Graphite plant
IS	Industrial Sand
Li	Lithium plant
Lime	Lime plant
Mn	Manganese Dioxide plant
P	Phosphate rock
P	Phosphorous plant
Per	Perlite plant
SG	Sand and Gravel
TiPig	Titanium Dioxide pigment plant
Vm	Vermiculite plant
Zn	Zinc
Zn	Zinc smelter

Concentration of mineral operations

Principal Mineral-Producing Localities

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 Ray C. Gilbert[3]

The value of nonfuel mineral commodities produced in Tennessee in 1990 increased almost 4% over that of 1989 to a record high of $662.5 million. Crushed stone, the State's leading mineral commodity, increased 6.3% to an estimated value of $268.6 million. Tennessee's three leading nonfuel commodities, cement, crushed stone, and zinc, accounted for almost 80% of the total. The State ranked first nationally in the value of ball clay and gem stones produced and second in the value of zinc produced. Although mineral production increased in 1990, Tennessee's national ranking for the value of all minerals produced dropped from 16th in 1989 to 17th.

TRENDS AND DEVELOPMENTS

For the fifth consecutive year, the value of Tennessee's nonfuel mineral production achieved a record high primarily as a result of the increase in the value of crushed stone, which accounted for two-thirds of the increase. Other mineral commodities that increased in value included construction sand and gravel, dimension stone, portland cement, gem stones, lime, and phosphate rock.

For only the third time in the past 33 years, the State failed to lead the Nation in zinc production. This resulted from the opening in August of a new Alaskan mine that had a projected zinc production capacity approximately four times greater than the entire annual zinc production of Tennessee.

Major corporate changes in 1990 included: the purchase of Tennessee Chemical Corp. by Boliden Intertrade AG of Sweden; Franklin Limestone Co.'s acquisition of Mineral Industrial Commodities of America; and The Rogers Group Inc.'s purchase of the assets of Billy Holloway Aggregates Corp. New plant openings included a new research and development center by E. I. du Pont de Nemours & Co. Inc. and a zinc oxide plant by North American Oxide Co. Rhone-Poulenc Basic Chemicals Co. Inc. announced in September that it planned to discontinue mining operations during the spring quarter of 1991.

The Director of the Tennessee Division of Geology, Dr. William T. Hill, retired as State Geologist on June 30, 1990. He

TABLE 1
NONFUEL MINERAL PRODUCTION IN TENNESSEE[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2]	metric tons	1,165,736	$27,696	1,137,152	$26,292	1,060,662	$25,776
Sand and gravel (construction)	thousand short tons	6,836	23,343	e6,100	e21,900	7,619	23,474
Stone:							
Crushed	do.	e52,200	e235,000	52,917	252,785	e54,600	e268,600
Dimension	short tons	e3,942	e567	4,888	437	e10,108	e2,051
Zinc[3]	metric tons	19,954	159,201	W	W	W	W
Combined value of barite (1988-89), cement, clays (bentonite [1988], common [1989], fuller's earth), copper, gem stones, lead, lime, phosphate rock, sand and gravel (industrial), silver, and values indicated by symbol W		XX	139,842	XX	36,993	XX	342,659
Total		XX	585,649	XX	638,407	XX	662,560

eEstimated. 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]Recoverable content of ores, etc.

was replaced by Mr. Edward T. (Ned) Luther, who was appointed Director and State Geologist on October 1 after serving as Acting State Geologist for 3 months.

Construction began on a section of Corridor B of the Appalachian Development Highway System (ADHS) running from Erwin, Unicoi County, south to the North Carolina State line. The 3,000-mile ADHS will be a network of modern highways linking most of the Appalachian region to the Interstate Highway System and the economic resources to which that system connects. Corridors A, B, and C of the network will provide a north-south connection between Columbus, OH, and Atlanta, GA, about halfway between Interstate Highways I-75 on the west and I-77 on the east.

Two new materials developed at the Oak Ridge National Laboratory were named among the top 100 new technology advances by Research and Development Magazine. The materials are a new ductile iron aluminide and a "lean" austenitic stainless steel. The iron aluminide is a high-strength, low-cost, oxidation- and corrosion-resistant structural material designed for use at temperatures up to 700° C. The material is said to be suitable as a replacement for stainless steel and ferrous alloys in structural applications in highly corrosive atmospheres such as chemical production systems and automotive components. The new "lean" stainless steel had been designed to provide the high-temperature strength and creep-resistance normally found in many superalloys and nickel aluminides. It is designed for use in fossil energy boilers, solar power systems, petrochemical process piping, and various aerospace and automotive applications. The Oak Ridge National Laboratory is owned by the U.S. Department of Energy and managed by Martin Marietta Energy Systems Inc.

EMPLOYMENT

U.S. Department of Labor (DOL) statistics showed an average of 6,200 workers employed in mineral-related industries in Tennessee in 1990. The figures represent a 1.6% decrease from that of 1989 and a 6.0% decrease from the mining employment figures reported in 1988. These data contrast with a 1.3% increase over those of 1989 and a 4.9% increase over those of 1988 in the State's total nonfarm employment. U.S. Mine Safety and Health Administration's (MSHA) records showed 4,052 workers employed at 420 metal and nonmetal mining locations. MSHA records did not include workers at coal mines that were included in the DOL statistics. Tennessee ranked 15th nationally in the total number of worker-hours worked in nonenergy mining operations in 1990.

REGULATORY ISSUES

Tennessee had 12 hazardous waste sites on the National Priority List (NPL) at yearend 1990. The Tennessee Department of Health and Environment, Division of Superfund, also identified[4] 300 promulgated sites containing hazardous waste that may require remediation. Sixty of the sites were in Anderson County.

A major 5-year research program to reduce by 80% the amount of hazardous waste generated at U.S. Government uranium-metal manufacturing plants was initiated by the U.S. Department of Energy (DOE) at the Oak Ridge Y-12 nuclear weapons plant. The Uranium Waste Minimization Program (UWMP) would serve as cornerstone for DOE's Environmental Restoration and Waste Management 5-Year Plan. UWMP will be operated for the DOE by Martin-Marietta Energy Systems, who will attempt to reduce hazardous, toxic, radioactive, and sanitary wastes through new methods of metal purification, shaping, and recycling. Technology obtained from this program will be shared with other Government and privately owned uranium processing facilities and may have application in the private metalworking industry. UWMP will complement an existing DOE Oak Ridge Operations program in overall waste minimization that began in 1987. According to DOE officials, the 1987 program in 2½ years has resulted in a total savings of more than $80 million and a reduction of 10.9 million kilograms and 31,000 cubic meters of generated wastes.

In April, the Secretary of the Interior issued a final decision designating 5,250 acres in the vicinity of Frozen Head State Park and Natural Area as unsuitable for coal mining. The decree will allow the continued use of an existing coal haulage road to provide commercial access to coal resources being mined outside the designated area.

Reclamation efforts in the Ducktown area of Polk County that were started by the Tennessee Copper Co. (TCC) and the Tennessee Valley Authority in the mid-1930's were continued by Boliden Intertrade AG in 1990. Much of the environmental damage was caused almost a century and one-half ago when miners cut the trees to roast, in open-hearth furnaces, copper ore brought up from underground workings. Early reforestation efforts were unsuccessful because of extreme deficiency of plant nutrients in the leached and eroded soils. Efforts since the 1970's have been more successful as a result of techniques developed by the U.S. Forest Service. Pines and other hardy trees such as black locust were able to grow if the ground was plowed, enriched with organic matter and agricultural limestone, and inoculated with fungi that associate with the plant roots.

Tennessee had two commercial hazardous waste treatment facilities, Tricil Environmental Services in Antioch, a Nashville suburb, and OSCO Inc. in Columbia, Maury County. OSCO also received a permit for a new larger facility that will be in Nashville. The Columbia operations were scheduled to be moved to the new site when it is completed. Chemical Waste Management was pursuing a permit to build a rotary kiln incinerator in Memphis at a site on which it operates a storage and processing facility. The site was acquired from SCA Chemical Services several years earlier.

In October, the U.S. Environmental Protection Agency (EPA) charged Refined Metals Corp. (RMC), a Memphis secondary lead smelter, with mishandling

of hazardous lead waste and levied fines totaling $354,600 against the company. At yearend, RMC was attempting to negotiate with the EPA for a reduced fine. The company contended that it was caught between a State interpretation that considered the lead-slag waste nonhazardous and the EPA interpretation.

A discharge of sulfuric acid from the Tennessee Chemical Co. plant at Copperhill, Polk County, was apparently responsible for the destruction of flower and vegetable gardens and the withering of trees and other vegetation. The discharge, which occurred during a plant startup on the morning of August 16, mixed with a heavy fog to form a corrosive mist that may have affected as many as 3,000 acres in Tennessee and Georgia. At least six individuals were treated in hospitals for acute respiratory distress.

The Center for Material Processing at the University of Tennessee Knoxville (UTK) conducted research related to production of fabric from recycled plastic bottles using meltblown and spunbond processes. Potential applications for the fabric included surgical gowns and masks, diapers, oil filters, tents, insulation for outdoor clothing, and material for cleaning up oil spills.

Reynolds Metals Co. paid recyclers in Tennessee more than $550,000 for almost 2 million pounds of aluminum derived mainly from more than 47 million beverage cans. Aluminum Corp. of America operated an aluminum recycling facility at its plant in Alcoa. Jersey Miniére Zinc. Co. employees donated more than $1,100 to the Nashville Shrine Club. The money, raised through the recycling of aluminum soft drink cans, was used to treat burn victims at the Shriner Burn Center in Cincinnati, OH. The owner of the abandoned Duke Lime and Stone Co. underground mine in Dickson County applied for approval from county and State officials to use the mine for the disposal of used tires. An estimated 100 million tires could be stored in the underground caverns until a commercially viable technology to recycle them is developed.

EXPLORATION ACTIVITIES

The geohydrological survey well being drilled by E. I. du Pont de Nemours & Co. in Humphreys County was coring in the Upper Cambrian Copper Ridge Dolomite and had reached a depth of 4,263 feet at yearend. The well, which was being cored from the surface to its total depth, was planned to bottom in the Precambrian crystalline basement at a depth of more than 8,000 feet. The well was begun in 1988 by Du Pont as part of an agreement with EPA. The company had applied to the EPA for permits to drill hazardous waste disposal wells under Underground Injection Control regulations. Reviews by the EPA considered some of the data submitted by Du Pont to be inconclusive with respect to underground sources of drinking water. Du Pont agreed to drill the well to obtain precise data that would resolve the issue. Although the well is being drilled for environmental reasons, the information it provides should benefit mineral exploration by providing a more complete understanding of regional geology and stratigraphy.

The Clinch Valley Mining Co., a subsidiary of Union Zinc Inc., completed evaluation of the inactive Idol Mine that was purchased from Gulf + Western Industries in 1989. Dewatering of the mine was begun during the summer, and reopening was scheduled for late 1991.

LEGISLATION AND GOVERNMENT PROGRAMS

Only two laws directly affecting the minerals industry were enacted in Tennessee in 1990. Senate bill 2393 extended the renewal period for a mining permit from 1 to 5 years and increased the time State officials have to approve a permit from 20 to 30 days to 45 to 60 days. Public chapter 741 amended the Geologist Registration Act of 1988 by changing one definition and by adding three new provisions to the act. The change restricted the definition of geologist by adding minimums in the number of hours of geologically related coursework required. The original definition required only a degree in geology or geological engineering from an accredited institution. Two additions gave the Department of Commerce and Insurance rulemaking authority with respect to registration of geologists in Tennessee and the power to enforce those rules and impose civil penalties for violations of the act. The final provision was for due process and for sworn complaints against persons allegedly violating provisions of the act to be filed directly with the commissioner.

A law relating to mineral rights that was enacted in 1987 became fully effective on July 1, 1990. The three-part law mandated the registration of mineral tracts by mineral owners, allowed surface owners to gain ownership of abandoned or dormant mineral rights, and allowed surface owners the first right to purchase mineral rights sold for taxes. Mineral owners were given until July 1, 1990, to register their mineral rights with the county Property Assessor and Register of Deeds before the final two provisions of the law became effective.

The Tennessee Division of Geology (TDG) resumed cooperative programs with the geology departments of State universities after an interruption of several years caused by austerity budgets that eliminated part-time positions upon which the system was based. Cooperative projects were initiated with Memphis State University; Vanderbilt University; the Universities of Tennessee at Chattanooga, Knoxville, and Martin; and Tennessee Technological University. Projects included mapping loess sheets in West Tennessee; conducting gravity surveys in and near the New Madrid Fault Zone; mapping a group of quadrangles in the Valley and Ridge Province and in northwestern Tennessee; coal analyses and a study of fly ash at coal-burning steam plants in Tennessee; and studies related to potential oil-producing zones.

TDG, with other State and Federal agencies, entered a cooperative project with the U.S. Geological Survey, Water Resources Division, (USGS) to convert 7.5-minute geologic maps into digital

data. The USGS also published a report[5] that included discussion of the ball clay resources in Tennessee.

The Division of Geology continued work on its part of the Governor's Coal Task Force. TDG's responsibilities included the initiation of a coal operator's assistance program and the development of a coal industry data base. In order to do this, TDG began, in August 1989, a total reevaluation of the State's coal resources on a quadrangle by quadrangle basis for the 125 quadrangles with coal reserves. At yearend 1990, 10 quadrangles had been completed, 5 were nearing completion, and 44 reproducible reserve maps had been completed.

The Intermountain Field Operations Center of the U.S. Bureau of Mines reviewed Draft Environmental Impact Statements and other environmental-impact-related documents for the Tennessee Department of Transportation, the U.S. Office of Environmental Affairs, the National Park Service, and the U.S. Fish and Wildlife Service. The Bureau's primary responsibility in evaluating the documents was to determine whether or not mineral resources would be adversely affected by the proposed projects.

A primary function of the Metropolitan Nashville Port Authority was to promote commerce on the Cumberland River at privately owned river terminals. Almost 1.5 million short tons of steel moved through the port in 1990, most of it destined to the Nisson automobile plant at Smyrna, Rutherford County. Tonnages were expected to increase significantly when the Saturn plant at Spring Hill, Maury County, begins manufacturing vehicles in 1991. Other mineral commodities moving through the Port of Nashville in 1990 included coke, ferrous chrome ore, fertilizer, salt, and sand.

The Port of Memphis is the most central port on the Mississippi River, an advantage that has made Memphis an axis for transportation throughout the central United States. Two interstate highways put 40% of the U.S. population within a day's drive of Memphis. The city is also served by six mainline railroads that combine with the highways and the river to make Memphis one of the largest intermodal distribution hubs in the Nation. About 200 trucklines feed 100 freight terminals scattered throughout Memphis. Two fuels, gasoline and coal, were the most abundant commodities passing through the port in 1990. Another mineral commodity, construction cement, ranked fourth, and iron, steel, construction aggregate, and scrap metal were included in the list of mineral commodities using the facility.

FUELS

Coal production increased for the third consecutive year to 6.7 million short tons posting a 3.4% increase over the 6.4 million short tons produced in 1989. Tennessee's usage of coal-generated electricity increased 8.3% to 50,187 gigawatt hours in 1990. Coal accounted for 68% of the electricty generated in Tennessee.

According to data provided by the Tennessee Oil and Gas Board,[6] oil production decreased for the eighth consecutive year, falling 4.5% to 508,292 barrels in 1990 from 531,854 barrels in 1989. However, the value of oil produced increased to more than $10 million, $1.5 million more that the 1989 value, because of a 22% increase in the price per barrel. Gas production increased for the first time in 6 years to 2.08 billion cubic feet valued at more than $3.4 million. The 1989 production was 1.92 billion cubic feet valued at $2.7 million in 1989. The number of permits issued for the drilling of oil and gas wells declined 28% to 76 in 1990. This represented the third lowest level of permitting since permitting began in 1968. Total drilling footage for oil and gas wells completed in 1990 was 298,452 feet, 1,438 feet more than was drilled in 1989.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Eight industrial minerals were mined in Tennessee in 1990. Their value accounted for 70% of the total mineral value produced in 1990.

Barite.—Tennessee's only barite producer, A. J. Smith, Jr., 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. in 1989.

Cement.—Cement was produced by Signal Mountain Cement Co., a subsidiary of IFI International, at Chattanooga and by Dixie Cement Co., a subsidiary of Southdown Inc., at Knoxville. Signal Mountain operated a two-kiln, 450,000-short-ton-per-year wet-process clinker capacity facility. Dixie operated a two-kiln, 550,000-short-ton-per-year dry-process plant. The company applied for a permit that would allow it to burn hazardous waste as a supplemental fuel.

Clays.—Clay production, excluding common clay and fuller's earth, which were withheld from data published by the U.S.Bureau of Mines in order to protect proprietary company data, decreased 6.7% in the quantity produced and 2.0% in value over production reported in 1989. Tennessee ranked 10th in volume and 6th in value with respect to the 43 States that produced clay in 1990. Eight companies mined clay from 25 pits in 10 counties.

Tennessee produced 69% of the ball clay mined in the United States, a decrease from the 71% produced in 1989. Ball clay was produced by 4 companies with 9 operations and 16 pits in 4 counties. More than three-fourths of the ball clay was mined in Weakley County.

The types of ball clay sold or used by producers in 1989 were air-float (48%), water-slurried (24%), and unprocessed (28%). The percentage of water-slurried ball clay increased from that of 1989, whereas that of both air-float and unprocessed ball clay decreased. Ball clay production decreased to 543,700 metric tons, 15% less than that produced in 1989. The major end uses of ball clay, in order of amount sold or used by producers, were sanitaryware; pottery; floor and wall tile; fiberglass; common brick; ceramics; miscellaneous fillers, extenders, and binders; 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, a subsidiary of Hecla Mining Co., mined and processed specialty grades of ball clay in Kentucky, Mississippi, and Tennessee. Mining and processing facilities were in Gleason and Whitlock, TN; 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' headquarters and laboratory are south of Paris, Henry County, at the site of the World War II Camp Tyson army base. The laboratory performed quality control testing, analyzed clay from new deposits, prepared special blends for customers, and monitored mine wastewater to ensure compliance with environmental regulations. Spinks had several active pits and two processing plants near Gleason. Clay beds are up to 20 feet thick and are overlain by lignites, clays, sands, and soil. Lignite from beds up to 2 feet thick was used to cap haul roads because the water-absorbent material permits mining operations to continue during adverse weather conditions. Ball clay is mined by backhoes and transported by truck to storage sheds at the processing sites. Reclamation begins as soon as reserves are depleted and usually results in a lake surrounded by vegetated slopes that are quickly inhabited by wildlife. United Clays, a subsidiary of Britain's Watts Blake Bearne & Co. PLC, completed its first full year of operation after acquiring the assets of Cyprus Industrial Minerals in 1989. It operated from six pits in Weakley County and a processing plant at Gleason. In addition to its ball clays, United produced a high-alumina ball clay that was marketed as kaolin for use in the manufacture of fiberglass.

Common clay was mined by two companies with six pits in five counties. The State's largest clay producer was General Shale Products Corp., a Johnson City brick manufacturer. General operated one pit each in Anderson, Knox, and Washington Counties and two pits in Sullivan County. Tennessee's other common clay producer, Signal Mountain Cement Co., mined from one pit in Hamilton County for its plant at Chattanooga.

Montmorillonite fuller's earth was mined by Moltan Minerals Co. from two pits in Hardeman County and processed at its plant near Middleton. Southern Clay Inc., a subsidiary of Edward Lowe Industries Inc., produced fuller's earth from one pit and a plant near Paris, Henry County. Major end uses of the fuller's earth were for pet waste, industrial absorbents, and as a fungicide carrier.

Gemstones.—Tennessee led the Nation in the value of gem stones produced as a result of having the largest U.S. production of freshwater pearls and freshwater mussel shells. Twenty different mussel species from the family Unioidae are commercially harvested in the 11 producing States. 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 were also 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.

Lime.—Tennessee ranked 16th in volume, down from 15th in 1989, and 14th in value, up from 17th in 1989, with respect to the 32 States producing lime. Both quicklime and hydrated lime were produced and sold by Tenn-Luttrell Co. in Union County. Quicklime was produced as a byproduct by the Bowater Paper Co. at its Calhoun plant in McMinn County.

Phosphate Rock.—Rhone-Poulenc Basic Chemicals Co. Inc.'s announcement that it planned to discontinue mining operations in 1991 dominated events in Tennessee's phosphate industry in 1990. The move would leave Occidental Chemical Corp. as the State's only phosphate rock producer. Ironically, both the quantity of phosphate rock produced and its value increased significantly in 1990. Bureau estimates of phosphate rock reserves for Tennessee in 1990 were 6 million metric tons based on a cost of $40 per ton f.o.b. mine and 10 million tons based on a $100 per ton cost. The figures were unchanged from those of 1989.

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 1988 and 1990 and estimates for 1989.

Tennessee construction sand and gravel statistics are compiled by geographical districts as depicted on the State map. Table 3 presents end-use statistics for Tennessee's three districts. Production of construction sand and gravel increased by almost 25% in 1990 after showing significant decreases in the 2 preceding years. Although the total value increased by 7.2% over the value of 1989's estimated production, construction sand and gravel's unit price decreased from $3.59 per metric ton to $3.08. Thirty-six companies mined construction sand and gravel at 41 operations from 51 pits in 21 counties. The leading companies, in order of quantity produced, were

Memphis Stone and Gravel Co., Standard Construction Co., Ford Construction Co., Vulcan Materials Co., Adamsville Sand and Gravel Co., W.S. Jordan & Son Inc., Teague Brothers Sand and Gravel Co., and Tinker Sand and Gravel Inc. Five counties, Shelby (15 pits), Benton (5 pits), Decatur (2 pits), Obion (1 pit), and Hamilton (1 pit), accounted for almost 60% of the construction sand and gravel produced. The principal uses of the commodity were concrete aggregate, road base and cover, asphaltic cover, and fill.

Industrial.—Industrial sand and gravel production decreased significantly in 1990 primarily because of the weak economy that impacted most of the Nation. Tennessee had two industrial sand and gravel producers, The Morie Co. Inc., with two operations, and Short Mountain Silica Co. (SMS), with one operation. Morie, 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, sand blasting, filtration, and traction sand industries. SMS was near Mooresburg in Hawkins County. Mining has averaged about 300,000 short tons of silica sand per year since SMS began operation in 1988. Reserves are projected to last 100 years and ultimately yield about 40 million tons of sand. The highly automated operation employed 35 workers. Sand was sold to AFG Industries Inc. in Kingsport for the manufacture of plate glass, to GTE and Phillips for use in light bulbs, and to most ready-mix concrete producers in the area. Golf courses, using the sand for traps, top dressing, and building greens, have emerged as SMS's second largest customer.[7]

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 1988 and 1990 and actual data for 1989.

Crushed.—Crushed stone production was estimated at 54.6 million short tons, an increase of 3.2% over the tonnage produced in 1989. Its value increased 4.3% to $268.6 million, accounting for 58% of the value of industrial mineral and 41% of the total value of nonenergy mineral commodities produced in Tennessee in 1990. Nationally, the State ranked sixth in the quantity and eighth in the value of crushed stone produced. Only one State did not report crushed stone production in 1990.

MSHA inspected 68 crushed stone quarries operated by 41 companies in 37 counties. Vulcan Materials Co., American Limestone Co., The Rogers Group, and Franklin Limestone Co., with 17, 7, 5, and 3 operations, respectively, were the leading producers of crushed stone.

Vulcan Materials Co. completed a $5 million upgrading of its 35-year-old Maryville, Blount County, limestone aggregate plant. The improvements, which featured a three-phase crusher, will allow Vulcan to continue quarrying without expanding the area of the quarry. A request to expand the quarry in 1987 was denied by county officials. Vulcan estimated that reserves are sufficient to allow an additional 20 years of quarrying by deepening the existing pit. If zoning to expand the pit could be obtained, quarrying could continue for 50 to 75 years.

American Limestone reported[8] sales of $36 million and an operating income of $5 million in 1990. Sales included both crushed stone and concrete products. The Rogers Group Inc., Nashville, acquired the assets of Billy Holloway Aggregates headquartered in Louisville, KY. Included in the purchase were two crushed stone quarries in Tennessee. Columbia Rock Products operated a 150-acre underground mine near Spring Hill in northern Maury County. The company produced more than 25 different crushed stone products, including construction aggregate, agricultural lime, and limestone crushed to rock salt size that is used for highway traction instead of salt.

Dimension.—Estimated production of dimension stone in Tennessee more than doubled in 1990, and its value increased from $437,000 in 1989 to more than $2 million. The increase was largely the result of a continued increase in demand for dimension stone since 1985 that has resulted in the redevelopment and expansion of idle and abandoned quarry properties. This has been especially true in States such as Tennessee that have stone that had been extensively used for architectural purposes in the past.

MSHA inspected dimension stone quarries operated by four companies with five facilities in three counties. Marble was quarried by Imperial Black Marble Co. in Grainger County and by Luck Stone Co. in Blount County. Sandstone was quarried in Cumberland County by Ross L. Brown Cut Stone Co. and by Tennessee Building Stone Co., which operated two quarries. Luck Stone Corp. received permission from the Louden County Board of Zoning Appeals to remove stockpiled blocks of marble from the abandoned Greenback quarry. Quarrying of new blocks will not be allowed under terms of the permit.

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. Additionally, byproduct gypsum was produced during the zinc refining process at JMZ's Clarksville operation and by the phosphate processing operations in Maury County. Tennessee ranked first nationally in the production of synthetic graphite in 1989. Although the Bureau did not report production statistics for synthetic graphite in 1990, it appeared unlikely that the State had relinquished its leading position. Union Carbide Corp. produced anodes, electrodes, unmachined shapes, and graphite powder at plants in Clarksville and Columbia. High-modulus fibers were manufactured by the Fortafil Fibers Div. of Akzo-Enka America Inc. at Rockwood, Roane County, and by Great Lakes Resources Corp. at Elizabethton, Carter County.

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 chorine 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.

Sulfuric acid was manufactured at Copperhill, Polk County. Boliden Intertrade AG of Stockholm, Sweden, purchased the Tennessee Chemical Co. (TCC) operation on September 20 after the transaction was approved by the U.S. Bankruptcy Court. The purchase price of $6,679,000 included 2,000 of the 7,600 acres owned by TCC plus all of its other assets. In addition, Boliden assumed responsibility for existing TCC liabilities and liens that will bring the actual purchase price to between $13 and $14 million. Court approval was given after Boliden and the EPA agreed on a settlement of Boliden's responsibility for future problems stemming from past environmental violations. In its settlement with the EPA, Boliden agreed to continue reforestation efforts, upgrade maintenance of existing facilities, and establish preventive measures to eliminate future spills and acid discharges such as one occurring last August 16 that allegedly damaged vegetation over a 3,000-acre area.

According to Boliden officials, between $7 and $10 million is expected to be spent on the environmental measures. Boliden had completed preliminary engineering studies for a $12 million upgrade of the No. 1 acid plant before the sale was finalized and expected the project to be completed early in 1992. Employment at the plant was expected to be reduced by 40 to about 360 when the upgrade is completed because of increased efficiency. TCC's operation employed about 2,000 when the copper mine was in full production.

Perlite from the Western United States was expanded by the Chemrock Corp. of Nashville for use in lightweight aggregates, insulation, absorbents, horticultural products, and insulation. Vertac Chemical Co. manufactured potassium nitrate from potash shipped from New Mexico. Rare earths imported from Australia were processed into thorium chemicals by Davidson Specialty Chemical Co. W.R. Grace and Co.'s exfoliated vermiculite plant in Nashville remained idle in 1990.

Du Pont manufactured titanium tetrachloride from rutile, ilmenite, and high-TiO_2 slag at its New Johnsonville titanium dioxide pigment plant. The $TiCl_4$ was oxidized to form TiO_2, which is calcined to remove the residual chlorine to produce the TiO_2 pigment. Du Pont opened a new $2 million research and development center at the New Johnsonville site in December. The facility was designed with the capability to produce short ton samples.

Metals

Zinc was the only metal mined in Tennessee in 1990. Minor quantities of several other metals, cadmium, germanium, lead, and silver, were recovered as byproducts when the zinc ore was refined. 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 are not included in table 1. Included in this group are aluminum, ferroalloys, lead, manganese, steel, uranium, and zinc.

Zinc.—Zinc was mined by two companies, ASARCO Incorporated and Union Zinc Co. Inc., a subsidiary of Belgium's Union Meniére 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 Jefferson City Zinc Co. operated the Davis Mine and mill at Jefferson City. Clinch Valley Mining Co. was reopening the Idol Mine in the Copper Ridge zinc district. In middle Tennessee, Jersey Miniére Zinc Co. (JMZ) operated the Elmwood-Gordonville Mine and mill in Smith County and the zinc refinery at Clarksville. Although the Bureau withholds zinc production data in Tennessee to protect proprietary company data, outside sources[9] reported JMZ's Clarksville refinery had a production of about 100,000 tons of refined zinc in 1990.

Zinc Products Div. of the Ball Corp. produced penny blanks, zinc battery cans, and rolled strip zinc at its plant at Greeneville, Greene County. North American Oxide made the first shipment of zinc oxide from its new Clarksville plant in September. The plant produced 12 grades of zinc oxide for the rubber, chemical, paint, plastics, ceramics, and other industries. Specific uses included paint pigment and as a rubber curing agent in the manufacture of tires.

Pasco Zinc Products Corp., Memphis, made its first shipment of zinc oxide to the U.S.S.R. in June. The shipment by the subsidiary of Canada's Pigment & Chemical Co. represented one of the first large mineral commodity sales by a Midsouth firm to the communist nation since its policy of perestroika was announced. The Soviets planned to use the zinc oxide powder to manufacture rubber, metal, and pharmaceutical products. Pasco produced zinc oxide powder from raw zinc mined in Canada supplemented with purchased recycled zinc milled from scrapped metal. The zinc oxide was sold to the pharmaceutical, rubber, cosmetic, soap, paint, plastic, and chemical industries. Pasco's major customers in 1990 included Goodyear Tire and Rubber Co., Union City, TN; Cooper Tire & Rubber Co., Tupelo, MS; and General Tire Inc., Mayfield, KY.

Horsehead Resource Development Co. (HRD) began a $15 million expansion of

its waelz plant at Rockwood, Roane County, in August. The waelz process reduces low-grade zinc ores, slags, or residues to maximum metallic concentration preparatory to extracting zinc in pure form. It employs a rotary kiln, and the zinc-bearing material mixed with fine coal is fed into the kiln and heated so that the zinc is vaporized and converted to oxide fume. HRD expected to have the expansion completed by the end of 1991. The company recovered cadmium, lead, and zinc from electric arc furnace (EAF) dust. The concentrate was sold to HRD's sister company, Zinc Corp. of America, which recovered the metals.

EAF dust was also processed at the Florida Steel Co. plant in Jackson, Madison County. IMS Inc., a wholly owned subsidiary of EnviroSource Inc., Stamford, CT, operated the on-site facility. The company recovered zinc metal from the dust using plasma furnace technology developed by Tetronic Research and Development Co. and Bethlehem Steel Co.

Other Metals.—The Aluminum Co. of America (ALCOA) operated a two-potline, 200-metric-ton-per-year plant at Alcoa, Blount County. The plant used both the prebaked (84%) and the soderberg (16%) processes to produce aluminum. Power used was 80% thermal from coal supplied by the Tennessee Valley Authority and 20% hydro supplied by its subsidiary, Tapoco Inc. The plant has been in continuous operation since 1914. Alcan Aluminum Ltd. opened a $7 million, 140-million-pound-per-year aluminum scrap facility at Shelbyville, Bedford County, in June. The secondary aluminum smelter, operated by Alcan's subsidiary, Alcan Recycling Co., recycled aluminum diecaster scrap, but did not process used beverage cans. Alcan spent more than $4 million to double the size of the plant, which it purchased from Southern Alloys Co. (SAC) in March. SAC closed the plant in September 1990 after it had been in operation for less than 1 year. A secondary aluminum smelter and milling facility was also operated by Consolidated Aluminum Corp. at New Johnsonville.

Matsushita Electonics Corp. of America began construction in May of a $10 million aluminum foil processing facility adjacent to its present facilities in Knoxville. The company will transfer the foil forming and etching work now done for the Knoxville unit's capacitor manufacturing operations by the parent company in Japan to the new facility. After completion of the present construction, scheduled for April 1991, Matsushita is considering a 5-year program that would double production.

Applied Industrial Minerals Corp.'s plant at Kimball, Marion County, which manufactured ferrosilicon from high-grade silica mined in North Carolina, remained idle in 1990. The plant was closed in 1987. Two companies in Maury County, Occidental Chemical Corp., Columbia, and Rhone Poulenc Co., Mount Pleasant, produced ferrophosphorus. The Bureau's manganese specialist reported that the former Roane Electric Furnace Co. Inc. ferromanganese-alloy plant near Rockwood, Roane County, could be reactivated should economic conditions warrant. The plant, formerly operated by Engelhard Minerals Corp. and now owned by South Africa's Samancor Ltd., has been idle for approximately 10 years.

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. Manganese oxide for use in dry cell batteries was manufactured by ESB Materials Corp. and Rayovac Corp., both in Covington, Tipton County, and by Chemetals Inc. in New Johnsonville. DMS Refineries Inc., Dallas, TX, opened a plant in Jefferson County to extract silver from used X-ray film. Secondary steel was produced by Florida Steel Co., with plants in Jackson and Knoxville, Leclede Steel Co. in Memphis, and Tennessee Valley Steel Corp. in Harriman, Roane County. Titanium Metals Corp. of America started operations at its Morristown, Hamblen County, alloy plant in July. The bar, sheet, plate, and tube finishing facility was not expected to be fully operational until early 1991.

Martin Marietta Energy Systems operated a plant for the DOE at the Oak Ridge facilities in Anderson and Roane Counties. The plant used a gaseous diffusion process to produce U^{235} from uranium mined in New Mexico and Wyoming. 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 32 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]Chief geologist, Tennessee Division of Geology, Nashville, TN.

[4]Tennessee Department of Health and Environment, Division of Superfund. Promulgated Sites As Of 01/01/91. Jan. 9, 1991, 9 pp.

[5]Hosterman, J. W. An Overview of Industrial Minerals of the U.S. Atlantic and Gulf of Mexico Coastal Plains, in Seventh Annual V. E. McKelvey Forum on Mineral and Energy Resources. U.S. Geol. Surv. Circ. 1062, 1991, pp. 42-43.

[6]Tennessee Division of Geology Newsletter. Oil and Gas Board Notes for 1990. V. 4, No. 1, Feb. 1991, p. 4.

[7]The Press (Johnson City). Top Quality Sand On Short Mountain. Feb. 17, 1991.

[8]Mining Annual Review 1991. North American Companies: ASARCO. June 1991, p. 34.

[9]American Metals Market. Jersey Miniére Buys 500 Tons Of LME Zinc. V. 99, No. 164, Aug. 27, 1991, p. 1.

TABLE 2

TENNESSEE: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	2,313	$7,354	$3.18
Plaster and gunite sands	145	761	5.25
Concrete products (blocks, bricks, pipe, decorative, etc.)	150	704	4.69
Asphaltic concrete aggregates and other bituminous mixtures	832	3,306	3.97
Road base and coverings	1,754	3,843	2.19
Fill	334	610	1.83
Snow and ice control	W	W	8.00
Railroad ballast	W	W	2.00
Other[1]	900	2,211	2.46
Unspecified:[2]			
Actual	W	W	1.81
Estimated	1,191	4,685	3.93
Total or average	7,619	23,474	3.08

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes roofing granules and filtration.
[2]Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 3

TENNESSEE: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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	1,417	$3,374	959	$3,525	232	$1,920
Asphaltic concrete aggregates, and road base and coverings[1]	2,279	4,390	362	1,489	279	1,879
Snow and ice control	—	—	—	—	W	W
Railroad ballast	W	W	—	—	—	—
Other miscellaneous[2]	517	1,115	2	5	62	515
Unspecified:[3]						
Actual	319	576	—	—	—	—
Estimated	937	3,440	18	83	236	1,163
Total[4]	5,468	12,894	1,341	5,102	810	5,477

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes fill.
[2]Includes roofing granules and 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.

TABLE 4
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 City, TN 37601	do.	Anderson, Knox, Johnson, Sullivan, Washington.
Fuller's earth:			
Moltan Minerals Co.	3555-T Moltan Dr. Memphis, TN 38115	do.	Hardeman.
Southern Clay Div. Edward Lowe Industries 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]	Box 591 Columbia, TN 38401	Pits and plant	Giles, Hickman, Maury, Williamson.
Rhone-Poulenc Basic Chemicals Co. Inc.[3]	Box 89 Mount Pleasant, TN 38474	Pits and plant	Giles, Hickman, Maury, Williamson.
Sand and gravel:			
Construction:			
Dixie Sand & Gravel Co.	515 River St. Chattanooga, TN 37402	Pits	Hamilton, Marion, Meigs, Rhea.
Memphis Stone & Gravel Co.	Box 1683 Memphis, TN 38101	do.	Dyer, Obion, Shelby.

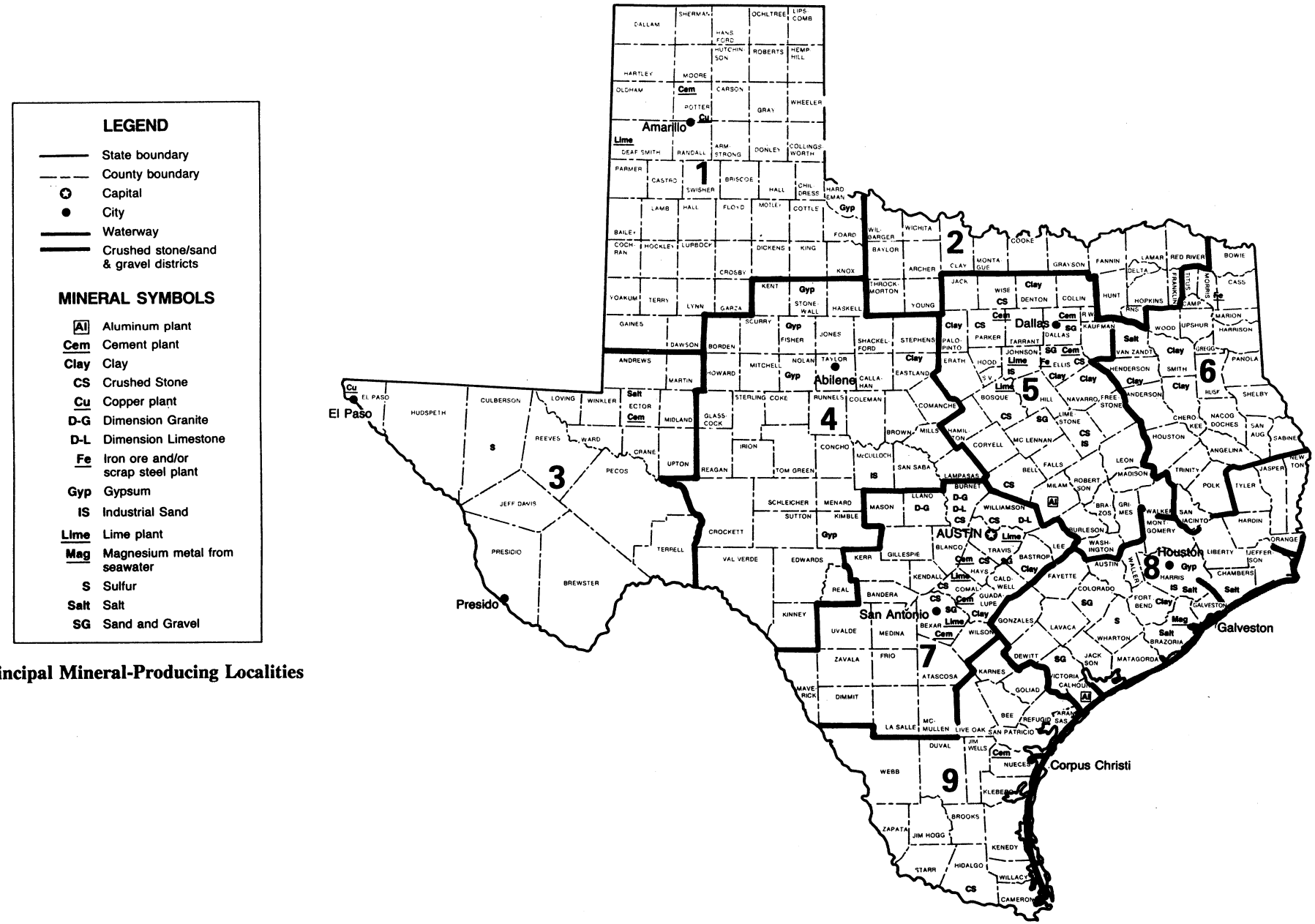
See footnotes at end of table.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Construction—Continued			
Roger Group Inc.[2]	Box 2525 Nashville, TN 37202	do.	Various.
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 Incorporated	2209 Blount Ave. Knoxville, Tn 37901	do.	Various.
Franklin Limestone Inc.	Box 23082 Nashville, TN 37202	do.	Do.
Vulcan Materials Co., Midsouth Division	Box 7 Knoxville, TN 37901	Quarries and plants	Do.
Dimension:			
Ross L. Brown Cut Stone Co. Inc.	Box 398 Crab Orchard, TN 37723	do.	Cumberland.
Crab Orchard Stone Co. Inc.	Drawer J Crossville, TN 38555	Quarry and plant	Do.
Imperial Black Marble Co.	8013 Chesterfield Dr. Knoxville, TN 37909	do.	Grainger.
Luck Stone Co.	629 Pellissippi Pkwy. Knoxville, TN 37932	do.	Knox and Blount.
Zinc:			
ASARCO Incorporated[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.

TEXAS



Principal Mineral-Producing Localities

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 Doss H. White, Jr.,[1] and L. Edwin Garner[2]

The mineral industry in Texas produced $1.5 billion of nonfuel minerals in 1990. This was the second consecutive year that mineral value declined; the 1990 value was $295 million below the record $1.8 billion established in 1981.

The decline in total value was due to a significant decrease in the output of gypsum, manganese metal, and sulfur. The value of these three mineral commodities was approximately 30% lower than that reported for 1989. In 1990, Texas ranked seventh nationally in mineral value and accounted for 4.37% of the Nation's total.

TRENDS AND DEVELOPMENTS

During the decade of the 1980's, mineral sales added almost $16 billion to the economy of Texas. The decade began with the State's mineral output valued at $1.752 billion. The recession in the early 1980's resulted in an approximate $200 million decline in 1982 and 1983. The decline resulted primarily from a reduced demand for the construction mineral commodities as construction activity was restricted by the effects of the recession. Historically, the construction minerals, cement, sand and gravel, and crushed stone, have accounted for approximately 50% of the State's total mineral value.

TABLE 1
NONFUEL MINERAL PRODUCTION IN TEXAS[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:							
Masonry	thousand short tons	136	$10,800	133	$10,735	142	$10,106
Portland	do.	7,000	292,256	7,200	286,236	7,678	296,680
Clays[2]	metric tons	2,714,451	17,468	2,276,629	15,962	2,162,095	14,652
Gemstones		NA	340	NA	W	NA	W
Gypsum (crude)	thousand short tons	1,943	15,790	1,993	17,044	1,868	10,166
Lime	do.	1,192	55,935	1,304	60,829	1,337	76,181
Salt	do.	7,802	62,925	7,856	69,934	8,212	75,149
Sand and gravel:							
Construction	do.	50,370	171,167	e43,900	e155,800	46,083	158,080
Industrial	do.	1,631	26,645	1,661	29,107	1,849	40,880
Stone:							
Crushed	do.	e82,000	e271,300	76,823	252,982	e81,800	e285,700
Dimension	short tons	e66,354	e8,310	81,268	12,449	e84,500	e12,600
Sulfur (Frasch)	thousand metric tons	2,622	W	2,446	W	2,340	W
Talc and pyrophyllite	metric tons	236,729	4,466	241,777	4,564	227,138	4,844
Combined value of clays [ball clay, [1988-89], bentonite [1990], fuller's earth [1990], kaolin), helium (crude and Grade-A), iron ore, magnesium metal, sodium sulfate (natural), and values indicated by symbol W		XX	531,416	XX	546,812	XX	472,187
Total		XX	1,468,818	XX	1,462,454	XX	1,457,225

eEstimated. 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.

In the 1984-86 period, mineral output and value rebounded to the $1.7 billion level due primarily to increased demand for crushed stone. The collapse of oil prices in the mid-1980's had a dramatic effect on the State's nonfuel mineral industry in general and the construction mineral commodities sector in particular. Texas mineral value fell to the $1.4 billion level in 1987, 1988, and 1989; hardest hit of the nonfuel minerals produced in-State were cement, sand and gravel, and crushed stone. Activity in the construction industry plummeted with the collapse of the oil industry. The nonfuel mineral industry began its recovery in 1989 as value again surpassed the $1.5 billion mark, and the recovery continued in 1990.

Many of the developments during the year were in the metals sector. Adolph Coors began construction of an aluminum rolling minimill in San Antonio. Work on modernizing ASARCO Inc.'s copper smelter in El Paso was ongoing, and Texas Copper Co. continued preliminary work for a new copper smelter at Texas City.

Chaparral Steel announced plans to construct a third rolling mill at its Midlothian plant. Tejas Resources Inc. began construction on a lead-acid recycling facility in Terrell.

Uranium Resources Inc. began production at its Rosita Mine late in 1990.

EMPLOYMENT

Employment statistics for the State are compiled by the Texas Employment Commission (TEC). The TEC statistics are compiled in a "Mining" category and two subcategories: (1) oil and gas and (2) "other"--metals, coal, and nonmetallic minerals.

"Mining" employment increased from 174,000 in 1989 to 179,400 in 1990. Oil and gas employment increased over the 2-year period from 164,200 to 169,900. The "other" employment, however, decreased from 9,800 in 1989 to 9,500 in 1990.

REGULATORY ISSUES

An environmental group, Citizens Aware and United for a Safe Environment (CAUSE), expressed concern over the possible granting of a hazardous waste storage permit at an Ellis County cement plant. Two cement plants in Ellis County, owned by Texas Industries Inc. (TXI) and Gifford-Hill Co., burn waste-derived products (paint thinner, printers ink, dry cleaning fluid, and solvents) to supply 30% to 40% of their kiln fuel. TXI requested a permit from the Texas Water Commission to permit on-site storage and blending of the waste. This would allow the company to maintain a constant supply of kiln fuel with a greater component consistency.

The members of CAUSE contended that if the permit were granted, the cement companies would become, in effect, hazardous waste disposal sites, falling under a Federal Government loophole. The companies would escape the regulations because they were cement producers. A Texas Air Control Board spokesperson noted that emissions from the kilns at the two plants were very low and that there was no cause for concern.

The Texas Water Commission received a plan from Alamo Cement Co., San Antonio, for the disposal of waste material at a cement plant that closed in 1986. Kiln dust discarded during the period the plant was in operation was discovered during the construction of a new road. The company's plan discussed the excavation, transportation, and spreading of the dust over a clay strata within the confines of the plant. After spreading, the dust would be encapsulated with additional clay.

LEGISLATION AND GOVERNMENT PROGRAMS

The Texas Bureau of Economic Geology began 15 new projects in 1990 that expanded the agency's operating budget from $10 million in 1989 to more than $12 million. Only 7.03% of the funding was from State legislative appropriations; the remainder was from university, State agency, Federal, and industry and private foundations; the latter contributed 40.53% of the funding. During 1990, the Bureau had contracts with the U.S. Department of Energy, the U.S. Environmental Protection Agency, the U.S. Geological Survey, the U.S. Minerals Management Service, and the U.S. Bureau of Mines.

New Bureau projects represented a mix of geoscientific topics, including mineral and energy resources. Among these were surveys of the industrial mineral and portland cement industries in Texas being prepared for publication at yearend. Energy resource investigations constituted more than 40% of the active projects in 1990.

The Geoscience Institute, composed of a consortium of State and university agencies, was investigating advanced hydrocarbon-recovery technology. The institute continued to classify and enter data on approximately 1,500 petroleum reservoirs into the U.S. Department of Energy's petroleum- resource data base.

The Surface Mining and Reclamation Division of the Railroad Commission of Texas completed a mined land inventory for an 84-county area in east Texas. The project was initiated in 1988 with an inventory of active and abandoned mines in south Texas that was completed in 1989. In east Texas, 6,492 mined sites covering approximately 140,000 acres were identified.

The Texas Mining and Mineral Resources Research Institute (TMMRRI), partially funded and administered by the U.S. Bureau of Mines, was dedicated to research and education in the minerals field. For the 1990-91 academic year, four fellowships were awarded to support graduate research in ore deposition, mineral economics, and petroleum recovery. TMMRRI research focused on the origin and distribution of mineral deposits in Texas and mineral exploration techniques in general.

U.S. Bureau of Mines personnel at the Bureau's Intermountain Field Operations Center in Denver, CO, reviewed several Environmental Impact Statements prepared by other Federal and State agencies on proposed projects in Texas.

The reviews were to ensure that the proposed projects had no negative impact on mineral reserves or existing mining or mineral processing operations.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

In 1990, the Texas mineral industry mined, manufactured (cement), or recovered as a byproduct (sulfur) 20 industrial minerals. Industrial minerals account for more than 98% of the mineral value in table 1. Several industrial minerals mined in other States or imported from foreign countries were shipped into Texas and processed into higher value products or used in manufacturing processes to create new products.

Cement.—Texas ranked second among the 38 States with cement- producing facilities. Cement sales accounted for 21% of the State's mineral value during 1990. Portland cement was the principal cement type produced, and Texas ranked second among the portland cement-producing States and eighth among the masonry-producing States. The output of portland cement rose 478,000 short tons above the tonnage reported for 1989. Portland cement value increased $10.5 million over that reported in 1990. Masonry cement output increased 9,000 short tons over that reported in 1989; value, however, decreased $629,000.

The Texas cement industry consisted of 11 plants operating 9 wet-process and 11 dry-process kilns. Cement sales were reported by the industry as follows: (1) ready-mix companies, 60%; (2) miscellaneous customers, 14%; (3) concrete products manufacturers, 9%; (4) highway contractors, 7%; and (5) "other" contractors, 5%. Other sales were to the building material dealers and Federal agencies. The average price per ton of portland cement was $38.64, a decrease from the $39.75 reported in 1989.

Texas Industries Inc. sold its subsidiary, United Cement Co. of Artesia, MS, to Holnam Inc., a holding company for Holderbank, the world's largest cement manufacturer. Holnam was formed in March when Dundee Cement Co. and Ideal Basic Industries merged, creating the largest cement company in North America.

Pioneer Concrete of America Inc. purchased a 50% interest in Beazer West Inc.'s Midlothian cement plant. A proposed $15 million deal between Southdown Inc. and Lone Star Industries Inc. was canceled in early November. Southdown was to purchase Lone Star's Maryneal cement plant and Amarillo cement terminal. Federal Trade Commission requirements and paperwork were cited as the reason the sale negotiations were terminated.

Clays.—Texas maintained its sixth-place ranking nationally in the production of clays. The Texas clay industry produced ball clay, bentonite, common clay-shale, fuller's earth, and kaolin.

Ball Clay.—Ball clay, a highly plastic clay with superior green strength properties, was mined by Southern Clay Products Inc. in Gonzales. After mining, the clay was dried, ground, screened, and sold to the ceramic tile and animal feed industries. Ball clay was used as a binder by the feed manufacturers. The Southwestern United States and Mexico are the major market areas. Output, 55,600 metric tons, was valued at almost $1.6 million.

Bentonite (Calcium).—A clay closely related to fuller's earth was produced by Southern Clay Products Co. from a mine near Gonzales, the Milwhite Co. Inc. with operations at Flatonia and Riverside, and Balcones Minerals Corp. near Flatonia. The three companies produced a number of grades of clay, including organically modified bentonite used in oil well drilling muds, paints, inks, adhesives, and greases. Also produced were highly refined white bentonites for use in cosmetics and pharmaceutical products and industrial grades for foundries. Production and value in 1990, not published to protect company proprietary data, fell below the 40,059 metric tons and $1.6 million reported in 1989.

Common Clay.—Texas ranked third among the 43 States with common clay and shale production. Common clay tonnage accounted for 97% of the total clay tonnage produced and 89% of the value. Production was reported by 18 companies operating 45 mines in a 18-county area. The three leading counties, Bastrop, Guadulupe, and Navarro, accounted for 50% of the common clay produced in 1990. Principal sales, as reported by the clay producers, were common brick (40%), portland cement (31%), and structural concrete (14%). Common clay production, 2.3 million metric tons, decreased 4% from the 2.2 million metric tons produced in 1989, while value, $13.1 million, increased 9% over the $11.9 millon reported in 1989.

Fuller's Earth.—Texas was one of nine States with fuller's earth production. Fuller's earth is a clay with superior absorptive properties that has use in adsorbents, pharmaceuticals, and fillers and extenders. Two companies operated two mines near Flatonia; production and value information are not published to protect company proprietary data. Production and value increased significantly above that produced in 1989.

Kaolin.--Twelve States, including Texas, reported the production of kaolin, a light-colored clay containing the mineral kaolinite. One firm, U.S. Silica Co., mined kaolin in Limestone County. Sales were to the fiberglass and wall and floor tile industries.

Gypsum.—Texas maintained its fourth place ranking in crude gypsum production, second place in the production of calcined gypsum, and first place in byproduct gypsum. Production and value declined after a 3-year increase. Crude gypsum was mined by five firms in a five-county area. Production and value, 1.9 million short tons and $10.2 million, decreased from

the 1989 level by 125,000 short tons and $6.8 million, respectively.

The production of calcined gypsum was reported by five companies operating five plants. Production and value was 1.3 million short tons and $15.5 million. Byproduct gypsum was purchased by U.S. Gypsum's plant in Harris County.

Helium.—Both crude and Grade-A helium were produced in 1990. Crude helium was recovered by Air Products and Chemicals Inc. in Hansford County. Principal customers were the cryogenic, welding, and pressurizing-purging applications. Output and value of crude helium plummeted 41% and 44%, respectively; Grade-A helium production and value rose 17%.

Lime.—Texas ranked sixth nationally in the production of lime, which, value-wise, ranked fifth among the mineral commodities produced in-State in 1990. Lime sales accounted for about 5% of the State's total mineral value for 1990. Six companies operated quicklime and hydrated lime plants in Bexar, Bosque, Comal, Hill, Johnson, and Travis Counties. Two other companies produced quicklime in Burnet and Deaf Smith Counties. Output, 1.3 million short tons, exceeded that produced in 1989 by 33,000 short tons. Value, $76.2 million, exceeded that reported in 1989 by $15.4 million.

Magnesium Compounds.—In 1990, six companies produced magnesium compounds from seawater in California, Delaware, Florida, and Texas. Dow Chemical Co., Freeport, TX, recovered magnesium from seawater by an electrolytic process. Seawater was reacted with dolomite to obtain magnesium hydroxide. The magnesium hydroxide was neutralized with hydrochloric acid to produce a magnesium chloride solution. The solution was dehydrated to produce a feed material for the electrolytic production of magnesium metal. Both production and value fell drastically below the 1989 level.

Salt.—The State ranked second nationally behind Louisiana in salt production and produced about 20% of the Nation's total. Value-wise, salt ranked sixth among the commodities produced in Texas, accounting for approximately 5% of the State's mineral value. Production, 8.2 short tons, increased 400,000 short tons above the 7.8 million short tons reported in 1989; value, $75.1 million, was $5 million above the $69.9 million reported in 1989.

Rock salt was produced by two companies operating room-and-pillar mines in Harris and Van Zandt Counties. Salt, extracted from brines by evaporation, was produced by one company in Brazoria County. Sales were to the chemical and ice removal industries.

Sand and Gravel.—Texas ranked third among the 50 sand and gravel producing States, and sand and gravel value ranked third, behind portland cement and crushed stone, in the State's 1990 mineral value. Sand and gravel value accounted for 14% of the State total. Production of both construction and industrial sand and gravel in 1990 was 2.3 million short tons above that estimated for 1989, and value exceeded the 1989 figure by $13.9 million.

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 1988 and 1990 and estimates for 1989.

Construction sand and gravel production was reported by 164 firms operating 403 mines in 82 Texas counties. Output, 46 million short tons valued at $158 million, fell below that reported in 1988, the last full year with industry data, by 4.2 million short tons and $13 million. The five leading counties were Bexar, Colorado, Dallas, Fort Bend, and McLennan. These accounted for 11% of the tonnage. The average unit price in 1990, $3.43 per ton, exceeded the figure reported in 1988 by $0.03. Major sales, as reported to the U.S. Bureau of Mines by the producers, were (1) concrete aggregate, (2) fill, (3) road base-cover, (4) asphaltic concrete, and (5) plastergunite.

Industrial.—Texas continued to rank 22d in tonnage among the 39 States with industrial sand production. The State's industrial sand industry, 9 companies operating 13 mines in 10 counties, produced 1.8 million short tons valued at $409 million; this was an increase of 190,000 short tons and $11.8 million over that reported in 1989. The average value per ton was $22.11. Nine of the counties with industrial sand production were in eastern Texas; the tenth, McCulloch County, was in the central part of the State.

The three leading counties, in terms of tonnage mined, were (1) McCulloch, (2) Johnson, and (3) Liberty. The three accounted for 43% of the industrial sand produced. Sales were for hydraulic fracturing (28%), sandblasting, (23%), glass container manufacturing (17%), and mold and core forming (10%).

Sodium Sulfate.—Texas was one of three States with sodium sulfate production. Ozark-Mahoning Co. extracted sodium sulfate from brines at its Seagraves facility in Gaines County. Plant feed was obtained from wells drilled into shallow, subsurface brines. Mechanical refrigeration techniques were used to extract the sodium sulfate from the brine. Both production and value increased slightly above the level reported in 1989. The principal markets were the pulp, paper, and powdered detergent industries.

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 1988 and 1990 and actual data for 1989.

Crushed.—The estimated value of crushed stone ranked second among the mineral commodities produced in Texas,

accounting for approximately 20% of the 1990 State total. The 1990 stone estimate, 81.8 million short tons valued at $285.7 million, ranked the State fifth nationally among the crushed stone-producing States. This was a significant increase over the tonnage, 76.8 million, and value, $253 million, reported by industry in 1989.

In 1989, the last year with a full industry canvass, production was reported by 112 companies operating 228 quarries in 72 counties. Stone-types produced, in descending tonnages, were (1) limestone and dolomite, (2) sandstone, (3) marl, (4) marble, and (5) traprock. Stone type was not reported for approximately 1.5 million short tons of production. The five leading counties were (1) Bexar, (2) Comal, (3) Wise, (4) Williamson, and (5) Ellis.

Dimension.—Granite and limestone were quarried in 6 counties by multiple companies operating 15 quarries. Granite was quarried in four counties, and limestone was quarried in two counties. The estimated production and value, over 84,000 short tons valued at $12.6 million, exceeded the 1989 figures by approximately 3,200 short tons and $51,000, respectively.

Sulfur.—Both Frasch sulfur production, pumping heated water into subsurface sulfur deposits and recovering the melted sulfur through wells, and recovered sulfur production, recovered as a byproduct of natural gas and petroleum processing, were reported. Output of recovered sulfur totaled 3.9 million metric tons valued at $142 million (recovered sulphur only). The principal use of sulfur recovered from both processes was in the manufacture of sulfuric acid.

Frasch.—Two companies, Pennzoil Sulfur Co. and Texasgulf Inc., with facilities in Culberson, Pecos, and Wharton Counties, produced sulfur using the Frasch process. Production, 2.3 million metric tons, fell 106,000 metric tons below the 1989 level. Value declined 17%. The Texasgulf mine was nearing depletion and could be closed by the mid-1990's.[3]

Recovered.—Refineries in 17 Texas counties recovered 1.6 million metric tons of sulfur valued at $142 million. During natural gas and petroleum refining, a portion of the sulfur in refinery stream was converted to hydrogen sulfide, which was converted to elemental sulfur by the Claus process.

Talc.—Texas ranked second behind Montana among the eight States reporting talc production. Five companies reported talc production from Hudspeth and Culberson Counties. Approximately 53% of the talc was sold for ceramic manufacture, almost 30% was exported, and the remainder was sold to the plastics, paint, paper refractories, and rubber industries.

Other Industrial Minerals.—In addition to the commodities listed in table 1, several mineral commodities were recovered from process streams or shipped into Texas from other States or foreign countries for use in various manufacturing processes or processed into higher value products.

Barite was shipped into Texas and ground by Milwhite Co. Inc., Millpark Drilling Fluids, and M-1 Drilling Fluids Co. The tonnage ground in 1990 totaled 428,000 short tons valued at $9.6 million. Major sales were to the chemical and drilling industries.

Iron ore and manganese were shipped into the State and ground into a powder. Sales were to the brick industry for use as a coloring agent.

Crude perlite, a volcanic rock that increases in volume when heated, was shipped into Texas from mines in the Western States and expanded by plants in Bexar, Comal, Dallas, El Paso, Harris, and Tarrant Counties. Output totaled 24,100 short tons valued at $5.6 million. The average price per ton was $232.03, an increase over the $219.60 reported in 1989. Major sales were for filter aids and fillers and in agricultural markets.

Monazite, converted to a rare-earth hydroxide in France, was shipped to a Rhone-Poulenc plant in Freeport where it was processed by the solvent-extraction method to recover the light group of rare-earth elements (i.e., those with anomic numbers 58 through 64). The remaining product, which contains minor impurities and a small amount of heavy rare-earth elements, was returned to France for processing.

Slag, a byproduct of iron and steelmaking, was marketed as a substitute for crushed stone.

Stone (dimension), primarily granite and marble, was shipped into the State to several local stone firms. Sales were mainly to the cemetery monuments and architectural applications.

Sulfuric acid was a byproduct of the ASARCO copper smelter in El Paso.

Vermiculite, a mineral with superior expansion properties, was exfoliated by Vermiculite Products Inc. at a plant in Harris County and by W.R. Grace and Co., Dallas County. The Grace plant in Bexar County was inactive. Most of the crude vermiculite was mined in South Carolina. Primary sales were for use in block, plaster, concrete aggregates, fireproofing, loose fill insulation, and soil conditioning.

Metals

Although no Texas ores were mined and processed into metals, the State had a strong metals industry that used scrap metal ores as plant feed.

Aluminum.—Alcoa operated a 1,735,000-metric-ton-per-year primary alumina plant at Calhoun and a reduction plant at Rockdale. Reynolds Metals Co. operated a 1,700,000-metric-ton alumina plant at Corpus Christi. Adolph Coors Co. began construction of a $150 million aluminum rolling minimill in San Antonio. The plant, scheduled for completion in 1991, will produce 130 million pounds annually of aluminum sheet using scrap beverage cans as raw material. The San Antonio site was chosen because of its proximity to several beverage can producers.[4]

Antimony.—Anzon America Inc., a U.S. subsidiary of the London-based Cookson Group, operated a smelter at Laredo. The smelter processed antimony concentrates from an Anzon America mine in Mexico. M & T Chemicals produced antimony oxide at its Laurel plant in La Porte. Antimony compounds were used as stabilizers and flame retardants in plastics. The largest end use for antimony compounds was in flame-retardants.

Copper.—ASARCO operated a copper smelter at El Paso and a copper refinery at Amarillo. Phelps Dodge Refining Corp. operated a copper refinery at Nichols. An $81 million modernization program at the ASARCO smelter will increase capacity to 135,000 tons per year. Plans to retrofit the existing furnace were scrapped in favor of a new furnace.[5] The plant produced sulfuric acid as a byproduct; acid production will be increased as a result of the modernization program. Completion date was scheduled for 1991.

Texas Copper Co., a subsidiary of Mitsubishi Metals Corp. and four other Japanese firms, continued preliminary work for a $200 million copper smelter at Texas City on Galveston Bay. The start of construction was delayed from April as the firm continued to seek the necessary environmental and engineering permits required to build the 250,000-ton-per-year smelter.[6]

Tatsumi Texas announced plans to construct a marine service terminal for handling raw materials destined for the Texas City copper smelter. The planned facility will cost $30 million.

Iron Ore.—Two companies, Mathis and Mathis Mining and Exploration Co. and Hudson Brothers Mining Co., mined iron ore for nonmetal markets. Mathis and Mathis sold siderite from its mine in Cass County for use in animal feed manufacture. Hudson Brothers' mine in Cherokee County produced a limonite and siderite for use in cement manufacture. Low-grade ore was sold for highway aggregate. The last iron ore mining for metals manufacture terminated in the mid-1980's when Lone Star Steel Co. terminated operations at its Cass County iron ore mine and sintering plant.

Iron and Steel.—Texas was one of the leading steel-producing States in the Nation. In 1990, five minimills were in operation.

During the year, Chaparral Steel announced plans to add a third rolling mill at its Midlothian mill. The $50 to $60 million project will allow the mill to produce flange beams up to 24 inches wide.

Lone Star Steel Co., Lone Star, under chapter 11 creditor protection, announced profits for most of the year. The company reported the upswing in profits were because of increased sales of oil field products, coupled with an abatement of $3.3 million in interest expenses.[7]

Lead.—Tejas Resources Inc. broke ground for the "first totally enclosed lead-acid recycling plant in the United States" in June. The plant, in Terrell, is scheduled to go on-stream in March 1991. The plant, which is scheduled to recycle 3.25 million batteries a year, was designed to prevent the escape of emissions and contaminants. The plant was expected to produce 25,000 short tons of lead, 3,000 short tons of polypropylene, and 1.6 million gallons of acid each year.[8]

Magnesium Metal.—Texas was one of three States with primary magnesium metal ingot production. Dow Chemical Co. produced magnesium metal from magnesium chloride at a plant in Freeport. The magnesium chloride was feed for electrolytic cells in which the magnesium metal was produced. Production and value fell substantially.

Platinum-Palladium.—ASARCO's primary electrolytic copper refinery at Amarillo separated platinum and palladium from precious metals in its anode slimes. Phelps Dodge produced a doré metal-containing platinum and palladium at its El Paso copper refinery.

Selenium-Tellurium.—Selenium was recovered as a byproduct from anode slimes at ASARCO's copper refinery in Amarillo and at the Phelps Dodge's copper refinery in El Paso.

The ASARCO refinery recovered commercial-grade tellurium metal and tellurium dioxide at its Amarillo facility. Recovery was from copper anode slimes and crude byproduct materials originating from the company's Omaha, NE, lead refinery. Copper telluride was recovered from anode slimes at the Phelps Dodge El Paso refinery.

Uranium.—Uranium Resources Inc., Dallas, began production at its Rosita mining project late in the year. The company placed its Kingsville Dome Mine near Corpus Christi on temporary standby basis in order to develop the Rosita Project. The Rosita property was projected to be one of the lowest cost uranium mines in the world. The Dallas-based mining company marketed its uranium production to electric utilities.[9]

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[1]State Mineral Officer, U.S. Bureau of Mines, Tuscaloosa, AL. He has 30 years of mineral-related industry and government experience. Assistance in the preparation of the chapter was given by Maylene E. Hubbard, editorial assistant.

[2]Research associate, Bureau of Economic Geology, The University of Texas at Austin, TX.

[3]Industrial Minerals (London). Natural Versus Refined Sulphur--A Breath of Frasch Air. No. 286, July 1991, pp. 19-29.

[4]Denver Post. Golden Aluminum Begins San Antonio Rolling Mill. Feb. 23, 1990.

[5]The Miner's News. ASARCO Enhances Copper Expansion Program. June-July 1990.

[6]American Metal Market. Texas Copper Gets Permit. Sept. 18, 1990.

[7]———. Lone Star Earnings are Back in Black as Subsidiary Improves. Oct. 30, 1990.

[8]———. Ground Broken at High-Tech Battery Recycling Plant. July 20, 1990.

[9]———. US Uranium Mine Coming On-stream. Mar. 13, 1990.

TABLE 2

TEXAS: LIME SOLD OR USED BY PRODUCERS, BY USE

Use	1989		1990	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Road stabilization	425,432	20,825	450,254	26,703
Other[1]	878,874	40,004	887,021	49,478
Total	1,304,306	60,829	1,337,275	76,181

[1]Includes acid water neutralization, agriculture, aluminum and bauxite, environmental uses (1990), mason's lime, open hearth steel, other chemical and industrial, paper and pulp, sewage treatment, sugar refining, and tanning.

TABLE 3

TEXAS: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	16,935	$61,453	$3.63
Plaster and gunite sands	241	1,125	4.67
Concrete products (blocks, bricks, pipe, decorative, etc.)	42	246	5.86
Asphaltic concrete aggregates and other bituminous mixtures	1,146	4,725	4.12
Road base and coverings[1]	2,387	7,242	3.03
Fill	2,338	3,576	1.53
Snow and ice control	1	3	3.00
Other[2]	191	507	2.65
Unspecified:[3]			
Actual	8,766	34,593	3.95
Estimated	14,048	44,612	3.18
Total[4] or average	46,093	158,080	3.43

[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules and 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.

TABLE 4

TEXAS SAND & GRAVEL SOLD OR USED BY PRODUCERS IN 1990, BY DISTRICT AND USE

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	535	2,761	533	2,335	W	W
Plaster and gunite sands	29	143	—	—	11	42
Concrete products (blocks, bricks, etc.)	8	61	—	—	—	—
Asphaltic concrete aggregates and other bituminous mixtures	264	1,588	—	—	44	176
Road base and coverings[1]	472	1,801	W	W	96	701
Fill	84	266	W	W	92	221
Snow and ice control	—	—	—	—	—	—
Other miscellaneous[2]	12	76	46	225	235	1,172
Unspecified:[3]						
Actual	—	—	46	163	324	1,726
Estimated	1,056	3,702	21	66	563	1,387
Total[4]	2,460	10,398	646	2,789	1,365	5,425

	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	163	903	4,735	17,897	W	W
Plaster and gunite sands	—	—	104	620	W	W
Concrete products (blocks, bricks, etc.)	—	—	W	W	W	W
Asphaltic concrete aggregates and other bituminous mixtures	—	—	W	W	W	W
Road base and coverings[1]	W	W	344	647	W	W
Fill	W	W	295	345	W	W
Snow and ice control	—	—	1	3	—	—
Other miscellaneous[2]	31	98	81	169	254	909
Unspecified:[3]						
Actual	59	392	4,108	15,723	200	950
Estimated	1,003	4,732	890	2,551	773	3,242
Total[4]	1,256	6,125	10,558	3,7956	1,227	5,100

	District 7		District 8		District 9	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	1,040	3,400	8,258	26,375	1,420	6,517
Plaster and gunite sands	W	W	85	246	W	W
Concrete products (blocks, bricks, etc.)	—	—	W	W	—	—
Asphaltic concrete aggregates and other bituminous mixtures	W	W	279	714	W	W
Road base and coverings[1]	859	2,661	560	1,149	—	—
Fill	637	866	1,185	1,789	—	—
Snow and ice control	—	—	—	—	—	—
Other miscellaneous[2]	146	322	5	17	336	1,660
Unspecified:[3]						
Actual	1,815	7,356	2,214	8,282	—	—
Estimated	2,114	6,667	5,897	17,207	1,730	5,059
Total[4]	6,612	2,1272	18,484	55,779	3,487	1,3236

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules and 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.

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.
Tin:		
TexTin Corp.:		
Texas City smelter	Galveston	Ore and concentrates.

[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.

TABLE 6
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Box Crow Cement Co.	4835 LBJ Freeway Lock Box 102 Dallas, TX 75244	Plant	Ellis.
Gifford-Hill & Co. Inc., a subsidiary of Beazer U.S.A.[1]	Box 520 Midlothian, TX 76065	Quarry and plant	Do.
Lafarge Corp.[2]	3333 Fort Worth Ave. Dallas, TX 75211	Quarries and plant	Comal, Dallas, Tarrant.
Texas Industries Inc.[3]	8100 Carpenter Freeway Dallas, TX 75247	do.	Comal and Ellis.
Clays:			
Acme Brick Co., a division of Justin Industries Inc.	Box 886 Denton, TX 76202	Pits and plants	Denton, Guadalupe, Nacogdoches, Parker, Van Zandt, Wise
Featherlite Building Products Corp.	Box 428 Garrison, TX 75946	Pit and plant	Eastland.
Wolff Inc.	Box 34870 San Antonio, TX 78265	do.	Guadalupe.
Gypsum:			
Domtar Gypsum Inc.	Box 720 Sweetwater, TX 79556	Quarry and calcining plant	Nolan.
Georgia-Pacific Corp.	900 S.W. 5th Ave. Portland, OR 97204	do.	Hardeman.
National Gypsum Co., Gold Bond Div.	2001 Rexford Rd. Charlotte NC 28211	Quarries and calcining plants	Fisher, Kimble, Stonewall.
Standard Gypsum Co.	Box 27 Fredericksburg, TX 78624	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.
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.	Box 427 Clifton, TX 76634	Plant	Bosque and Burnet.
Holly Sugar Corp.	Drawer 1778 Hereford, TX 79045	do.	Deaf Smith.
Redland Worth Corp.[4]	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 and Travis.
Salt:			
The Dow Chemical Co.[5]	2020 Dow Center Midland, MI 48640	Brine	Brazoria.
Morton Thiokol Inc.	100 North Wacker Dr. Chicago, IL 60606	Underground mine and brine	Van Zandt.
Texas Brine Corp., a subsidiary of United Salt Corp.	2000 West Loop S. Houston, TX 77027	Brine	Fort Bend, Harris, Jefferson, Matagorda.

See footnotes at end of table.

TABLE 6-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Construction:			
Capitol Aggregates Inc. (H. B. Zachry Co.)	Drawer 33240 San Antonio, TX 78265	Stationary plants	Bexar, Travis, Val Verde.
Centex Materials Inc.	Drawer 928 Buda, TX 78610	Pits and plants	Hays and Travis.
The Fordyce Co.	Box 1981 San Antonio, TX 78297	do.	Hidalgo and Victoria.
Ideal Basic Industries Inc., a subsidiary of Holnam Inc.	363 North Belt Houston, TX 77054	Pits	Colorado and Fayette.
Parker Bros. & Co. Inc.[6]	Box 107 Houston, TX 77001	Stationary plants and dredges.	Colorado, Fayette, Harris.
Pioneer Concrete of Texas Inc.[7]	Box 12449 Dallas, TX 75225	Pits and plants	Colorado, Liberty, Montgomery.
Industrial:			
Oglebay Norton Co., Texas Mining Co.	2104 East Randol Mill Road Suite 101 Arlington, TX 76011	Pits and plant	McCulloch.
UNIMIN Corp.	50 Locust Ave. New Canaan, CT 06840	Plant	Johnson.
U.S. Silica Co.	Box 187 Berkeley Springs, WV 25411	Pits and plants	Limestone, Live Oak, McCulloch.
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.[8]	Box 13010 San Antonio, TX 78213	Plants and quarries	Bexar, Brown, Crockett, Eastland, Grayson, Kerr, Parker, Taylor, Uvalde, Wise.
Sulfur:			
Byproduct:			
Amoco Production Co. (Standard Oil Co., Indiana)	Box 591 Tulsa, OK 74102	Secondary recovery	Andrews, Ector, Galveston, Hockley, Van Zandt, Wood.
Chevron U.S.A. Inc.	575 Market St. San Francisco, CA 94105	do.	Crane, El Paso, Hopkins, Jefferson, Karnes.
Exxon Chemical Americas	Box 77253-3272 Houston, TX 77079	do.	Atascosa, Crane, Harris.
Phillips Petroleum Co.	Bartlesville, OK 74003	do.	Andrews, Brazoria, Crane, Hutchinson.
Smackover Shell Ltd.	Route 2, Box 152 Eustace, TX 75124	do.	Henderson.
Texaco Producing Inc.	Box 8 Scroggins, TX 75480	do.	Franklin and Freestone.
Native:			
Pennzoil Sulphur Co.	1906 First City National Bank Houston, TX 77002	Frasch mine	Culberson.
Texasgulf Chemicals Co., a subsidiary of Elf Aquitaine Inc.	Glenwood at Glen Eden Box 30321 Raleigh, NC 27622-0321	do.	Wharton.

See footnotes at end of table.

TABLE 6-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Talc:			
Apache Minerals Inc. and Pioneer Talc Co.	1000 Coolidge St. South Plainfield, NJ 07080	Pits and plant	Hudspeth.
Dal Briar Corp. (Dal-Tile)	Box 17130 Dallas, TX 75217	Pits	Do.
The Milwhite Inc.	Box 15038 Houston, TX 77020	Mine and plant	Culberson.
Southern Clay Products Inc.[9]	Box 44 Gonzales, TX 78629	Pit and plant	Hudspeth.
Vermiculite (exfoliated):			
W. R. Grace & Co.	2651 Manila Rd. Dallas, TX 75200	Exfoliating plants	Bexar and Dallas.
Vermiculite Products Inc.	Box 7327 Houston, TX 77008	Exfoliating plant	Harris.

[1]Also clays, Ellis County; sand and gravel, Brazos, Dallas, Ellis, and McLennan Counties; and crushed stone, Comal, Cooke, Ellis, Limestone, Walker, and Wise Counties.
[2]Also clays, Dallas County; sand and gravel, Dallas, Johnson, Tarrant, and Wise Counties; and stone, Dallas, Tarrant, 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, Jack, and Wise Counties.
[4]Also crushed stone, Bexar, Hidalgo, Limestone, Medina, Midland, and San Petricio Counties.
[5]Also magnesium compounds and magnesium chloride for magnesium metal, Brazoria County.
[6]Also crushed stone, Comal County.
[7]Also crushed stone, Burnet and Parker Counties; and industrial sand, Colorado and Liberty Counties.
[8]Also industrial sand, McCulloch County.
[9]Also clays, Gonzales County.

UTAH

LEGEND

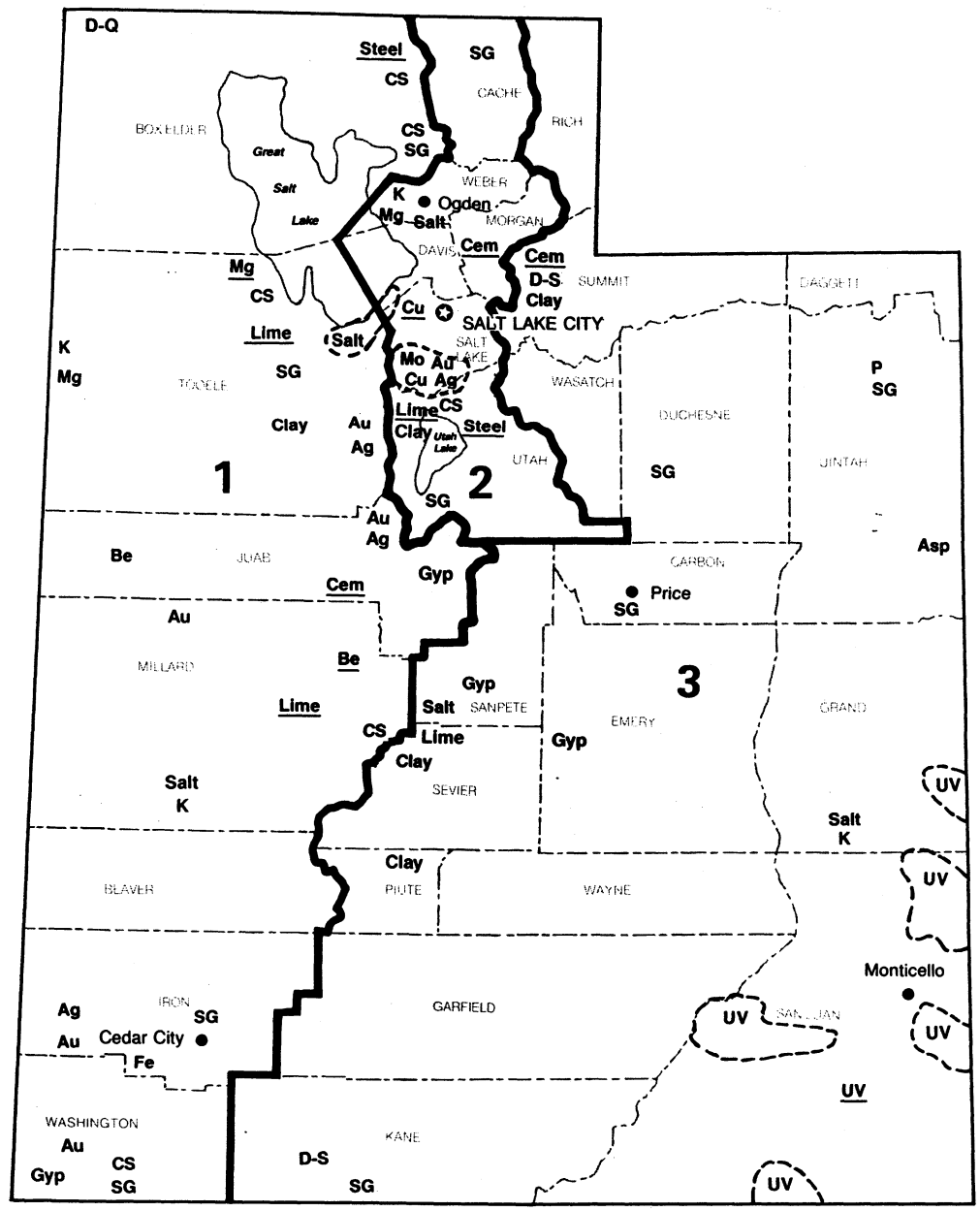
- State boundary
- County boundary
- Capital
- City
- Crushed stone/sand & gravel districts

MINERAL SYMBOLS

Ag	Silver
Asp	Asphaltite
Au	Gold
AuAg	Gold-silver refinery
Be	Beryllium
Be	Beryllium plant
Cem	Cement plant
Clay	Clay
CS	Crushed Stone
Cu	Copper
Cu	Copper plant
D-Q	Dimension Quartzite
D-S	Dimension Sandstone
Fe	Iron
Gyp	Gypsum
K	Potash
Lime	Lime plant
Mg	Magnesium
Mg	Magnesium metal plant
Mo	Molybdenum
P	Phosphate rock
Salt	Salt
SG	Sand and Gravel
Steel	Iron and Steel plant
UV	Uranium-Vanadium
UV	Uranium-Vanadium plant

Concentration of mineral operations

Principal Mineral-Producing Localities



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 and Mineral Survey for collecting information on all nonfuel minerals.

By Michael N. Greeley[1] and Robert W. Gloyn[2]

Utah mines continued to increase their production of nonfuel minerals in 1990. The total value of output increased about 3% over that of the previous year to more than $1.3 billion. This record-high value kept the State in ninth place in the nonfuel minerals industry of the Nation.

Metals accounted for approximately four-fifths of the mineral value, with copper, gold, and magnesium as the principal components. Other commodities important to the State, some of which posted impressive gains in 1990, included beryllium, iron, molybdenum, portland cement, phosphate, potash, sand and gravel, and salt.

TRENDS AND DEVELOPMENTS

Although the mineral industry of Utah was among the top 10 States in 1990, the total value of its mineral output rose only slightly during the year. Unit prices of essentially all the metals produced in the State declined substantially. Offsetting the low prices, however, was increased output and total sales volume of gold and molybdenum. Among industrial minerals, only potash and salt showed significant gains in sales volume. The production value of most other nonmetallic minerals, including construction materials, either fell during 1990 or was similar to that of the previous year.

EMPLOYMENT

According to the Utah Department of Employment Security, the State's mining industry employed an average of 8,602

TABLE 1
NONFUEL MINERAL PRODUCTION IN UTAH[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrates	metric tons	5,308	$6	4,592	$5	4,548	$5
Cement (portland)	thousand short tons	772	39,664	W	W	W	W
Clays	metric tons	308,585	2,469	321,949	2,633	[2]277,795	[2]1,774
Gem stones		NA	370	NA	659	NA	713
Lime	thousand short tons	365	17,252	373	17,974	354	18,878
Salt	do.	1,006	35,294	1,183	40,421	1,171	50,436
Sand and gravel:							
Construction	do.	17,843	49,796	e14,300	e41,500	13,601	44,881
Industrial	do.	3	60	3	60	2	42
Silver[3]	metric tons	W	W	W	W	147	22,750
Stone:							
Crushed	thousand short tons	e7,300	e20,600	4,683	19,176	e4,600	e20,200
Dimension short tons		e2,004	e93	—	—	—	—
Combined value of cement (masonry), clays (bentonite, 1990), copper, fluorspar, gold, gypsum (crude), iron ore, magnesium compounds, magnesium metal, mercury, molybdenum, phosphate rock, potash, silver, sodium sulfate (natural), vanadium, and values indicated by symbol W		XX	849,243	XX	r1,168,065	XX	1,174,331
Total		XX	1,014,847	XX	1,290,493	XX	1,334,010

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.

workers during 1990. This figure, which represents an increase of about 6% from industry employment in 1989, included employees in the fuels sector.

The mining industry provided total income to its workers of $307 million. Average wages paid on a monthly basis to individual employees rose about 2% from those of 1989 to $2,976.

REGULATORY ISSUES

Late in the year, Kennecott Corp. offered a $166 million plan to reduce sulfur dioxide emissions by 67% at its copper smelter in Magna. The plan was the company's counterproposal to a plan approved by the Utah Air Conservation Committee that would require Kennecott to reduce sulfur dioxide emissions by about 81%. According to the committee, its plan, if implemented, would reduce PM-10 emissions (particulate matter less than 10 microns in diameter) in the Salt Lake valley atmosphere by 15%. The company believes, however, that the smelter contributes only 2% of the total PM-10 emissions, and it argued that the committee plan was unscientific and unrealistic. One source of PM-10 emissions is fine, respirable sulfate particles that are found in the upper atmosphere as a result of chemical conversion of sulfur dioxide. Kennecott's plan to install a double-contact acid plant to scrub more sulfur dioxide from the smelter would reportedly increase the removal of total sulfur from 92% to 96%.

Concern continued to be expressed over a final solution to remediation projects involving mill tailings at Midvale in Salt Lake County and cement kiln dust at a site in Salt Lake City. At the Midvale site, the Environmental Protection Agency (EPA) preferred to cap the tailings with soil and vegetation and fence the area, but some members of the community wanted the tailings (14 million tons) removed. In July, the EPA issued a decision to dispose of the kiln dust (500,000 cubic yards) in a lined landfill near Magna, but this plan was also opposed by the community. As an alternative, U.S. Pollution Control Inc., a subsidiary of Union Pacific Corp., offered to move the dust to its plant near Tooele where the material would be used to stabilize the company's caustic waste. At yearend, neither remediation issue concerning the tailing or the dust had been resolved.

EXPLORATION ACTIVITIES

Prospectors and mine developers continued to show an increased interest in the precious-metal potential of Utah. Claim staking, particularly in the western part of the State, was heavy. Much of the exploration was concentrated around old mining districts, but a significant percentage took place outside of known districts and established trends.

Records maintained by the U.S. Bureau of Land Management ranked Utah second in the Nation in the number of active claims for all commodities. According to the Utah Division of Oil, Gas and Mining, 92 applications to drill and perform other exploration activities in the State were submitted to the agency in 1990.

LEGISLATION AND GOVERNMENT PROGRAMS

The State legislature in 1990 considered several bills that addressed environmental protection, taxation, and workers' compensation. Senate bill 199, to increase the severance tax on all metalliferous production to 2.6%, was passed into law after some modification suggested by the mining industry. Passage of Senate bill 170 adopted the Federal criminal penalties for hazardous waste violations. The Governor's proposal to create an independent department of environmental quality was reviewed by legislative leaders and recommended for further evaluation.

The Utah Supreme Court issued two decisions during the year that may have significant impact on the State's mining industry. At midyear, the court ruled in a case involving AMAX Inc. that State-assessed property must be taxed essentially in the same manner as county-assessed property. Specifically, the court stated that a 20% tax exemption allowed county-assessed properties was discriminatory.

Later in the year, the court remanded a case involving Kennecott to the Third District Court. In this case, the district court had ruled that the State Constitution and State statutes upheld the exemption of a property's mineral estate as a taxable asset. The State Supreme Court agreed with the lower court but ruled, however, that a factual hearing must be held to determine if the actual practice of tax assessment conforms to the intent of the law or if it treats taxpayers differently and is, therefore, unconstitutional.

The Division of State Lands and Forestry placed a moratorium on the issuance of royalty agreements and surface leases for the extraction of brines and minerals from the Great Salt Lake. The moratorium reportedly was enacted to provide time to determine the most beneficial way for the State to promote and regulate the development of the lake's natural resources. Current leasing practices will be examined and alternatives to leasing will be evaluated.

The Utah Geological and Mineral Survey (UGMS) continued its Mineral Lease Special Projects Program that funded geologic projects designed to encourage economic development of Utah's resources. The special projects were submitted by outside consultants to the UGMS for approval. During the 1990-91 fiscal year, approximately $44,000 generated from State mineral leases and Federal rebates was allocated to six projects, of which two were directly related to the mineral industry.

During 1990, the UGMS released a report on the Newcastle geothermal system, computer disks of mineral data bases for the Delta, Richfield, and Cedar City 1° x 2° quadrangles, a geothermal resource map of the State, and continued research on high-calcium limestone resources.

At yearend, the U.S. Bureau of Land Management (BLM) recommended that almost 2 million acres of land in Utah be added to the National Wilderness Preservation System. The State's

congressional delegation was divided on its recommendation; one faction proposed 1.4 million acres of BLM land be designated as new wilderness and the other recommended 5.1 million acres. A report issued by the Western Economic Analysis Center asserted that restriction of the lands to wilderness use would cost the State between an average of $1.4 billion (for 1.4 million acres) and $13.2 billion (for 5.1 million acres) per year for 25 years following wilderness designation.

The U.S. Bureau of Mines continued a study begun in 1988 under the auspices of the Inventory of Land Use Restraints Program (ILURP). This long-term program was initiated by the Bureau to inventory Federal land use restrictions to assess accurately the availability of Federal lands for mineral entry. Under ILURP in 1990, the Bureau prepared a manuscript for the Utah study and completed mineral favorability maps for the State. Technical review of the work was made by the UGMS.

In addition to operating the Salt Lake City Research Center, the Bureau supervised the administration of the Utah Mining and Mineral Resources Research Institute and the Comminution Generic Center. The Institute and the Generic Center were housed at the University of Utah and administered by faculty members of the College of Mines and Earth Sciences. Total grant money awarded by the Bureau to both units and other research programs at the university in 1990 exceeded $901,000.

FUELS

The fuel minerals industry was a major economic factor in Utah during 1990. Coal, oil and gas, and uranium were produced in the State.

Net production of coal during the year exceeded 22 million short tons, a record for the seventh consecutive year.[3] Total value of the output was $479 million. Most of the coal was mined in the Wasatch Plateau coal field located in three adjacent counties: Carbon, Emery, and Sevier. Thirteen companies operated 18 underground mines, employing 2,791 workers.

According to the Utah Division of Oil, Gas and Mining, the State ranked 11th nationally in oil production during 1990 and 16th in gas during 1989.[4] In 1990, oil output fell 3% from that of 1989 to about 27.6 million barrels, but gas production rose 16% to approximately 321.6 billion cubic feet.

Uranium production in the State continued to decline in 1990. During the year, Nuclear Fuel Services purchased Plateau Resources Limited's uranium properties in the Ticaboo area (Garfield County) for $500,000 and was negotiating for purchase of the mill at Ticaboo. The properties contain a reported proven reserve of nearly 20 million pounds of U_3O_8.[5]

REVIEW BY NONFUEL MINERAL COMMODITIES

Metals

Beryllium.—The largest operating beryllium mine in the world is in Juab County, located at Spor Mountain. The ore consists of bertrandite-bearing tuffs and is mined with open pit methods by Brush Wellman Inc. The company converts this ore, including small quantities of domestically produced beryl and imported beryl, to beryllium hydroxide and/or beryllium carbonate at its facility in Delta (Millard County). This facility is the only extraction plant in a market economy country that can recover beryllium from both types of ore. In its annual report for 1990, the company reported that the mine produced 85,000 short tons of ore with an average grade of 0.234% beryllium.

During the year, Brush Wellman restructured its Utah operations, announced a $11 million expansion program and began excavation of two new pits. It also announced a $26 million sales contract with the Defense Logistic Agency for delivery of 91,000 pounds of beryllium over the next two years with options for a third year. In other beryllium developments, Inspiration Gold Inc. of New York and Beryllium International Corp. of Delta announced plans to begin a new beryllium mining and milling operation adjacent to Brush Wellman's property.[6]

Copper.—In 1990, Utah retained its position as the third largest copper-producing State in the Nation. This ranking was supported almost exclusively by the output of the Bingham Canyon open pit mine in Salt Lake County. This mine was the second largest domestic producer of copper during the year, and it is the deepest man-made excavation in the world.

During the year, Kennecott Corporation's Bingham Canyon Mine produced 236,100 metric tons (260,300 short tons) of copper.[7] The value of this copper represented a significant portion of the value of all nonfuel mineral production in the State.

In January, Kennecott announced a $227 million construction project to increase copper production by 32,000 metric tons (35,000 short tons) per year. This expansion will increase annual capacity by about 15% to 245,000 metric tons (270,000 short tons) compared with the current level of 213,000 metric tons (235,000 short tons). The output of byproduct metals will also increase about 15%. The main component of the 2-year project will be the addition of a fourth grinding line and flotation circuit at the new Copperton concentrator. At yearend, construction was 25% complete.

In late May, Kennecott and union members ratified a 3-year agreement that provided an average wage increase of 23% over the life of the contract to more than 1,900 employees. Substantial improvements were also made in the medical plan.

Some copper was contributed to the State total by the Trixie flux mine in Utah County. According to Sunshine Mining Company's 1990 form 10-K, approximately 105 metric tons (116 short tons) of copper was recovered from Trixie ores.

Gold.—The production of gold by Utah mines was the third largest in the Nation.

Output increased approximately 10% over that of 1989. Although most of the gold was produced as a mine byproduct, several primary gold producers were major contributors to the total output.

The leading primary producer of gold in Utah was the Barneys Canyon Mine in Salt Lake County. In its first full year of production, the mine produced 4,292 kilograms (kg) or 138,000 troy ounces of gold, approximately 73% over predicted output.[8] It ranked 19th among all gold mines in the Nation during the year. In 1989, the output of the mine was about 591 kg (19,000 troy ounces). It was the third consecutive year of record production.

The Mercur Mine (Tooele County) owned by Barrick Mercur Gold Mines Inc., produced a record 3,795.8 kg (122,043 troy ounces) of gold in 1990, which was an increase of about 4% over that of the previous year.[9] During the year, the mine ranked 20th among domestic gold producers.

The Mercur property was the subject of legal action field in 1986 by Gold Standard Inc., the former owner, against Barrick and previous operators of the mine. The lawsuit alleged breach of contract and breach of fiduciary duty and sought monetary damages and return of the property to Gold Standard. The case was litigated throughout 1990.

Other primary producers of gold in 1990 included Tenneco Minerals Inc. at the Goldstrike Mine (Washington County), Jumbo Mining Co. at the Drum Mine (Millard County), and the North Lily Mining Co. (Juab County). The Goldstrike Mine operated for its first complete year and produced 1,353 kg (43,494 troy ounces) of gold.

Jumbo continued to recover gold by leaching, and North Lily maintained its leaching of gold from mill tailings near Silver City. According to its annual report, North Lily produced 180 kg (5,787 troy ounces) of gold in 1990. During the year, the company acquired several additional tailings dumps in the area to increase its reserves for continued operation and planned to spend $1.1 million for leach-pad expansion.

Kennecott's Bingham Canyon Mine was the largest producer of gold in Utah and the second largest producer in the Nation. All of this gold was recovered as a byproduct of the mine's copper output. The total amount of gold produced in 1990 was 13,063 kg (420,000 troy ounces), a decline from the 15,769 kg (507,000 troy ounces) produced in 1989.[10]

The Sunshine Mining Co. operated the Trixie Mine throughout the year and shipped flux ore containing precious metals to Kennecott's smelter at Magna, UT, and to ASARCO Incorporated's smelter at El Paso, TX. In its 1990 form 10-K, Sunshine reported total byproduct gold from the mine was 265 kg (8,519 troy ounces). One of the owners of the property, the South Standard Mining Co., stated in its annual report that the ore mined during the year averaged 0.274 troy ounce of gold per short ton and 6.82 troy ounces of silver per short ton.

Iron Ore and Steel.—Geneva Steel continued to operate its integrated steel facility at Vineyard in Utah County. During 1990, the company shipped more than 1 million short tons of steel. Approximately 729,300 long tons (818,000 short tons) of iron ore was fed to the steel plant from Geneva's contract mining operations in Iron County.[11] The balance of the iron ore requirement, about 60%, was imported as iron ore pellets from Minnesota.

Work continued on the modernization program announced by Geneva in 1989. One component of the program, a biological wastewater treatment plant, was completed in September 1990 at a cost of $7.5 million. Total cost of the modernization was revised upward from $226 million to $239 million.

The Nucor Corp. continued to operate a steel minimill at Plymouth in Box Elder County. In the plant, electric arc furnaces melt ferrous scrap from which steel is produced on continuous casting equipment. The annual production capacity is about 600,000 short tons of billet.

Magnesium.—The production of magnesium metal in Utah was the second largest in the Nation. In terms of value, magnesium production was the third largest mineral industry (after copper and gold) in the State. The sole producer, Magnesium Corp. of America (Magcorp), completed installation of new equipment to reduce chlorine emissions from its plant at Rowley, on the west side of the Great Salt Lake.

Molybdenum.—Molybdenumoutputrose about 24% over that of the previous year; production in 1990 was 5,200 metric tons (11.5 million pounds).[12] Kennecott was the only producer in Utah. Molybdenite concentrates were recovered as a byproduct of copper production at the Bingham Canyon Mine. The sulfide concentrates were roasted and converted to molybdic oxide in the company plant at Magna.

Silver.—Mine production of silver in Utah fell approximately 21% from that of 1989. The State ranked sixth in domestic output of silver.

Production of byproduct silver at the Bingham Canyon Mine ranked the mine seventh among all silver producers in the country. In 1990, this output was about 105.1 metric tons (3,379,000 troy ounces).[13]

Sunshine reported in its 1990 form 10-K that flux ores shipped from the Trixie Mine contained 6.5 metric tons (207,706 troy ounces) of byproduct silver. Barrick's Mercur Mine in Tooele County, North Lily's Silver City tailings operation in Juab County, and Tenneco's Goldstrike Mine in Washington County also continued to produce byproduct silver.

In recent years, the Escalante Mine in Iron County has been Utah's only primary silver producer. At the end of 1988, however, the mine was closed because the known ore body was mined out and because exploration efforts to discover additional ore were not successful. The mill continued to process stockpiled ore until August 1990. According to Hecla's form 10-K, silver

production in 1990 was 24.4 metric tons (784,919 troy ounces).

Production from the Escalante deposit was essentially continuous since Ranchers Exploration and Development Corp. resumed mining at the historic site in late 1981. During the following decade, Ranchers and Hecla milled approximately 3 million short tons of ore and recovered about 560 metric tons (18 million troy ounces) of silver and a minor quantity of gold.

Vanadium.—Utah was one of only four States in which vanadium was mined. Output in 1990 was down slightly from the previous year.

The White Mesa Mill at Blanding (San Juan County), a joint venture of Umetco Minerals Corp. and Energy Fuels Nuclear Co., continued to treat ores from Arizona, Colorado, and Utah. It is the only mill in the United States that has both uranium and vanadium recovery circuits. The annual capacity of the mill to produce vanadium pentoxide (V_2O_5) is about 6,800 metric tons (7,500 short tons), one of the largest capacities in the Nation. Vanadium is often a coproduct with uranium in the ores mined in Colorado and Utah.

Late in the year, Umetco announced a temporary shutdown of the mill at Blanding because of low market prices for uranium and vanadium.

Other Metals.—In early 1990, Hecla began to mine and process gallium-germanium-copper ore at its Apex Mine in Washington County. In August, however, the company suspended production because of weak prices for the principal products germanium and gallium. At yearend, Hecla pursued a program to develop alternative feedstocks for processing.

The Mercur Mine continued recovery of byproduct mercury. By virtue of this production, Utah was one of only a few producers of quicksilver in the United States during 1990.

Various trace metals, including palladium, platinum, and selenium, were recovered from anode slimes at the copper refinery owned by Kennecott at Magna in Salt Lake County. Kennecott was one of only three domestic producers of refined selenium.

Western Zirconium continued production of primary zirconium sponge and coproduct hafnium sponge from zircon concentrates. The concentrates were imported from Australia to the company plant near Ogden in Weber County.

Industrial Minerals

Cement.—Utah ranked in the top half of all cement-producing States in 1990. The output of portland cement rose slightly during the year, but there was no change in the production of masonry cement. Although the average price of portland cement remained fairly steady, the price of masonry cement dropped almost 10% from 1989 levels.

Plants were operated at Devil's Slide in Morgan County and at Leamington in Millard County. During the year, Ideal Basic Industries Inc., owner of the Devil's Slide property, was merged into Holnam Inc. Holnam, the largest producer of cement in the United States, is an indirect subsidiary of "Holderbank" Financiere Glaris Ltd. of Switzerland. The company's plant in Utah has an annual capacity of 350,000 short tons. According to Holnam's 1990 annual report, the wet-process plant operated at full capacity during the year.

The dry-process plant at Leamington has an annual capacity of 650,000 short tons. Ash Grove Cement West Inc. operated this plant for its first full year of ownership in 1990.

A third cement plant located in Salt Lake City (Salt Lake County) was idle throughout the year. This plant has a capacity of 420,000 short tons per year. In 1990, it and other assets were sold for $16,528,000 by Lone Star Industries Inc., which filed late in the year for protection under Chapter 11 of the Federal Bankruptcy Code.

Clays.—During the year, the total clay production in Utah increased in quantity and value. The increase in total value was attributed to a significant rise in the price of bentonite.

The two largest clay producers in the State were Interstate Brick Co. and Interpace Corp., both of which blended clays from numerous quarries to manufacture brick. Bentonite was produced by the Redmond Clay and Salt Co. and by the Western Clay Co. Fuller's earth was produced by Western Clay at its mine near Aurora in Sevier County. An organic-rich shale, which is expanded and used as lightweight aggregate, was mined by the Utelite Corp. in western Summit County.

Gypsum.—Most gypsum mined in the State was from several open pit mines northeast of Sigurd in Sevier County. Compared with the previous year, the production of crude gypsum and calcined gypsum remained steady in 1990. The average price of both commodities dropped sharply, however. Crude gypsum prices fell about 38% to $4.54 per short ton, and calcined gypsum, used primarily in wallboard, fell more than 17% to $14.13 per short ton.

The two principal producers in the Sigurd area were Georgia-Pacific Corp. and the United States Gypsum Co. Other producers in the State included T. J. Peck and Sons, which mined gypsum near Nephi (Juab County) for export to a cement plant in Idaho, and Standard Gypsum Products, which mined gypsum in Washington County for export as an agricultural supplement. Some production was sold by other suppliers to cement plants operating in the State.

Lime.—Output of lime decreased about 5% from that of 1989. Most of the commercial production was provided by Chemstar Inc. in Tooele County and Continental Lime Inc. in Millard County. Both of these companies have large total domestic capacity and, in 1990, were among the top 10 producers of lime in the Nation. In Utah, most of Chemstar's dolomitic lime was hydrated and used in construction applications. Continental's high-calcium lime was used for a variety of purposes, including removal of sulfur dioxide from smokestack gasses and

control of pH in mineral processing. The only other producer of lime was Materials Energy Research and Recovery Inc., which used quicklime as a neutralizer in the company-owned landfill in Tooele County and sold dead-burned dolomitic lime to Geneva Steel.

Magnesium Compounds.—The production of magnesium compounds in the State plummeted about 62% from that of 1989. Magnesium chloride, produced as a final product, was recovered from brines by Great Salt Lake Minerals & Chemicals Corp. and Reilly Industries Inc. Great Salt Lake Minerals & Chemicals operated its production facility near the northeast arm of the Great Salt Lake, west of Ogden in Weber County. Reilly Industries (formerly Reilly Tar and Chemicals Corp.) operated its plant near the Bonneville Salt Flats in Tooele County.

Phosphate Rock.—In 1990, the output of phosphate rock in Utah increased 8% over that of the previous year. Chevron Resources' open pit mine near Vernal at Little Brush Creek (Uintah County) was the only producer in the State. The phosphate rock was beneficiated at the Little Brush Creek facility and pumped as slurry through a 94-mile pipeline to the company's fertilizer plant in Rock Springs, WY. At the beginning of the year, the phosphate operation was transferred to the Chevron Chemicals Division of Chevron Corp., and toward yearend, Chevron announced plans to sell its fertilizer division including the phosphate mine.

Potash.—Utah was the second largest producer of potassium salts in the Nation. Output rose approximately 73%, and the total sales value increased more than 2.5 times that of 1989. The average annual price nationwide for all potash products was essentially unchanged.

Great Salt Lake Minerals and Chemicals operated its potash division for a full year in 1990 since resuming production during the previous year. The company produced potassium sulfate by solar evaporation and conversion from kainite.

The Reilly-Wendover plant, owned by Reilly Industries at the west end of the Bonneville Salt Flats, produced potassium chloride by solar evaporation and flotation from shallow subsurface brines.

In eastern Utah, near Moab in Grand County, Moab Salt Inc. extracted potassium chloride and byproduct salt from underground bedded deposits by solution mining and evaporation. Moab Salt is an affiliate of Texasgulf Inc., which is a wholly owned subsidiary of Elf Aquitaine Inc. In its annual report, Elf Aquitaine stated that the solution mine produced 99,392 short tons of potash in 1990. This quantity represented an increase of about 10% over that of the previous year.

Salt.—During the year, nine firms produced salt in the State. In some operations, salt was recovered as a primary product; in others, it was recovered as a byproduct or coproduct. Four operators produced salt from the brines of the Great Salt Lake: Akzo Salt Inc., North American Salt Co. (formerly American Salt Co.), Great Salt Lake Minerals and Chemicals Corp., and Morton Salt Co. These companies harvested salt from shallow solar evaporation ponds. Great Salt Lake Minerals and Chemicals has the largest annual production capacity of solar salt in the United States: 1.5 million short tons.

Shallow subsurface brines were the feedstock for two salt producers: Crystal Peak Minerals Corp. and Reilly Industries. In 1990, Crystal Peak, a subsidiary of the W.D. Hayden Co., began producing salt from solar evaporation ponds constructed at the southern end of Sevier Lake in Millard County. The company operated the production facility for a complete year after startup in 1989.

Salt was extracted in a manner similar to that of Crystal Peak by Reilly at its plant near the Bonneville Salt Flats in Tooele County. Sylvinite was recovered in solar evaporation ponds and treated to extract sylvite and halite.

In central Utah, at Redmond in Sevier County, the Redmond Salt and Clay Co. produced rock salt from an underground mine. Near Moab in Grand County, solar salt was produced as a byproduct of Moab Salt's potash operation and marketed by the firm's affiliate, Carey Salt. The 1990 annual report of Elf Aquitaine stated that salt production for the year was 160,721 short tons. This quantity represented an increase of about 62% over that of the previous year.

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 1988 and 1990 and estimates for 1989.

Utah construction sand and gravel statistics are compiled according to geographical districts as depicted on the State map. The State's production in 1990 dropped almost 24% from that of 1988. Most of the output in Utah was from District 2, which encompasses the population centers of Ogden, Provo, and Salt Lake City.

Industrial.—Utah's sole producer of industrial sand was Salt Lake Valley Sand and Gravel Co. Mined from the Nash pit in Salt Lake County, the commodity was sold for the construction of molds and linings and as a traction sand.

Sodium Sulfate.—During 1990, Great Salt Lake Minerals and Chemicals produced sodium sulfate by solar evaporation of lake brines. The brines were recovered from the eastern portion of the Great Salt Lake in Weber County. Output during the year rose about 5% over that of 1989.

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 1988 and 1990 and actual data for 1989.

Crushed.—Utah's production of crushed stone in 1990 was estimated to have remained essentially level with actual production of 1989.

Dimension.—Several companies quarried dimension stone in Utah and supplied various users during 1990. A diversity of products, including aragonite, limestone, quartz schist, and sandstone were mined on a regular or intermittent basis.

Other Industrial Minerals.—Three companies produced the hydrocarbon asphaltite from underground mines in Uintah County. The commodity was marketed as an additive for foundry sand, printing inks, drilling muds, and a variety of other nonfuel applications. Lexco Inc., a new producer, began operations during the year. The American Gilsonite Co. was placed on sale at midyear by its parent firm, the Chevron Corp.

Utah ranked ninth in the Nation in the value of gem stones produced in 1990. A relatively large variety of gem materials was mined in the State; some of the most popular materials included beryl, obsidian, topaz, and variscite.

Chlorine was recovered as a byproduct of the magnesium plant operated by Magcorp at Rowley.

Synthetic graphite was produced for use in composite materials developed and manufactured by Hercules Inc. at its plant near Salt Lake City (Salt Lake County).

As in prior years, perlite was shipped in from out of the State to be expanded at a plant owned by the Pax Co. in Salt Lake County.

A relatively small amount of sulfur was recovered at the Petroleum refinery owned by Chevron Oil Co. in Salt Lake County. As a byproduct of smelting copper ore, Kennecott produced sulfuric acid at its Magna facility. Although acid production declined about 10% during the year, its value rose approximately 5% over that of 1989.

Intermountain Products Inc. continued to purchase crude vermiculite from out-of-State sources and produce exfoliated vermiculite at its plant in Salt Lake County.

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[1]State Mineral Officer, U.S. Bureau of Mines, Tucson, AZ. He has covered the mineral activities in Utah for 3 years. Assistance in the preparation of the annual report was given by Barbara Stinnett, editorial assistant.

[2]Senior Geologist, Utah Geological and Mineral Survey, Salt Lake City, UT.

[3]Jahanbani, F. R. 1990 Annual Review and Forecast of Utah Coal Production and Distribution. Utah Div. of Energy, Salt Lake City, UT, 1991, 17 pp.

[4]Div. of Oil, Gas and Mining. 1990-91 Annual Report. Dept. of Natural Resources, Salt Lake City, UT, 1991, pp. 17-26.

[5]Utah Mining Association. Management Digest. Feb 1990.

[6]Utah Mining Association. Management Digest. May 1990.

[7]RTZ Corp. PLC 1990 Annual Report, 66 pp.

[8]Work cited in footnote 7.

[9]American Barrick Resources Corp. 1990 Annual Report, 57 pp.

[10]Work cited in footnote 7.

[11]Skillings' Mining Review. July 27, 1991, p. 27.

[12]Work cited in footnote 7.

[13]Work cited in footnote 7.

TABLE 2

UTAH: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,873	$14,912	$3.85
Plaster and gunite sands	75	233	3.11
Concrete products (blocks, bricks, pipe, decorative, etc.)	267	838	3.14
Asphaltic concrete aggregates and other bituminous mixtures	2,036	10,496	5.16
Road base and coverings[1]	3,054	9,243	3.03
Fill	1,979	2,729	1.38
Snow and ice control	90	162	1.80
Railroad ballast	W	W	2.33
Other[2]	415	1,097	2.64
Unspecified:[3]			
Actual	1,069	3,422	3.20
Estimated	743	1,747	2.35
Total or average	13,601	[4]44,881	3.30

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules and 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.

TABLE 3

UTAH:[1] SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	467	1,363	3,026	12,212	360	1,202
Plaster and gunite sands	W	W	W	W	W	W
Concrete products (blocks, bricks, etc.)	137	431	130	407	—	—
Asphaltic concrete aggregates and other bituminous mixtures	137	440	1,272	4,695	534	4,712
Road base and coverings[2]	707	1,705	1,250	3,063	786	2,920
Fill	95	202	1,818	2,449	66	78
Snow and ice control	66	127	W	W	W	W
Railroad ballast	W	W	—	—	—	—
Other miscellaneous[3]	20	95	453	1,179	40	91
Unspecified:[4]						
Actual	4	11	957	3,192	109	218
Estimated	110	264	457	953	176	529
Total	1,743	[5]4,639	9,363	28,150	2,071	9,750

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Excludes 423,257 short tons valued at $2,340,845 not reported by county.
[2]Includes road and other stabilization (cement and lime).
[3]Includes roofing granules and 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.

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Asphaltite:			
American Gilsonite Co., a subsidiary of Chevron Corp.	136 East South Temple, #2350 Salt Lake City, UT 84111	Underground mines and plant	Uintah.
Lexco Inc.	Box 1198 Vernal, UT 84078	do.	Do.
Ziegler Chemical and Mineral Corp.	Star Route 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 2]	Box 51 Nephi, Ut 84648	Quarries and plant	Millard.
Holnam Inc. (formerly Ideal Basic Industries Inc.)[1]	Aux. Route 3 Morgan, UT 84050	do.	Morgan.
Clays:			
Interpace Industries	Box 12118 Ogden, UT 84402	Open pit mines and plant	Utah.
Interstate Brick Co., a division of Pacific Coast	9780 South 5200 West West Jordan, UT 84084	do.	Box Elder, Tooele, Utah.
Utelite Corp.	Box 387 Coalville, UT 84017	Open pit mine and plant	Summit.
Western Clay Co.[1]	Box 127 Aurora, UT 84620	Open pit mines	Sevier.
Copper:			
Kennecott Corp., a subsidiary of RTZ Corp. PLC [3]	Box 11248 Salt Lake City, UT 84147	Open pit mine, mills, smelter, refinery.	Salt Lake.
Gold:			
Barrick Mercur Gold Mines Inc., a subsidiary of American Barrick Resources Corp.[4]	Box 838 Tooele, UT 84074	Open pit mine, mill, carbon in-pulp plant.	Tooele.
Jumbo Mining Co.	Box 999 Delta, UT 84624	Heap leach	Millard.
North Lily Mining Co.[5]	1111 Bayhill Dr., #210 San Bruno, CA 94066	do.	Juab.
Gypsum:			
Georgia-Pacific Corp.	Box 80 Sigurd, UT 84657	Open pit mine and plant	Sevier.
United States Gypsum Co., a subsidiary of USG Corp.	Box 160 Sigurd, UT 84657	do.	Do.
Iron and Steel:			
Geneva Steel[1]	Box 2500 Provo, UT 84603	Mines and plant	Iron and Utah.
Nucor Steel Div., Nucor Corp.	Box 488 Plymouth, UT 84330	Plant	Box Elder.
Lime:			
Chemstar Lime[1]	Box 537 Grantsville, UT 84029	Open pit mine and plant	Tooele.
Continental Lime Inc., a subsidiary of Steel Bros. Canada Ltd.[1]	Box 266 Delta, UT 84624	Quarry and plant	Millard.

See footnotes at the end of table.

TABLE 4-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Lime—Continued			
Materials Energy Research & Recovery Corp., a subsidiary of United States Pollution Controls Inc.[1]	Box 596 Grantsville, UT 84029	Open pit mine and plant	Tooele.
Magnesium:			
Magnesium Corp of America, a subsidiary of Renco Group Inc.[6 7]	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.
Potassium Salts:			
Great Salt Lake Minerals & Chemicals Corp., a division of GSL Acquisition Corp.[8]	Box 1190 Ogden, UT 84402	Plant, concentrator, solar evaporation ponds.	Weber.
Moab Salt Inc., a division of Texasgulf, Inc., a subsidiary of Societe Nationale Elf Aquitaine[7]	Box 1208 Moab, UT 84532	Solution mine, solar evaporation, concentrator, plant.	Grand.
Reilly Industries Inc. (formerly Reilly Tar and Chemicals Corp.), Reilly Wendover Div.[7 9]	Box 580 Wendover, UT 84083	do.	Tooele.
Salt:			
Akzo Salt Inc.	1428 J. Palmer Rd. Lake Point, UT 84074	Plant	Do.
North American Salt Co. (formerly American Salt Co.)	Box 477 Grantsville, UT 84029	do.	Do.
Morton Salt Co., a division of Morton International Inc.	A.M.F. Box 22054 Salt Lake City, UT 84122	do.	Salt Lake.
Redmond Clay & Salt Co.[2]	370 South State St. Redmond, UT 84652	Underground mine	Sanpete.
Sand and gravel (construction):			
Big Cottonwood Sand & Gravel Co.	6695 Wasatch Blvd. Salt Lake City, UT 84121	Pits and plants	Salt Lake.
Concrete Products Co., a division of Gibbons & Reed Co.[2]	Box 7356 Murray, UT 84107	do.	Davis, Salt Lake, Summit, Utah, Weber.
Geneva Rock Products Inc.	Box 538 Orem, UT 84057	do.	Salt Lake.
Harper Excavating Inc.	4655 West 5415 South Kearns, UT 84118	do.	Do.
J and J Mill & Lumber Co. Inc.	180 North 300 East St. George, UT 84770	do.	Washington.
LeGrand Johnson Corp.[1]	Box 248 Logan, UT 84321	do.	Cache, Grand, Rich.
Pioneer Sand & Gravel Co.	Box 18457 Kearns, UT 84118	do.	Salt Lake.
Savage Rock Products[1]	748 West 300 South Salt Lake City, UT 84104	do.	Davis and Salt Lake.
Staker Paving & Construction Co.[1]	Box 27598 Salt Lake City, UT 84127	do.	Salt Lake.
Western Rock Products Corp.	820 North 1080 East St. George, Ut 84770	do.	Washington.
Silver:			
Hecla Mining Co., Escalante Unit.[10]	Box 310 Enterprise, UT 84725	Concentrator	Iron.

See footnotes at the end of table.

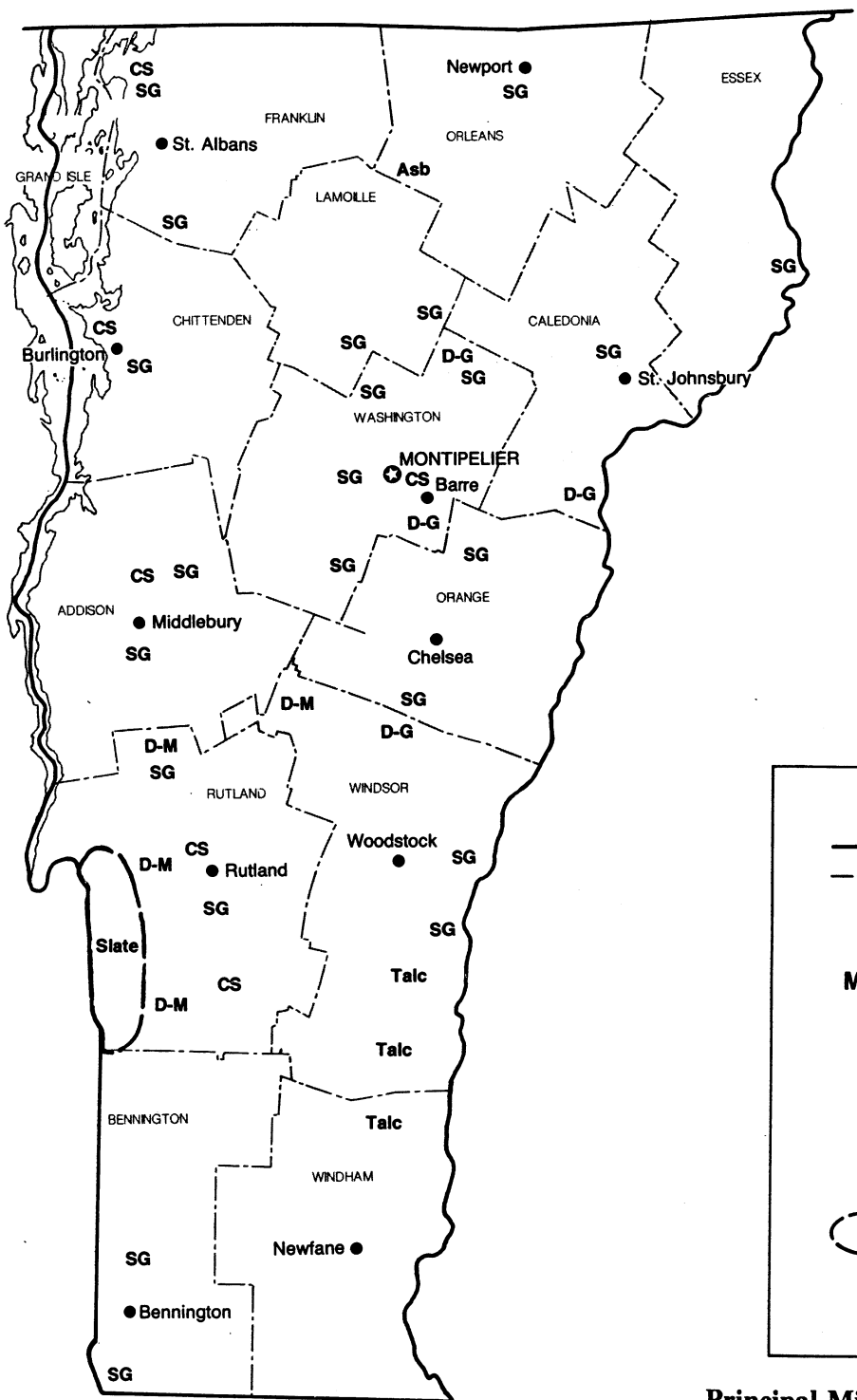
TABLE 4-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cedarstrom Calcite & Clay Corp.	145 East 5th North Lehi, UT 84045	Quarry	Utah.
Diversified Marketing Services Inc.	Box 1181 Filmore, UT 84631	Quarry and plant	Millard.
Larson Limestone Co.	95 North 200 East American Fork, UT 84003	Quarry	Utah.
Lava Products Inc.	94 West Tabernacle St George, UT 84770	do.	Washington.
Santaquin Calcite Co.	355 East 100 North Santaquin, UT 84655	Quarry	Santaquin.
Stone (Dimension):			
Hansen Stone Quarries	8809 South 700 West Sandy, UT 84070	Quarry	Wayne.
State Stone Corp.	4640 South 300 West Salt Lake, UT 84107	do.	Do.
Stone (Smelter Flux):			
Sunshine Mining Co.[5 10]	Box 250 Eureka, UT 84628	Underground mine	Utah.
Vanadium:			
Umetco Minerals Corp.	Box 669 Blanding, UT 84511	Underground mines, ore-buying station, mill.	Emery,Garfield, San Juan.

[1] Also crushed stone.
[2] Also clay.
[3] Also gold, molybdenum, and silver.
[4] Also silver and mercury.
[5] Also silver.
[6] Also chlorine.
[7] Also salt.
[8] Also magnesium compounds, salt, and sodium sulfate.
[9] Also magnesium compounds.
[10] Also gold.

VERMONT



LEGEND

- State boundary
- County boundary
- Capital
- City

MINERAL SYMBOLS

Asb	Asbestos
CS	Crushed Stone
D-G	Dimension Granite
D-M	Dimension Marble
SG	Sand and Gravel
Slate	Slate
Talc	Talc minerals
	Concentration of mineral operations

Principal Mineral-Producing Localities

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]

The value of nonfuel mineral production in Vermont in 1990 was almost $82 million, a $7 million decrease from that of 1989. This decrease can largely be attributed to lower sales of construction sand and gravel and dimension stone. Other mineral commodities produced included crushed stone, talc, and asbestos. Nationally, the State ranked second of 11 States that produced talc and pyrophyllite. It ranked third in quantity and second in value of dimension stone and was one of only two States that produced asbestos.

TRENDS AND DEVELOPMENTS

In 1990, the value of total construction contracts, which relied heavily on mineral aggregates, was down 27% from that of 1989. The hardest hit sector was in residential construction, which fell 31% from $348 million in 1989 to $241 million in 1990. The value of nonresidential construction was down 26% from $296 million to $218. The only increase reported was in nonbuilding contracts, which rose by 13%, from $118 million in 1989 to $136 million in 1990. However, the increase in this category was not enough to offset the losses in the other two categories. As a result of these construction declines, demand for aggregates and building materials was soft in 1990. Output and value of construction sand and gravel declined 46% and 41%, respectively, from that of 1989. Estimated sales of dimension stone, the State's second leading mineral commodity, declined slightly from 1989 output. The only exception in the decline for mineral aggregates was in crushed stone output. In 1990, the U.S. Bureau of Mines estimated that crushed stone output was higher than 1989 canvassed figures. However, this increase was not enough to offset the $8.4 million decline in construction sand and gravel output. As a result, Vermont's total mineral value in 1990 was $7 million lower than that of 1989.

EMPLOYMENT

In 1990, the average number of workers[2] employed in the mineral extractive industries in Vermont was 1,056. This included 30 personnel in underground mines, 697 at surface operations, and 329 working in mineral-related mills and preparation plants.

REGULATORY ISSUES

Yankee Nuclear Power Corp. proposed to the State to site a low-level radioactive waste depository on land adjacent to its nuclear powerplant near the town of Vernon. Vermont Yankee produces 95% of the State's low-level radioactive waste; the rest is mainly radioactive medical waste. The company would like the State to build the waste storage facility by 1996 on a 5-acre field northwest of its plant in a 20-acre buffer zone. Company officials also contend that 40 half-buried cement bunkers would hold all the State's low-

TABLE 1
NONFUEL MINERAL PRODUCTION IN VERMONT[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$10	NA	$10	NA	$10
Sand and gravel (construction)	thousand short tons	6,047	17,478	e6,900	e20,400	3,675	11,948
Stone:							
Crushed	do.	e2,000	e18,000	3,119	28,110	e3,700	e35,000
Dimension	short tons	e105,000	e30,500	100,698	31,413	e99,243	e28,950
Combined value of other industrial minerals		XX	9,667	XX	8,969	XX	6,046
Total		XX	75,655	XX	88,902	XX	81,954

eEstimated. 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; kind and value included with "Combined value" figure.

level waste for the next 40 years, including decommissioning waste from the plant's closure, now set for the year 2007.

LEGISLATION AND GOVERNMENT PROGRAMS

Two bills were passed in 1990 concerning radioactive waste. Public Act 242 related to the scope of State regulatory control over radioactive materials. Public Act 296 created a low-level radioactive waste authority and provided for a possible low-level radioactive waste facility. To date, Vermont has been dependent on low-level radioactive waste disposal sites in other States that are no longer required to accept waste from Vermont under provisions of the Federal Low-Level Radioactive Waste Policy Act (FLLRWPA). The State's efforts to join an interstate compact or to sign a long-term agreement with a State or compact for the disposal of some or all of Vermont's low-level radioactive waste, have not been successful to date. The FLLRWPA also states that if a State is unable to provide for the disposal of all low-level radioactive waste generated in the State by January 1996, the State must take possession of all low-level waste in its borders, whether it has a place to put it or not.

Public Act 296 also authorized eight new positions in the Agency of Natural Resources to provide the staff to regulate the siting, design, construction, operation, monitoring, and closing of the disposal facility. The State Geologist was given the responsibility to supervise the organization of a new division of radioactive waste management and to oversee the startup of its operation.

Public Act 245, "An Act Relating to a Division of Geology and Mineral Resources," was signed into law in June. The act created a Division of Geology and Mineral Resources within the Agency of Natural Resources. Previously, there had been no enabling legislation that authorized the existence of a geological organization in Vermont. In 1844, the position of State Geologist was created. This initial legislation directed the State Geologist to conduct a geological survey of the State. Over the years, the "duty" became an organizational name, i.e., the Vermont Geological Survey. The 1990 legislation provides an organizational title that conforms to the Superagency hierarchy of Agency, Department, Division. The duties and responsibilities of the division were also modernized.

House bill 648, "An Act Relating to Municipal Regulation of Earth Resources, Exploration, Extraction, and Processing Operations," died in committee in May. The bill would have made it easier to establish sand and gravel pits by allowing an act 250 permit to be avoided if a town created its own sand and gravel regulations. Act 250, the State's 20-year-old land use law, established criteria that proposed development must meet before a permit is granted. Mining falls under the category of proposed development.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Asbestos.—Vermont Asbestos Group Inc. (VAG), one of two active asbestos producers in the country, produced asbestos at an open pit mine and operated a dry-processing mill at Lowell, Orleans County. In 1990, shipments declined only slightly from those of 1989. The asbestos was sold primarily for making clutches, brake components, and diaphragms for chlorine production.

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 1988 and 1990 and estimates for 1989.

Construction sand and gravel was the State's third leading mineral commodity produced in terms of value. In 1990, production and value fell 47% and 41%, respectively, compared with that of 1989. A total of 65 companies mined construction sand and gravel from 81 operations in all of the State's counties. Leading counties, in order of descending output, were Washington, Rutland, and Chittenden. Main uses were for road base and coverings, concrete aggregate, and fill.

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 1988 and 1990 and actual data for 1989.

Crushed.—Crushed stone was the State's leading mineral commodity produced and accounted for 43% of the State's mineral value. Limestone was the primary rock quarried, followed by marble and granite. Crushed stone was produced in 7 of the State's 13 counties. Leading counties, in order of output, were Chittenden, Addison, Rutland, and Franklin. Crushed stone was also quarried in Caledonia, Orleans, and Rutland Counties. Main uses were for road base, bituminous concrete, and fill.

Dimension.—Dimension stone, the State's second leading mineral commodity, accounted for more than one-third of the State's mineral value. Nationally, the State ranked third in quantity and second in value of dimension stone. Types of rock quarried, in descending order of output, were granite, slate, and marble.

In October, the Parma Corp. requested approval from the Hardwick Zoning Board of Adjustment to reopen a granite quarry near Mackville. Parma wants to mine monument-grade granite, 6 days per week, from the former 34-acre quarry site. If approved by the zoning board, the company would still have to obtain an Act 250 permit and other State permits before mining could begin.

Talc.—Nationally, Vermont ranked second in talc and pyrophyllite production. Cyprus Industrial Minerals

Co. operated four mines and four mills in the State. The talc and pyrophyllite were used in cosmetics, insecticides, paint, paper, roofing, and rubber, and for other fine-grade products.

In November, the company announced that they would close the State's last underground talc mine in Hammondville by yearend. The company indicated that the mine was closing for economic and safety reasons. The 14 workers at the 40-year-old mine were expected to be shifted to company operations elsewhere. Cyprus operates talc mines in Orleans, Windham, and Windsor Counties and mills in Lamoille and Windsor Counties. In May, workers at Cyprus approved a new 4-year contract with the company. The contract was the first one negotiated with Cyprus, which purchased the assets of Vermont Talc Inc. in 1988. The workers belong to the United Cement, Lime, Gypsum, and Allied Workers Union.

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[1]State Mineral Officer, U.S Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related experience and has covered the mineral activities in Vermont for 6 years. Assistance in the preparation of the chapter was given by Sally J. Stephenson.

[2]"Average number of workers" is a summary of the average number of workers at individual mining establishments during period (not necessarily continuous) of active operations.

TABLE 2

VERMONT: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

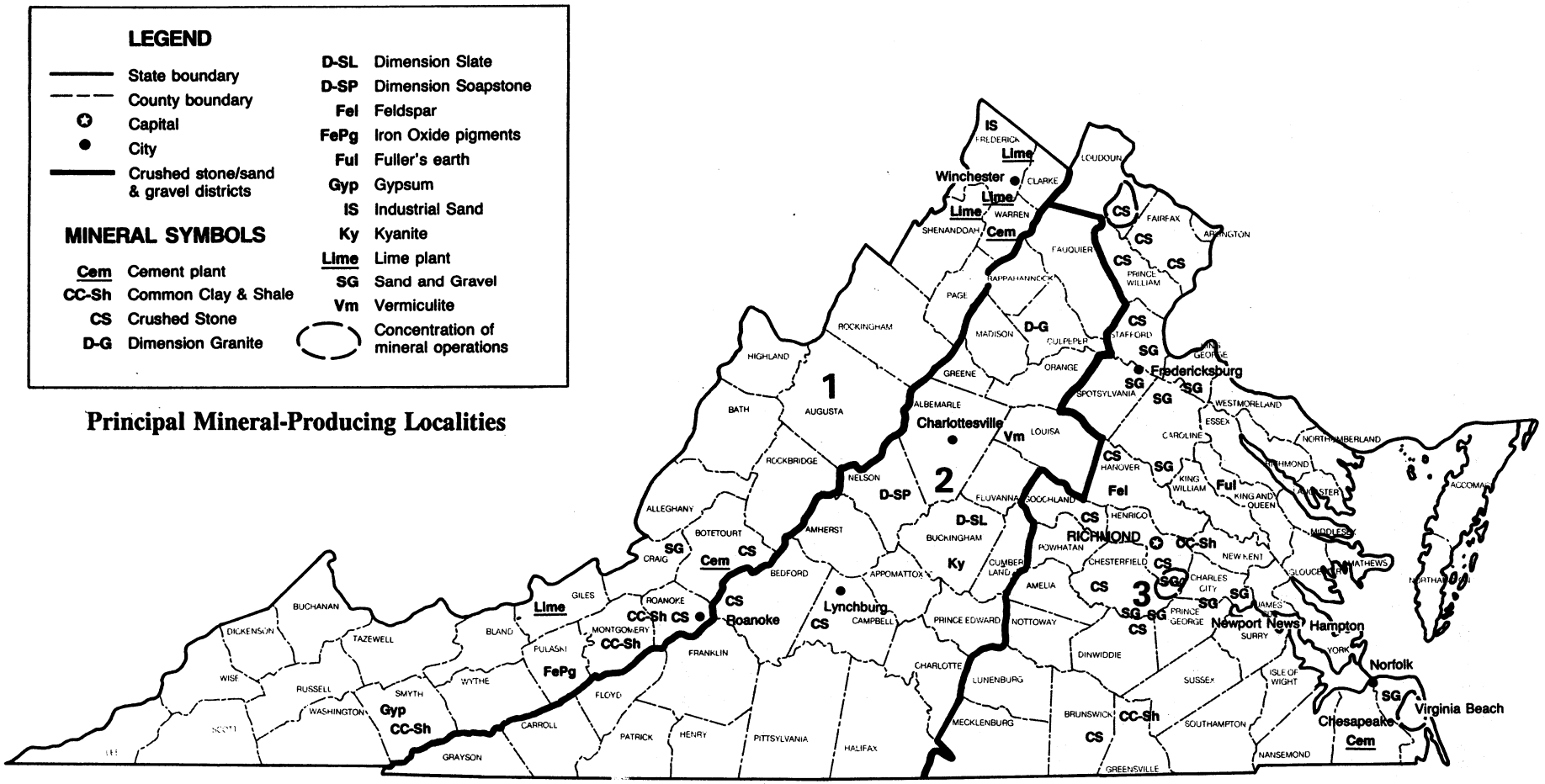
Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	336	$1,611	$4.79
Plaster and gunite sands	W	W	6.50
Concrete products (blocks, bricks, pipe, decorative, etc.)	17	79	4.65
Asphaltic concrete aggregates and other bituminous mixtures	352	1,971	5.60
Road base and coverings[1]	1,103	2,819	2.56
Fill	304	542	1.78
Snow and ice control	220	619	2.81
Railroad ballast	(3)	2	4.86
Other[2]	255	1,059	4.15
Unspecified:[4]			
Actual	509	1,783	3.50
Estimated	579	1,463	2.53
Total or average	3,675	11,948	3.25

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes road and other stabilization (cement).
[2]Includes filtration.
[3]Less than 1/2 unit.
[4]Includes production reported without a breakdown by end use and estimates for nonrespondents.

TABLE 3
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Asbestos:			
Vermont Asbestos Group Inc.	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.	Route 116 Middlebury, VT 05753	Pits	Addison and Rutland.
William E. Daily Inc.	Route 1, Box 51 Shaftsbury, VT 05262	do.	Bennington.
Hinesburg Sand & Gravel Co.	Box 200 Hinesburg, VT 05461	Pit	Chittenden.
Pike Industries Inc.	Route 3, Box 91 Tilton, NH 03276	Pit	Washington.
Stone:			
Crushed (1989):			
L. A. Demers Co.	Box 359 Essex Junction, VT 05452	Quarry	Addison.
Pike Industries Inc.	Route 3, Box 91 Tilton, NH 03276	Quarries	Addison, Caledonia, Washington
Swanton Limestone Corp.	Box 359 Essex Junction, VT 05452	do.	Chittenden and Franklin.
Frank W. Whitcomb Construction Corp.	Box 429 Bellows Falls, VT 05101	do.	Chittenden.
White Pigment Corp.	Florence Plant Florence, VT 05744	do.	Addison and Rutland.
Dimension (1989):			
OMYA Inc.	61 Main St. Florence, VT 05744	Quarry and plant	Rutland and Windsor.
Rock of Ages Corp., a subsidiary of John Swenson Granite Co. Inc.	Box 482 Barre, VT 05641	Quarries	Washington and Windsor.
John Swenson Granite Co. Inc.	North State St. Concord, NH 03301	Quarry	Washington.
Talc:			
Cyprus Industrial Minerals Co.	Box 117 Chester, VT 05143	Mines and mills	Lamoille, Windham, Windsor.

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
Winchester
Fredericksburg
Charlottesville
Lynchburg
Roanoke
RICHMOND
Newport News
Hampton
Norfolk
Virginia Beach
Chesapeake
Boanoke
FREDERICK
CLARKE
LOUDOUN
WARREN
SHENANDOAH
FAIRFAX
ARLINGTON
FAUQUIER
PRINCE WILLIAM
RAPPAHANNOCK
PAGE
MADISON
CULPEPER
STAFFORD
KING GEORGE
ROCKINGHAM
HIGHLAND
GREENE
ORANGE
SPOTSYLVANIA
WESTMORELAND
BATH
AUGUSTA
ALBEMARLE
LOUISA
ESSEX
CAROLINE
NORTHUMBERLAND
ROCKBRIDGE
NELSON
HANOVER
KING WILLIAM
KING AND QUEEN
RICHMOND
ACCOMACK
ALLEGHANY
BOTETOURT
AMHERST
FLUVANNA
GOOCHLAND
HENRICO
MIDDLESEX
CRAIG
BEDFORD
BUCKINGHAM
POWHATAN
NEW KENT
MATHEWS
APPOMATTOX
CUMBERLAND
CHESTERFIELD
CHARLES CITY
GLOUCESTER
GILES
AMELIA
JAMES CITY
BUCHANAN
CAMPBELL
PRINCE EDWARD
NOTTOWAY
PRINCE GEORGE
SURRY
DICKENSON
TAZEWELL
BLAND
MONTGOMERY
FRANKLIN
DINWIDDIE
YORK
WISE
PULASKI
WYTHE
CHARLOTTE
LUNENBURG
SUSSEX
ISLE OF WIGHT
RUSSELL
SMYTH
FLOYD
WASHINGTON
CARROLL
PATRICK
HENRY
PITTSYLVANIA
HALIFAX
MECKLENBURG
BRUNSWICK
SOUTHAMPTON
SCOTT
GRAYSON
GREENSVILLE
NANSEMOND
LEE

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 was about $507 million in 1990, the second consecutive year in which value exceeded $500 million. Nationally, Virginia ranked 22d in the value of nonfuel mineral production.

Total value declined slightly, the first decline since 1982. Production of construction aggregates, which accounted for about 75% of the State's value, also declined slightly.

EMPLOYMENT

The Virginia Department of Mines, Minerals, and Energy (DMME), Division of Mineral Mining, reported 2,370 plant workers and 1,793 quarry workers were employed in the nonfuels mining industry in 1990. Compared with that of 1989, employment of plant workers dropped by 340 and quarry workers by 276. Overall, in 1990, the limestone industry employed the most workers, with a total of 1,100 employees.

The State's coal industry employed about 9,725 workers according to the U.S. Mine Safety and Health Administration. Of that total, about 83% was underground coal miners and 17% worked at surface mine operations.

EXPLORATION

The drilling and sampling of titanium sand mineralization continued during the year in southeastern Virginia. At least 10,000 acres was leased from landowners in parts of Dinwiddie, Sussex, and Greensville Counties by major mining companies. One of the firms, South East TiSand, a joint venture of Becker Minerals Inc. and Consolidated Rutile Ltd., completed a reclamation research project. The study, conducted on a small scale, showed that upon completion of mining, the soil remained suitable for farming.

Marline Uranium Corp. essentially ended efforts to develop a uranium mine in Virginia. Marline had discovered a deposit in the Coles Hill area containing an estimated 30 million pounds of uranium oxide (U_3O_8) ore in the early 1980's. Subsequently, uranium prices dropped from about $40 per pound to $10 per pound. In addition, local citizens groups opposed to uranium mining were successful in petitioning the General Assembly to pass legislation that banned uranium mining in Virginia. In August, Marline shut its Danville office and sold its remaining land holdings in Pittsylvania County.

TABLE 1
NONFUEL MINERAL PRODUCTION IN VIRGINIA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2]	metric tons	1,010,114	$6,614	1,001,394	$6,302	882,383	$3,741
Gemstones		NA	20	NA	27	NA	34
Lime	thousand short tons	741	33,875	821	38,353	846	39,784
Sand and gravel (construction)	do.	12,551	42,573	e12,900	e49,700	13,096	48,950
Stone:							
Crushed	do.	e66,000	e326,700	64,061	328,050	e59,400	e320,000
Dimension	short tons	e10,000	e2,900	W	W	W	W
Combined value of aplite, cement, clays (fuller's earth), gypsum (crude), iron oxide pigments (crude), kyanite, sand and gravel (industrial), talc and pyrophyllite, vermiculite, and values indicated by symbol W		XX	81,830	XX	r86,669	XX	94,766
Total		XX	494,512	XX	509,101	XX	507,275

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.

LEGISLATION AND GOVERNMENT PROGRAMS

Enactment of amendments to the Federal Clean Air Act in late 1990 and construction of a major new powerplant in Virginia were expected to increase the demand for low-sulfur coal produced in the State. Late in the year, a joint venture of Old Dominion Electric Cooperative, an electric power supplier, and Virginia Electric & Power Co. proposed construction of a $1.2 billion, 786-megawatt coal-fired powerplant at Clover. The plant was designed to use a liquid scrubber emissions-control system and pulverized coal-burning technology. Research by the joint venture and information provided by the Virginia Center for Coal and Energy Research resulted in the decision to use coal as the fuel source because of long-term availability and accessibility of that commodity.[3]

Virginia produced about 46.5 million short tons of coal, according to the DMME. Nationally, Virginia ranked seventh in coal production and has reported an increase in output each year since 1984, except for 1989.

The Division of Mineral Resources (DMR) of the DMME published an updated version of its 1988 directory of nonfuel mineral producers and processors.[4]

In 1990, nine occurrences of precious metals in Virginia were reexamined by the DMR. Metal mining companies remained sporadically interested in the gold-pyrite belt in the Virginia Piedmont province and in the mineralized areas in the Blue Ridge province. A summary of the investigation was scheduled for publication in 1991.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Virginia was one of the top States in the Nation in the variety of minerals produced. Overall, the nonfuel minerals produced in Virginia (listed in table 1) can be generally categorized in three ways. Construction aggregates, which include crushed stone and sand and gravel, were produced at almost 200 operations in 1990. These two commodities accounted for about 75% of State's value of mineral production and were mined by at least 1 company in 77 of Virginia's 96 counties and 5 cities, according to data reported to the U.S. Bureau of Mines.

Another part of Virginia's mineral industry produced bricks, cement, and lime at 19 plants. Common clays and shale were mined in 12 counties, and the State's brick industry had the capacity to produce 500,000 bricks per year. These industries combined to account for about 15% to 25% of Virginia's value of nonfuel mineral production.

The third and most diverse part of Virginia's mineral industry included nine commodities, and these were mostly mined at one operation. Some of the mines were the only ones in the United States that produced these minerals. Virginia was the sole State producing aplite and kyanite and one of three mining vermiculite. Fuller's earth, gypsum, industrial sand, and soapstone were each produced by one company in Virginia. Iron oxide pigments were mined at two operations and dimension stone at three quarries.

Clays and Shale.—Output of clays and shale declined by about 12% as demand for brick used in residential and commercial building construction slowed in 1991. Late in the year, Virginia Clay Co. Inc. began preparations for submitting permit applications to mine fuller's earth in King William County. In 1990, fuller's earth was mined in King and Queen County.

Lime.—Nationally, Virginia ranked eighth in lime production, accounting for about 5% of the U.S. output. A very limited breakdown on end-use patterns for lime produced in Virginia is given in table 2. This data is limited in order to maintain the confidentiality of company proprietary data.

One change in the end use for lime produced in Virginia has been the decline in the consumption of lime by the steel industry. In 1980, when the State produced a comparable amount of lime, the segment of the steel industry using basic oxygen furnaces consumed about 186,000 tons of lime. In 1990, that same segment of the steel industry used about 75,000 tons of lime. The decrease in production of lime used by the steel industry, however, has been, for the most part, regained through expanding markets for lime used in environmental applications.

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 1988 and 1990 and estimates for 1989.

Virginia 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 1990 of 13.1 million short tons was the highest in Virginia since 1974. During the year, 45 companies operated 78 pits; in 1988, 50 companies operated 72 pits. About 90% of the production came from District 3 in the western part of Virginia.

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 1988 and 1990 and actual data for 1989.

Output of 59.4 million short tons in 1990 was the fourth highest in State history but about 7% lower than that in 1989. Crushed stone was again the State's leading mineral commodity accounting for almost 65% of Virginia's total nonfuel value. Nationally, the State ranked fifth in output of crushed stone.

During the year, a new quarry was opened in Mecklenburg County. Mecklenburg Rock Inc. began producing

crushed granite at a 40-acre site near South Hill. Stone had last been quarried in this county in 1961.[5]

Agglite Corp. opened a lightweight aggregate facility in Chesapeake. The aggregate was manufactured from a mixture of fly ash, surfactant foam, dry catalyst, accelerators, and cement.[6] Fly ash was obtained from the Virginia Power Co., which operated a coal-fired powerplant adjacent to Agglite's plant.

Some plans by the crushed stone industry to develop quarries were denied in 1990. Culpepper Stone Co. Inc. was denied a permit to operate a quarry near Hartwood by Stafford County government officials. In Caroline County, government officials denied Solite Corp.'s request for rezoning 20 acres of land next to its quarry, thus preventing the company from expanding its operation. Vulcan Materials Co. continued to seek permission to open a quarry in Gainesville, Prince William County. The firm had initially sought permission in 1986.

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[1]State Mineral Officer, U.S Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related and government experience and has covered the mineral activities in Virginia for 6 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]Rual Living. Coal: Fuel of Choice. V. 47, No. 1, Nov. 1990, pp. 18-21.

[4]Sweet, P. C., and G. P. Wilkes. Directory of the Mineral Industry in Virginia—1990. VA Div. of Miner. Resour., 1990, 36 pp.

[5]The South Hill (VA) Enterprise. Mar. 28, 1990, p. 1.

[6]Rock Products. Cement + Ash = Aggregate. V. 93, No. 8, Aug. 1990, pp. 53-55.

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

Use	1989		1990	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Acid water neutrilization	67,217	2,061	W	W
Paper and pulp	166,150	8,292	W	W
Steel, basic oxygen	93,369	4,670	74,893	3,448
Steel, electric	W	W	W	W
Other[1]	493,945	23,330	771,557	36,336
Total	820,681	38,353	846,450	39,784

W Withheld to avoid disclosing individual company proprietary data; included with "Other."
[1]Includes, agriculture, alkalies(1989), citric acid(1989), ladle desulfurization, mason's lime, ore concentration, other chemical and industrial, precipitated calcium carbonate, road stabilization, sewage treatment, water purification, tanning and uses indicated by symbol W.

TABLE 3

VIRGINIA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	1,570	$7,653	$4.87
Plaster and gunite sands	169	1,042	6.17
Concrete products (blocks, bricks, pipe, decorative, etc.)	97	310	3.20
Asphaltic concrete aggregates and other bituminous mixtures	681	2,905	4.27
Road base and covering	282	1,556	5.52
Fill	2,284	5,055	2.21
Snow and ice control	46	135	2.93
Other[1]	379	2,190	5.78
Unspecified:[2]			
Actual	7,173	27,126	3.78
Estimated	415	977	2.35
Total or average	13,096	[3]48,950	3.74

[1]Includes roofing granules.
[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.

TABLE 4

VIRGINIA: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, BY USE AND DISTRICT

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	184	1,197	17	82	1,370	6,374
Plaster and gunite sands	W	W	—	—	164	1,006
Concrete products (blocks, bricks, etc.)	—	—	—	—	97	310
Asphaltic concrete aggregates and road base and coverings[1]	312	1,670	80	184	2,856	7,662
Snow and ice control	W	W	22	59	W	W
Other miscellaneous[2]	40	270	24	85	342	1,948
Unspecified:[3]						
Actual	234	901	—	—	6,939	26,225
Estimated	—	—	18	35	397	942
Total	[4]769	4,038	161	445	12,165	44,467

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes fill.
[2]Includes roofing granules and 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.

TABLE 5
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Aplite:			
The Feldspar Corp.	Route 1, Box 305 Montpelier, VA 23192	Quarry and plant	Hanover.
Cement:			
Masonry:			
Riverton Corp.	Box 4004 Front Royal, VA 22630	do.	Warren.
Portland:			
Tarmac Mid-Atlantic Inc.[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.
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.
Virginia 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	Charles City, 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	do.	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	Amherst, Augusta, Bedford, Bland, Botetourt, Campbell, Greensville, Henry, Nelson, Tazewell.
Luck Stone Corp.	Box 29682 Richmond, VA 23229	do.	Albemarle, Augusta, Fairfax, Fauquier, Goochland, Greene, Loudoun, Nottoway, Rockingham.
Tarmac Mid-Atlantic Inc.	Box 34527 Richmond, VA 23234	do.	Chesterfield, Dinwiddie, Henrico.
Vulcan Materials Co., Mideast Div.	Box 1590 Manassas, VA 22110	do.	Brunswick, Fairfax, Fauquier, Halifax, Henrico, Prince William, Pittsylvania, Stafford.
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.

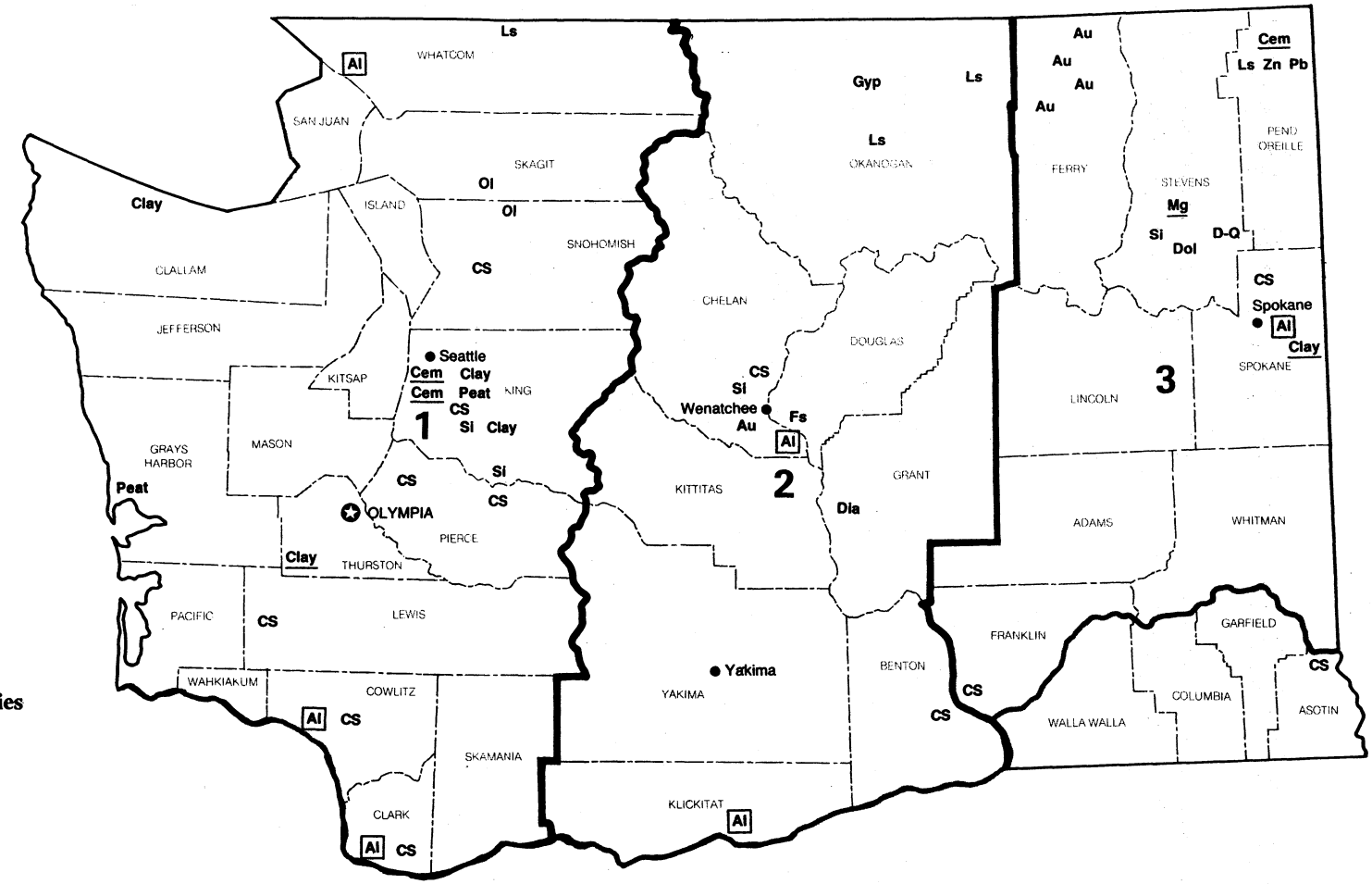
WASHINGTON

LEGEND

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

MINERAL SYMBOLS

Al	Aluminum plant
Au	Gold
Clay	Clay
CS	Crushed Stone
D-Q	Dimension Quartzite
Dia	Diatomite
Dol	Dolomite
Fs	Ferrosilic
Gyp	Gypsum
Ls	Limestone
Mg	Magnesium metal plant
Ol	Olivine
Pb	Lead
Peat	Peat
Si	Silica
Zn	Zinc



Principal Mineral-Producing Localities

THE MINERAL INDUSTRY OF WASHINGTON

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, 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] and N. L. Joseph[2]

Nonfuel mineral production value in Washington dropped to $473 million in 1990, a decrease of almost 2% from that of 1989, according to the U.S. Bureau of Mines. Decreases in the production value of portland cement, lime, magnesium metal, and crushed stone more than offset gains in the value of gold and construction sand and gravel. Construction sand and gravel was the leading commodity in terms of value, followed by gold, magnesium metal, portland cement, and crushed stone.

Washington ranked 23d in the Nation in nonfuel mineral production value in 1990 compared with 21st in 1989.

TRENDS AND DEVELOPMENTS

With the opening of a major gold project, the aggregated production value of Washington's metallic minerals--gold, magnesium metal, and silver--increased by more than 4% from that of 1989. Metallic minerals accounted for 46% of the State's nonfuel mineral production value in 1990, a small increase from that of 1989. Four metal mines at three operations were reported in production, with gold and silver the primary commodities. In northeast Washington, work continued on reopening two properties, a gold mine and a zinc-lead mine. In addition to the active exploration normally seen for precious metals, there were increased efforts in the search for base metals, primarily lead and zinc deposits in the Metaline Formation in Stevens and Pend Oreille Counties.

With the closure of a cement plant contributing to the decline, the production value of industrial minerals dropped 6% from that of 1989. Construction materials--portland cement, construction sand and gravel, and crushed stone—accounted for more than 46% of the State's total nonfuel mineral production value. Excluding sand and

TABLE 1
NONFUEL MINERAL PRODUCTION IN WASHINGTON[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland)	thousand short tons	979	$48,233	W	W	W	W
Clays	metric tons	376,924	2,235	233,267	$1,591	158,257	$1,357
Gemstones		NA	200	NA	208	NA	281
Gold	kilograms	W	W	W	W	9,620	119,671
Peat	thousand short tons	5	142	W	W	W	W
Sand and gravel (construction)	do.	31,170	94,402	e37,800	e124,700	40,251	133,067
Stone:							
Crushed	do.	e13,900	e48,700	13,259	55,624	e12,700	e41,900
Dimension	short tons	e697	e60	W	W	W	W
Combined value of calcium chloride (natural, 1988), cement (masonry), diatomite, gypsum (crude), lime, magnesium metal, olivine, sand and gravel (industrial), silver, and values indicated by symbol W		XX	265,362	XX	298,756	XX	176,953
Total		XX	459,334	XX	480,879	XX	473,229

eEstimated. 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).

gravel, 17 companies produced industrial minerals from 23 sites during 1990, according to the Washington Division of Geology and Earth Resources (DGER).

EMPLOYMENT

The State's mining industry employment increased by almost 6% over that of 1989. According to the State of Washington Employment Security Department, average mining and quarrying employment rose to 3,800 workers from the 3,600 workers recorded in 1989. Employment in the State's primary metals industry fell to 13,100 in 1990, a modest decline from that of 1989. Continued strength in the aluminum smelting sector was reflected in its employment numbers--8,900 workers by yearend, unchanged from that of 1989.

REGULATORY ISSUES

Del Hur Industries of Port Angeles completed the second year of its 3-year, $3.1 million U.S. Forest Service contract to clean up the extensive tailings pile at the former Holden Mine in Chelan County. The mine, near Holden Village, was operated by the Howe Sound Mining Co. and produced copper and some silver, gold, and zinc between 1939 and 1957; the tailings were leased to Red Butte Resources Ltd. High above Lake Chelan, the remote area can only be reached by boat and then a steep, winding mountain road. The project included revegetation and the placement of riprap along a creek. The property is now owned by a nearby Lutheran Church retreat.

A final cleanup plan was selected for the abandoned Silver Mountain Mine near Loomis, Okanogan County. Reportedly, it includes placing a clay and soil cap over the contaminants, fencing the area, closing the mine entrance, installing a new animal water supply well, and monitoring the ground water for 2 years. The remote silver and gold mine was northcentral Washington's only Superfund (Comprehensive Environmental Response, Compensation, and Liability Act of 1980) site.

ASARCO Incorporated continued the cleanup of several arsenic-contaminated areas in Rushton, Pierce County. The Superfund site was contaminated by Asarco's former copper smelter in Rushton, but is often referred to as the Tacoma smelter.

EXPLORATION ACTIVITIES

Exploration continued at a strong pace, especially in the northeastern part of the State. According to the DGER, more than 70 companies and individuals explored for metals in Washington in 1990. Although precious metals were the primary target, stable base metal prices led to increased exploration for copper, lead, and zinc throughout the State.

In Okanogan County, Battle Mountain Gold Co. drilled the Crown Jewel deposit on the Buckhorn Mountain gold property, 3 miles east of Chesaw, after it purchased an option to acquire a 51% interest from Crown Resources Corp. Detailed metallurgical testing and environmental studies were conducted. The deposit contains two main zones, the Gold Bowl and the Gold Axe, and would be developed as an open pit. Also on Buckhorn Mountain, Battle Mountain conducted geophysical and geochemical surveys on the Crystal Butte property, which is owned by Keystone Gold Inc. and Orvana Resources Corp.

Also in Okanogan County, Crown Resources and Echo Bay Exploration continued to explore near Strawberry Lake, west of Chesaw; Crown Resources also drilled at the Molson Gold property south of Molson and, in a joint venture with Cambior USA Inc., explored the Ida property. In addition, Kennecott Exploration Co. and Westmont Mining Inc. drilled on their properties near Manhattan Mountain, and FMC Gold Co. conducted exploration at the Poland-China deposit. After evaluation, Vanderbuilt Gold Co. decided against developing an open pit copper and molybdenum mine northeast of Mazama. In 1989, Vanderbuilt optioned the Flagg Mountain property from owner Quintana Minerals Corp. Wilbur Hallauer explored the Starr Molybdenum porphyry on Aeneas Mountain west of Tonasket, drilled the Kelsey property, and sunk a hole at the Cecile Creek property on Douglas Mountain. Others reported in the area included Sunshine Valley Minerals Inc., ECM Inc., and Northwest Minerals Corp.

In Stevens County, Orient Mining Co., a joint venture of Boise Cascade Minerals Corp. and Pathfinder Gold Corp., continued to explore the First Thought Mine. The partners also drilled their McNally property; acquired property rights from Limestone Creek to Flat Creek, including the Easter Sunday and Big Iron Mines; explored the Fifteen Mile Creek property; and sampled their Gold Hill and Toulou Mountain properties. Bitterroot Resources Ltd. acquired a lease and option to purchase the mineral rights of Washington Resources Partnership and Grandview Mining Co. in the Northport Mining District. The district includes the former Calhoun, Deep Creek, Iroquois, Scandia, and Sherlock zinc-lead mines. Bitterroot then optioned interest in its holdings to Northport Minerals Ltd., which owns the 1,500-ton-per-day Calhoun mill. The mill is sited in the middle of Bitterroot's holdings and was last operated by Combustion Engineering in 1984. Silver Hill Mines Inc. reported it purchased the Young America lead-zinc mine, 15 miles north of Kettle Falls; the mine last operated in 1954. Others conducting exploration in the county included Battle Mountain Gold, Echo Bay, Gold Fields Mining Corp., Kennecott Exploration, Newmont Exploration Ltd., and Placer Dome U.S. Inc.

Raven Hill Mining Co. explored two properties in Pend Oreille County. At the Cooks Copper property, the company conducted a surface exploration program, with silver and copper the target; some preliminary development work, including laying track, ramp building, and dewatering, was reportedly done at its Glass Mountain Mine. Also in the county, Bitterroot Resources acquired an option on the former Grandview zinc-lead mine adjacent to Resource Finance

Corp.'s Pend Oreille Mine near Metaline Falls.

In Ferry County, Echo Bay initiated a drilling project at the Lamefoot prospect east of Curlew Lake. The company also drilled at the Lake, Oz, and Middlefork properties. Inland Gold and Silver Corp., in a joint venture with Pegasus Gold Inc. and N.A. Degerstrom Inc., explored the Leland property near Echo Bay's Overlook Mine. The joint venture of Crown Resources and Sutton Resources Inc. drilled the South Penn deposit and at the Seattle Mine; also, in a joint venture with Cambior, Crown Resources explored the Mount Elizabeth property.

In the Wenatchee Heights area of Chelan County, the joint venture of Asamera Minerals (U.S.) and Breakwater Resources Ltd. continued to drill its Wenatchee Gold Project. Near Wenatchee, Safeguard Ventures Inc. and Consolidated Ramrod Gold Corp. agreed to evaluate the Neel-Jacobsen Prospect. In the Liberty area of Kittitas County, American Copper and Nickel Co. leased and staked a large claim block and conducted an exploration program, Battle Mountain Gold worked Mill Creek, and Crown Resources drilled in the Williams Creek drainage.

In Whatcom County, after conducting a drilling program, FMC Gold dropped an option with owner Steelhead Resources to enter into a profit-sharing agreement on the Excelsior gold and silver property.

Exploration for industrial minerals focused on lump silica, talc, and clay. United Catalyst Inc., in a joint venture with First Mississippi Gold Corp., explored for talc in Pend Oreille County. The company submitted a plan of operation to the U.S. Forest Service. Basic Resources Corp. continued to bulk sample and test for nonswelling bentonite at its Rock Top property in Grant County.

LEGISLATION AND GOVERNMENT PROGRAMS

DGER reported that total revenue to the State from prospecting, mining, and quarrying on State lands was $827,989 for the fiscal year ending June 30, 1990. This represented a 20% increase from the 1989 total and included a 26% increase in payments from sand and gravel operations. Additional revenues of $238,835 were received from mineral activity on Washington's aquatic lands.

The Mining and Mineral Resources Institute of the University of Washington, Seattle, received an allotment of $58,000 from the U.S. Bureau of Mines in 1990. The school has received a total of $1.77 million since inception of the Mineral Institute Program in 1978.

The U.S. Bureau of Mines Spokane Research Center (SRC) continued its leadership in metal mine design technology using finite modeling in conjunction with in situ mine monitoring. The solution of complex problems in mine layout, stope design and sequencing, shaft pillar stability, rock burst control, and ground control using flexible tendons has provided industry with the necessary tools to improve the safety and economics of mining. SRC research into innovative mining techniques led to the conceptual design of two new mining methods. "Spiral Mining" and "Conical Caving" concepts are being investigated as alternative methods for the industry to mine difficult and lower grade mineral deposits.

SRC's automation research is focusing on developing enabling technologies for the eventual full automation of roof support installation. A key segment of this research, the "Smart Roof Drill," was successfully tested underground in prototype form. This system, which was mounted on a standard roof bolter, automatically senses and records drilling parameters, which are used to help determine roof conditions and anchorage zones more accurately. Research in mine waste management dealt with issues such as developing new mining methods for improving resource recovery, assessing the environmental impacts associated with surface mining wastes and mine waste backfill, and investigating alternatives to surface waste disposal practices and remediations.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Calcium Chloride.—Washington was one of two States reporting synthetic calcium chloride production. Occidental Chemical Corp. in Tacoma, Pierce County, manufactured synthetic calcium chloride using hydrochloric acid and limestone barged in from British Columbia, Canada. Output fell by 3% in quantity and almost 6% in value from that of 1989.

Cement.—The production of portland cement in Washington decreased 28% in quantity and 15% in value from that of 1989. The State accounted for a modest amount of masonry cement production, which also dropped slightly in quantity and value.

La Farge Corp. closed its 200,000-ton-per-year portland cement plant in Metaline Falls, about 30 miles south of the Canadian border in Pend Oreille County, citing higher than expected costs to renovate and modernize the 80-year-old facility. La Farge bought the plant, the only cement plant that used stone mined in Washington, and three distribution terminals, including Spokane and Tri-Cities locations, from Lehigh Portland Cement Co. in 1989.

In 1990, Ideal Basic Industries Inc. merged with the U.S. subsidiary of Holderbank Financiere Glaris Ltd. to become Holman Ideal Inc. Holman Ideal produced portland cement at its wet-process facility in Seattle, King County. The company barged limestone to its plant site from Texada Island, British Columbia, and used clay from its Twin River quarry in Clallam County.

Also in King County, Ash Grove Cement West Inc. mined silica from the Superior Quarry, operated a grinding facility, and maintained a bulk cement distribution center from which it sold portland cement. The company began building a new state-of-the-art portland cement plant in the Puget Sound area. The facility was scheduled to begin

production of Types I and II portland cement in mid-1992.

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. Portland cement was used by ready-mix concrete companies (66%), concrete product manufacturers (10%), other contractors (8%), building material dealers, highway contractors, government agencies (7%), and miscellaneous customers (9%).

The cement plants used a mix of natural gas, fuel oil, and bituminous and anthracite coal for fuel; electricity also was purchased for energy. Raw materials consumed included aluminum dross, clay, gypsum, iron ore, limestone, and sand.

Clays.—Total clay production reported was down more than 32% in quantity and value fell almost 14% from that of 1989. Common clay production was reported by four companies from five pits in four counties, with Clallam County accounting for the bulk of the output. Reported production for the State fell more than 31% in quantity and 11% in value from that of 1989. Compared with 1989, when fire clay production was reported from three pits in two counties, there was no reported production in 1990.

Mutual Materials Co. was the State's largest producer. A large part of the company's production came from two pits in King County, with lesser amounts from pits in Pierce and Thurston Counties. Interpace Industries Inc. sold its clay pit and brick plant near Mica, Spokane County, to Mutual Materials. The plant and gas-fired kiln were modernized in 1987. Holman Ideal, formerly Ideal Basic Industries, mined its Twin River quarry west of Port Angeles in Clallam County, the largest clay pit in the State. The clay was barged to Holman Ideal's cement plant at Seattle for the production of portland cement. Other clay producers included Moulden & Sons Inc., which operated a pit in King County, and the Hidden Brick Co. in Clark County.

Diatomite.—The quantity of diatomite production fell almost 13%, but value remained unchanged from that of 1989. Washington was the third highest valued producing State in the Nation. After opening a new pit in the Frenchman Hills area, the Inorganic Specialties Div. of Witco Corp. produced diatomaceous material from a total of three pits in Grant County. The diatomaceous earth was processed and calcined at the company's plant in Quincy. The bulk of the diatomite was used for filtration, with a modest quantity consumed as mineral filler. Witco expanded equipment in order to take advantage of the growing plastics market.

Gypsum.—Washington's production of crude gypsum was unchanged in both quantity and value from that of 1989. Crude gypsum was mined by Agro Minerals Inc. from the State's only gypsum mine near Tonasket, Okanogan County. Agro Minerals has mined gypsite from small saline lake bottoms since 1948; the dried and sized product is used as a soil conditioner. James Hardie Gypsum in Seattle and Domtar Gypsum America Inc. at Tacoma reported calcined gypsum production in 1990.

Lime.—Although Washington's lime production rose by more than 7% in quantity, value dropped by 22% from that of 1989. Northwest Alloys Inc., the State's largest producer, produced quicklime as a byproduct of magnesium metal production at a plant in Addy, Stevens County. Quicklime and hydrated lime were produced by The Tacoma Lime Div. of Continental Lime Inc. at its Tacoma plant in Pierce County.

Olivine.—Washington ranked second in the Nation for olivine production, which rose slightly in quantity and more than 28% in value from that of 1989. Olivine products were produced by two companies. In Whatcom County, Olivine Corp. continued to mine and mill fresh, unaltered olivine from the Swen Larsen quarry in the Twin Sisters dunite. The company used part of the production to fabricate modular refractory slabs for waste incinerators. Olivine Corp. also sold olivine to Applied Industrial Materials (AIMCOR), which processed the material at its plant near Hamilton, Skagit County. AIMCOR sold the refined product for use as foundry and blasting sands both domestically and as an export to South America and Pacific Rim countries.

Peat.—The quantity of Washington's peat production was unchanged, but the value dropped almost 3% from that of 1989. Two companies--Bonaparte Peat in Okanogan County and Chrystel Soils in Grays Harbor County--reported production of sold-in-bulk peat.

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 1988 and 1990 and estimates for 1989.

The State was the fifth largest producer of construction sand and gravel in the Nation in 1990. Production increased by more than 6% in quantity and by almost 7% in value from that estimated for 1989 and 29% in quantity and 41% in value from that surveyed in 1988. The bulk of the output came from the aggregate-rich, ice-margin deposits in the Puget Sound region of Clark, King, Pierce, and Snohomish Counties and from late Wisconsin Lake Missoula flood deposits near Spokane. Of 39 counties, 30 had 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 almost 78% of the surveyed output. Major uses were for fill (21%), concrete aggregates, including concrete sand (15%), and road base and coverings (14%). Table 3 presents end-use data for

construction sand and gravel produced in the three Washington districts.

Industrial.—The production of industrial sand and gravel fell 6% in quantity, but the value remained essentially unchanged from that of 1989. 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, cement-grade silica was mined by L-Bar Products Inc. from the Ravensdale pit and by Ash Grove Cement from its Superior quarry.

Surveyed results showed industrial sand and gravel mined in Washington was primarily used for glass containers (43%), flat-glass manufacture (16%), sandblasting (11%), cement manufacture (10%), and fiberglass (8%).

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 1988 and 1990 and actual data for 1989.

Crushed.—The estimated production of crushed stone in Washington dropped more than 4% in quantity and by almost 25% in value from that surveyed in 1989. In 1989, crushed stone production was reported in 36 of the State's 39 counties, with traprock accounting for the bulk of the output.

Dimension.—Estimated production of dimension stone in Washington in 1990 increased more than twice in quantity and 4.5 times in value from that surveyed in 1989.

Sulfur (Recovered).—While total value remained essentially unchanged, the quantity of sulfur produced in Washington increased more than 22%. 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 increased almost 3% in quantity, but dropped almost 14% in value from that of 1989. The State's seven aluminum smelters, in aggregate, operated at near total annual rated capacity of 1,231,000 metric tons of aluminum ingot. Prices, which averaged $1.10 per pound in 1988 and 88 cents per pound in 1989, fell to an average of 74 cents per pound in 1990. Washington was the Nation's largest aluminum producer. Reported production was more than three times that of any other State and accounted for more than 30% of the Nation's total output.

With a total rated capacity of 274,000 metric tons per year, Kaiser Aluminum & Chemical Corp., a division of MAXXAM Inc., was the State's largest producer. The company operated plants 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. The plant, the company's largest, has eight potlines with a total rated capacity of 220,000 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.

Intalco Aluminum Corp., a subsidiary of Alumax Inc., operated the largest single plant, with a rated capacity of 260,000 metric tons per year, in Ferndale, Whatcom County. In late June, the Aluminum Co. of America (Alcoa) restarted a potline at its Chelan County smelter that was shut down in August 1989. The potline was one of five operated by Alcoa at its plant south of Wenatchee and returned the plant to its 220,000-ton-per-year rated capacity. Reportedly, the potline was shut down because of low aluminum prices and a lag time in the plant's variable power rates.

Washington's other aluminum smelters, by order of rated capacity, were 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.

Arsenic.—Asarco shipped byproduct arsenic trioxide from stock at its closed Tacoma copper smelter. The smelter, permanently shut down in 1985, had been the only domestic processor of high-arsenic copper concentrate. In 1990, shipments of arsenic from the stockpile approximately doubled in quantity and value from that reported in 1989.

Gold and Silver.—Three lode mines in Ferry County, two at the new Kettle River gold project and one mine in Chelan County, reported production in 1990. With the new mines, total gold production increased by more than 40% in quantity and rose 42% in value from that of 1989. For 1990, the State's ranking for gold production rose to sixth from seventh place nationally. Silver output was reported at two properties, a byproduct of gold production. The production of silver dropped more than 5% in quantity and fell almost 16% in value from that of 1989.

Echo Bay Minerals Co. began production at its Kettle River gold project north of Republic, Ferry County. After beginning construction in 1989, Kettle River's first dore bar was poured in February. The project, which includes both the Kettle and Overlook underground mines, is a joint venture of Echo Bay, with a 70% interest, and Crown Resources Corp., with Echo Bay as the operator. The Overlook deposit, which contains the majority of the reserves, is about 11 miles northeast of Republic. A modified room-and-pillar method was used at the mine, and a decline ramp system accommodates rubber-tired vehicles. The Kettle Mine, approximately 1 mile west of Curlew, was also accessed by a decline ramp system. About 2.5 miles south of the Overlook Mine, Echo Bay constructed the

1,500-ton-per-day Key mill, which was used to recover gold and silver from both mines. The plant contains a carbon-in-pulp vat-leach system and uses a zinc precipitation (Merrill-Crowe process) to recover the precious metals. Other areas on the property being evaluated for potential production include the Key East and Key West. Echo Bay reported encouraging results from drilling at it Lamefoot property, a gold deposit east of Curlew Lake.

In Chelan County, Asamera Minerals operated the Cannon Mine, a joint venture with Breakwater Resources, at Wenatchee. The operation was the largest gold mine in the State and the second largest underground gold mine in the Nation; the mine also produced silver. Asamera Minerals, a subsidiary of Gulf Canada Resources Ltd., conducted an ambitious underground and surface exploration program, including a search for new reserves in the Wenatchee Heights and Squilchuck areas, west and northwest of the current operation.

Hecla Mining Co. operated its Republic Unit (Knob Hill), an underground gold and silver mine, at Republic, Ferry County; the mine was Washington's top-ranked silver producer. The main production shaft, Knob Hill No. 2, was used to remove ore primarily from the Golden Promise vein system. The company employed a cut-and-fill mining method and underground rail haulage to transport the ore from the Golden Promise area to the shaft. Once on the surface, the ore was hauled by truck to the 270-ton-per-day Republic mill where gold and silver were recovered. As part of Hecla's Republic Accelerated Development program, almost 6,500 feet of a new decline and a number of drifts were developed. The decline will allow the company to use rubber-tired production and haulage equipment underground and will provide a low-cost method for bringing ore to the surface. Using a three-stage carbon column circuit that was installed in 1989, Hecla also recovered residual gold from its tailings pond. Hecla continued to explore its Golden Eagle property, about one-half mile northwest of the Republic Unit mill.

The joint venture of N. A. Degerstrom Inc. and Gold Express Inc. was in the process of acquiring permits for its Gold Mountain Mine south of Danville, Ferry County. The former Gold Dike property was operated by Vulcan Mining Inc. until 1988. Plans included enlargement of the original open pit, expansion onto the adjacent Gold Hill property owned by Sundance Mining and Development Inc., and construction of a new heap-leach pad.

Magnesium Metal.—Magnesium metal production in Washington dropped more than 15% in quantity and more than 21% in value from that of 1989. The State ranked third nationally in production of the metal.

Northwest Alloys Inc., a wholly owned subsidiary of Alcoa, produced magnesium metal from locally mined dolomite at its plant in Addy, Stevens County. The plant employed a silicothermic process using ferrosilicon and aluminum-quartzite flux. Reportedly, two-thirds of the magnesium metal was used by Alcoa in the production of aluminum alloys and the remainder sold on long-term contract for uses that included desulfurizing steel.

Northwest Alloys sold its process waste sludge to L-Bar Products Inc., which produced fertilizer and magnesium granules from the sludge at its plant near Chewelah, Stevens County.

Silicon.—Silicon Metaltech Inc. completed repairs on one of three arc furnaces at its silicon plant at Rock Island in Douglas County. Raw material for the plant was obtained from the company's quartzite mining operation in British Columbia, Canada. Markets for the silicon included the domestic aluminum industry and manufacturers of adhesives and caulks; ferrosilicon was sold to the iron and steel industry. Silica fume produced during the production of silicon metal and ferrosilicon was sold as a strengthener for concrete products.

Union Carbide Corp. sold its polysilicon plants in Moses Lake, Grant County, and Washougal, Clark County, to Komatsu Electronic Metals Co. Ltd. (KEM) of Japan. The name of the new company is Advanced Silicon Materials Inc. Reportedly, KEM was the company's largest polysilicon customer and had exclusive rights to market Union Carbide silicon product in India, Japan, Korea, and Taiwan. Polysilicon was used in the manufacture of silicon wafers for computer chips and other electronics.

Zinc and Lead.—Equinox Resources Ltd. began mine development and renovation of the 1,100-ton-per-day mill at its Van Stone zinc-lead mine in Stevens County. The company completed construction of a new tailings pond and planned to be in production in 1991. Equinox purchased the mine in 1990 from Callahan Mining Co., U.S. Borax and Chemical Corp., and Brinco Ltd.; it was last operated by Asarco in 1971. Equinox conducted a feasibility study that included underground drilling, mine design, environmental studies, and permitting. Reportedly, Cominco Ltd. provided financial support for the study. The Van Stone Project is 25 miles south of Cominco's Trail, British Columbia, zinc smelter, and an agreement was reached whereby the concentrates would be shipped to Trail. Plans call for mining the deposit as an open pit for the first 2 years and then as an underground operation for the next 5 years.

Based on the results of a diamond drilling program and feasibility study, Resource Finance Inc. (RFC) exercised an option to purchase the Pend Oreille Mine from Pintlar Corp., a wholly owned subsidiary of Gulf Resources & Chemical Corp. The company has been pumping water from the former zinc and lead producer, 4 miles north of Metaline Falls in Pend Oreille County. RFC conducted an underground exploration program that targeted the Yellowhead zone, the lowest of two mineralized zones previously mined, and was working to acquire the permits necessary to reopen the property.

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[1]State Mineral Officer, U.S. Bureau of Mines, Spokane, WA. He has 16 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, Washington Division of Geology and Earth Resources, Spokane, WA.

TABLE 2

WASHINGTON: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	6,185	$22,890	$3.70
Plaster and gunite sands	69	218	3.16
Concrete products (blocks, bricks, pipe, decorative, etc.)	505	1,289	2.55
Asphaltic concrete aggregates and other bituminous mixtures	2,936	10,796	3.68
Road base and coverings[1]	5,486	18,614	3.39
Fill	8,651	18,434	2.13
Snow and ice control	201	691	3.44
Railroad ballast	132	585	4.43
Other[2]	972	3,828	3.94
Unspecified:[3]			
Actual	11,673	44,933	3.85
Estimated	3,440	10,789	3.14
Total or average	[4]40,251	133,067	3.31

[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.

TABLE 3

WASHINGTON:[1] SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, 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)	5,504	20,961	374	1,185	307	744
Plaster and gunite sands	W	W	W	W	—	—
Concrete products (blocks, bricks, etc.)	W	W	—	—	W	W
Asphaltic concrete aggregates and other bituminous mixtures	2,474	9,123	239	966	223	708
Road base and coverings[2]	4,520	15,525	373	1,356	557	1,618
Fill	8,553	18,121	85	295	13	18
Snow and ice control	107	321	73	311	21	59
Railroad ballast	W	W		W	—	—
Other miscellaneous[3]	982	3,241	53	100	643	2,579
Unspecified:[4]						
Actual	6,340	24,496	774	3,449	1,753	7,732
Estimated	2,749	8,789	449	1,321	243	679
Total[5]	31,229	100,578	2,419	8,982	3,760	14,137

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Excludes 2,842,309 short tons valued at $9,371,042 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.

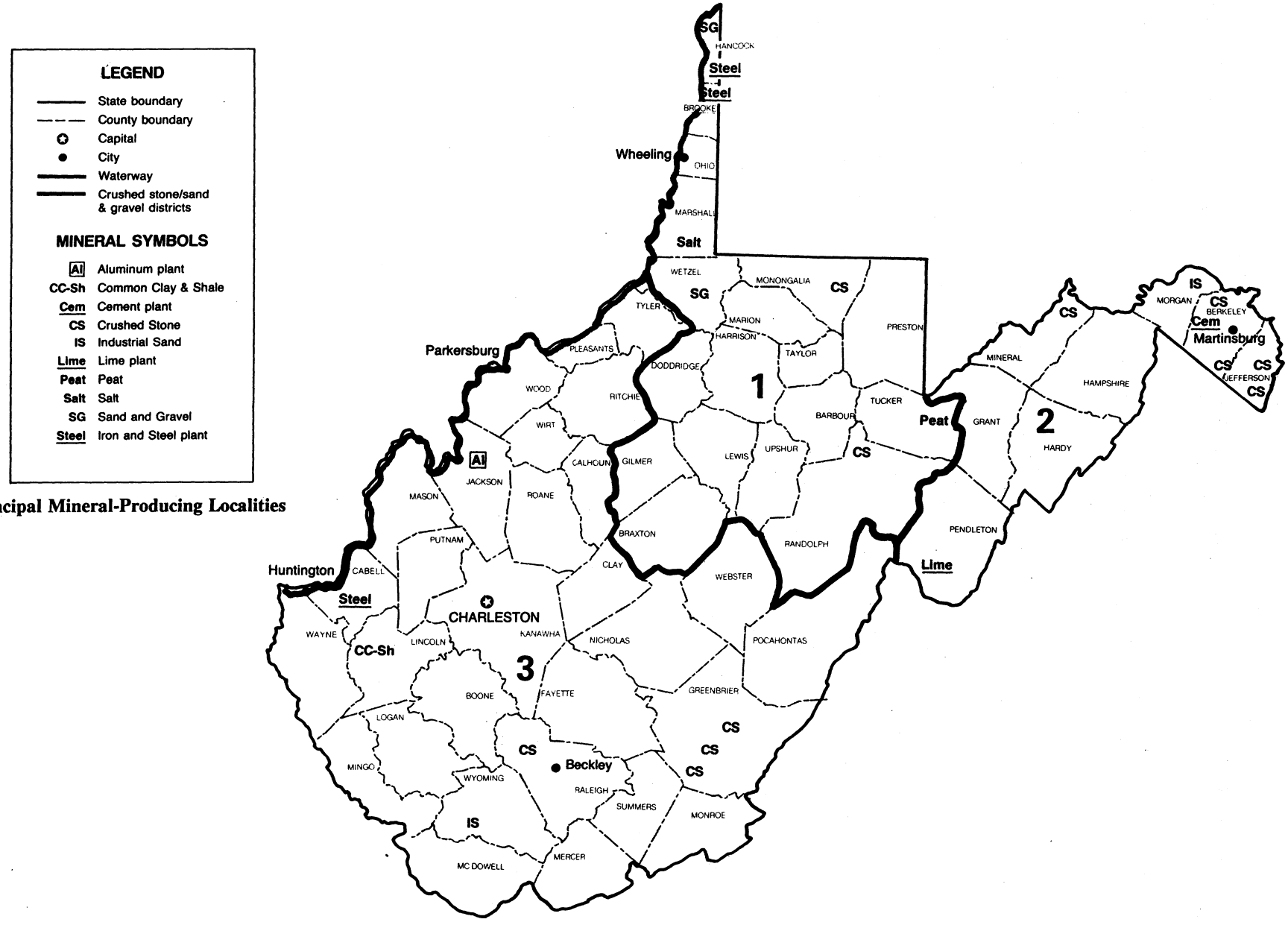
TABLE 4
PRINCIPAL PRODUCERS

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.	5550 SW Macadam Ave. Suite 300 Portland, OR 97201	do.	King.
Holman Ideal Inc.	Box 8789 Denver, CO 80201	do.	Do.
Clays:			
Holman Ideal Inc.	Box 8789 Denver, CO 80201	Pit	Clallam.
Mutual Materials Co.	Box 2009 Bellevue, WA 98009	Pits and plant	King and Pierce.
Diatomite:			
Inorganic Specialities, a division of Witco Corp.	520 Madison Ave. New York, NY 10072	Mine and plant	Grant.
Gold:			
Asamera Minerals (U.S.) Inc.	2100, 144 4th Ave., SW Calgary, AB T2P 3N4 Canada	Underground mine and mill	Chelan.
Echo Bay Minerals Co.	921 Fish Hatchery Rd. Republic, WA 99166	do.	Ferry.
Hecla Mining Co.	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	do.	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:			
Northwest Alloys Inc.	Box 138A, Route 1 Addy, WA 99101	Mine and plant	Stevens.
Olivine:			
AIMCOR	Box 58 Hamilton, WA 98225	do.	Skagit.
Peat:			
Bonaparte Peat	Aeneas Route, Box 5 Tonasket, WA 98855	Bog	Okanogan.
Chrystel Soils	Ocean City, WA 98569	Bog	Grays Harbor.

TABLE 4-Continued
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Construction:			
Central Pre-Mix Concrete Co.	Box 3366 Spokane, WA 99220	Pits	Franklin, Spokane, Yakima.
Lakeside Industries	Box 967 Issaquah, WA 98027	do.	King, Lewis, Thurston.
Lone Star Northwest Aggregates	6320 Grandview Dr., W Tacoma, WA 98467	Pit	Pierce.
Miles S&G Co.	Box 280 Mount Vernon, WA 98273	Pits	King, Kitsap, Island, Skagit, Snohomish.
Industrial:			
Lane Mountain Silica Co.	Box 236 Valley, WA 99181	Quarry and plant	Stevens.
L-Bar Products Inc.	Box 95 Ravensdale, WA 98051	Quarry and plant	King.
Silver:			
Hecla Mining Co.	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	Underground mine and mill	Ferry.

WEST VIRGINIA



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 1990 was about $136 million. Increased output of sand and gravel and crushed stone primarily accounted for a gain in value of about $11 million over that of 1989.

While West Virginia's nonfuel sector showed only a slight increase in production in 1990, the coal industry reported a fifth consecutive year of higher output. The State's steel and aluminum industries reported a decline in output.

TRENDS AND DEVELOPMENTS

Passage of amendments to the Federal Clean Air Act in 1990 was expected to impact the State's coal and limestone industries. The legislation required a 50% reduction in sulfur dioxide emissions during the next 10 years. Methods proposed for lowering sulfur dioxide emissions from powerplants included installation of coal-cleaning equipment, called scrubbers, or a switch to a lower-sulfur-content coal.

The use of scrubbers removes sulfur during coal burning with lime or limestone, was expected to increase demand for those commodities for the State's limestone industry. Coal switching in West Virginia would benefit coal producers in southern West Virginia because of the lower sulfur content coalbeds in that area. However, higher-sulfur-content coalbeds in Northern West Virginia would be expected to experience a drop in demand.

West Virginia produced about 171 million short tons of coal in 1990, according to the West Virginia Division of Energy, and ranked third nationally in output. Production was the highest since 1947 and when 173 million tons of coal was produced.

LEGISLATION AND GOVERNMENT PROGRAMS

The West Virginia Legislature, in a special session on education reform, enacted measures to generate $80 million in tax revenue. Included in the tax package was an increase of 50 cents per ton on the minimum alternative severance tax on coal.

The West Virginia Geological and Economic Survey, in cooperation with the U.S. Geological Survey, began a study on manganese in the counties of Greenbrier, Mercer, Monroe, and Pocahontas in southeastern West Virginia. Ore sampling and mapping of the area were started late in the year. A final report on the study was scheduled for completion in early 1992. The United States imports 100% of the manganese it uses, primarily from France, Gabon, and the Republic of South Africa.

In November, the U.S. Bureau of Mines awarded West Virginia State

TABLE 1
NONFUEL MINERAL PRODUCTION IN WEST VIRGINIA[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	metric tons	239,473	$586	251,385	$553	164,257	$384
Gemstones		NA	1	NA	1	NA	1
Sand and gravel (construction)	thousand short tons	1,653	6,099	e2,300	e6,700	e3,208	e14,950
Stone (crushed)	do.	e11,600	e47,600	210,904	242,538	e 212,000	e 245,200
Combined value of cement, lime, peat (1988, 1990), salt, sand and gravel (industrial), and stone (crushed granite, 1989-90)		XX	73,169	XX	75,706	XX	75,803
Total		XX	127,455	XX	125,498	XX	136,338

eEstimated. 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.

College a $50,000 grant to conduct research in human resource development in underground coal mines. The study was expected to provide information on how miners use technology in emergency situations. The work was scheduled for completion in December of 1991. The Bureau also completed a study on burnout control in Albright, Preston County. Burnout control is a process developed by the Bureau for accelerating the burning of wasted coal fires in situ in an abandoned underground coal mine or waste bank, while at the same time controlling the heat and fumes produced.[3]

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

For the most part, little change occurred in the production of industrial minerals in West Virginia. Clays were again produced by three companies for use in brickmaking, cement manufacture, and as stemming for explosives. Cement, peat, and industrial sand were each produced by one company and salt by two. Each of these operations have established markets and remained stable in 1990.

Lime.—German Valley Limestone Co. completed installation of a new kiln at a cost of $7 million. The kiln has the capacity to produce 360 tons of quicklime per day (131,400 tons per year). Quicklime was used as a flux in steelmaking, in the bleaching process of making paper, and in treatment of acid mine drainage and wastewater.

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 1988 and 1990 and estimates for 1989.

In 1990, West Virginia produced about 3.2 million short tons of sand and gravel from nine pits and dredges.

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 1988 and 1990 and actual data for 1989.

Crushed stone was again the leading nonfuel mineral commodity produced in West Virginia, accounting for about one-third of the State's value. Early in 1990, the State's top stone producer, Millville Quarry Inc., completed the sale of its Jefferson County limestone operation to Evered PLC of the United Kingdom. Most of the crushed stone produced at the Millville quarry was sold in the Baltimore, MD, and Washington, DC, markets for use in construction.

Because of the continuing growth and development in the Baltimore and Washington areas, Brigham & Day Co. proposed developing a quarry on a 310-acre site in Kearneysville. In 1990, Brigham & Day submitted a mining permit application to the West Virginia Division of Energy and requested rezoning from local government. Both matters were pending at yearend.

Metals

Metals discussed in this section were processed from materials received from both foreign and domestic sources; no metals were mined in West Virginia in 1990. Production and value data for these commodities, which are not included in table 1, are given, if available.

Aluminum.—Ravenswood Aluminum Corp., Jackson County, was the State's only aluminum producer. In November, the company's labor contract expired, and a strike began that continued through yearend. In December, Ravenswood began hiring workers to replace the United Steelworkers Union employees. The plant had a capacity of about 120,000 short tons per year and employed 1,700 workers prior to the labor dispute. During the strike, Ravenswood continued to operate two of four potlines with management and replacement workers.

Iron and Steel.—Three companies manufactured steel in West Virginia: Weirton Steel Corp. and Wheeling-Pittsburgh Steel Corp., which are both integrated producers, and Steel of West Virginia, which operated a minimill. Combined output of these steelmakers accounted for less than 5% of U.S. production.

Weirton Steel, the State's top producer, reported a decline in sales from $1.3 billion in 1989 to $1.2 billion in 1990. Shipments of steel decreased to about 2.2 million short tons in 1990 from 2.5 million tons in 1989.[4] The firm also showed a loss in net income for the first time in 6 years.

Part of the loss was attributed to a capital improvement program that enabled Weirton to produce 100% of its steel using continuous casting. Before the caster project, the company produced 38% of its steel by ingotmaking and rolling process, which is more expensive because of higher energy requirements. The U.S. steel industry continuously cast almost two-thirds of its production in 1990.

A major steel galvanizing company in West Virginia, Wheeling-Nisshin Inc., began a $120 million expansion project. The firm, a joint venture of Wheeling-Pittsburgh Steel Corp. and Nisshin Steel Co. Ltd. of Japan, planned to boost the annual capacity of its Follansbee plant from 350,000 tons to 590,000 tons. The new continuous galvanizing line was expected to be in operation by 1993.

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[1]State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA. He has 17 years of mineral-related industry and government experience and has covered the mineral activities in West Virginia for 5 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]Chaiken, R. F., and L. G. Bayles, Burnout Control at the Albright Coal Waste Bank Fire, BuMines RI 9345, 1990, 26 pp.

[4]American Metal Market. Weirton's Earnings Down 98% in 1990. V. 98, No. 232, Nov. 29, p. 3.

TABLE 2

WEST VIRGINIA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	1,373	$7,699	$5.61
Asphaltic concrete aggregates and other bituminous mixtures	335	1,286	3.84
Road base and coverings	470	1,772	3.77
Fill	274	1,269	4.63
Snow and ice control	2	4	2.00
Unspecified:[1]			
Actual	754	2,920	3.87
Total or average	3,208	14,950	4.66

[1]Includes production reported without a breakdown by end use and estimates for nonrespondents.

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.	Route 9, Box A1 Martinsburg, WV 25401	Pit and plant	Do.
Sanders Dummy Co.	Box 38 Midkiff, WV 25540	Pit	Lincoln.
Lime:			
Germany Valley Limestone Co.	Box 302 Riverton, WV 26814	Quarry and plant	Pendleton.
Salt:			
Hanlin Chemicals-West Virginia Inc.	Drawer J Moundsville, WV 26041	Brine wells and plant	Marshall.
PPG Industries Inc.	1 Gateway Center Pittsburgh, PA 15222	do.	Do.
Sand and gravel:			
Construction:			
Dravo Corp.	5253 Wooster Rd. Cincinnati, OH 45226	Dredge	Wetzel.
ET&S Inc.	Route 1, Box 475A Gallipolis Ferry, WV 25515	Pit	Mason.
Jesco Corp.	Route 2, Box 186-A Letart, WV 25253	Pit	Do.
Pittsburgh Sand & Gravel Inc.	Box 248 Coraopolis, PA 15108	Dredge	Brooke.
Standard-Lafarge	6715 Tippecanoe Rd. Bldg. C Canfield, OH 44406	Pit	Hancock.
Industrial:			
U.S. Silica Co.	Box 187 Berkeley Springs, WV 25411	Quarry and plant	Morgan.
Stone:			
J. F. Allen Co.	Box 49 Clarksburg, WV 26301	Quarry	Randolph.
Beckley Stone Co.	Box 1148 Beckley, WV 25801	Quarries and plants	Raleigh.
Evered Materials USA Inc. (Millville Quarry Inc.)	Box 166 Millville, WV 25432	Quarry	Jefferson.
Fairfax Sand & Crushed Stone Inc. (Laurel Sand & Gravel Inc.)	Box 719 Laurel, MD 20705	Quarries	Grant, Mineral,

[1]Also clays and crushed stone.

WISCONSIN

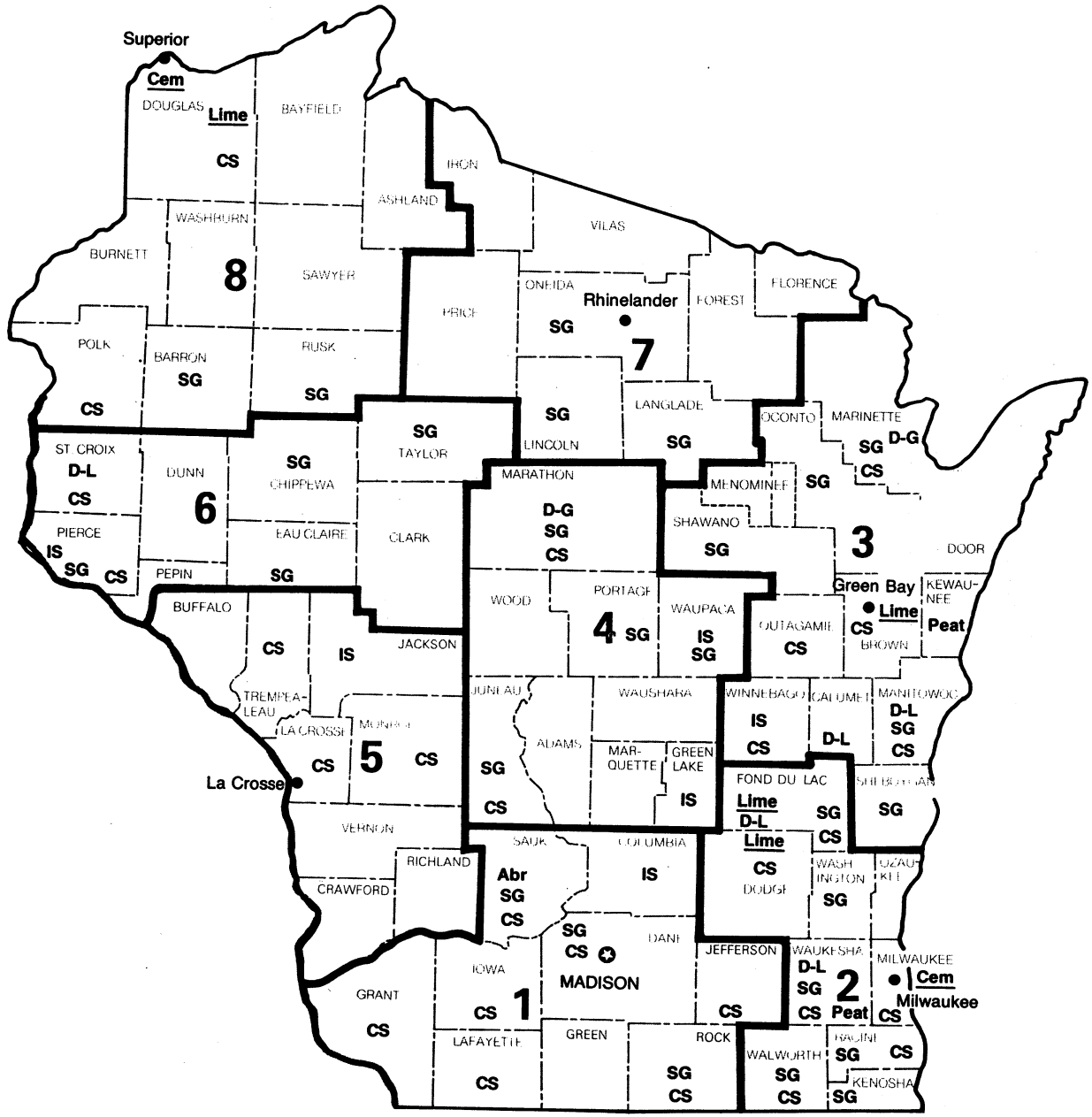
LEGEND

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

MINERAL SYMBOLS

Abr	Abrasives
Cem	Cement plant
CS	Crushed Stone
D-G	Dimension Granite
D-L	Dimension Limestone
IS	Industrial Sand
Lime	Lime plant
Peat	Peat
SG	Sand and Gravel

Principal Mineral-Producing Localities



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 James H. Aase[1] and Thomas J. Evans[2]

Nonfuel mineral production in Wisconsin was valued at $212 million in 1990, a 14% increase over the previous year's value and 40% above the average for the decade of the 1980's. Advances in both quantity and value were recorded for one-half of the commodities produced compared with 1989 figures. Production came from sites in 68 of the State's 72 counties, with Waukesha County the leader in terms of nonfuel mineral production value.

The State ranked 38th nationwide in value of nonfuel mineral production, contributing less than 1% of the U.S. total.

Crushed stone, the principal commodity produced in the State during 1990, in terms of value, accounted for slightly over $4 out of every $10 of the State's total nonfuel mineral value and was credited for 27% of the $27 million increase over the previous year.

Among the mineral commodities produced in Wisconsin during the year, the quantity of lime produced ranked 12th among 32 States reporting production; peat, 12th of 22; construction sand and gravel, 9th of 50; industrial sand, 7th of 38; crushed stone, 19th of 49; and dimension stone, 12th of 34.

TRENDS AND DEVELOPMENTS

After 3-1/2 years of environmental assessment and permit reviews, Flambeau Mining Co., a wholly owned subsidiary of Kennecott Corp., received all the permits necessary for its proposed open pit copper/gold mine south of Ladysmith in Rusk County. Construction of the Flambeau Mine was expected to begin in mid-1991. Project development costs were estimated at $30 million. The 32-acre massive-sulfide deposit was reported to contain approximately 1.9 million short tons of ore, grading about 10.5% copper, 2.1 troy ounce per short ton of silver, and 0.1 troy ounce per short ton of gold.

Noranda Exploration Co. announced near mid-year the discovery of massive sulfide deposits in the town of Lynne in west-central Oneida County. Preliminary analysis made from drill hole information suggested that the deposit contained more than 6 million short tons of ore,

TABLE 1
NONFUEL MINERAL PRODUCTION IN WISCONSIN[1]

Mineral		1988		1989		1990	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gemstones		NA	$15	NA	W	NA	W
Lime	thousand short tons	452	23,986	437	$18,129	461	$24,608
Peat	do.	11	270	13	309	12	256
Sand and gravel:							
Construction	do.	25,048	60,080	e21,700	e56,400	29,572	73,750
Industrial	do.	1,351	15,458	1,514	22,399	W	W
Stone:							
Crushed	do.	e[2]28,500	e[2]98,300	26,520	83,664	e26,600	e91,000
Dimension	short tons	e49,900	e6,200	35,587	4,376	e31,316	e3,811
Combined value of other industrial minerals and value indicated by by symbol W		XX	564	XX	(3)	XX	18,622
Total		XX	204,873	XX	e[4]185,277	XX	212,047

eEstimated. 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 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.

averaging 7.1% zinc, 1.84% lead, 0.34% copper, 3.08 troy ounces per short ton of silver, and 0.013 troy ounce per short ton of gold. Predevelopment planning was underway, leading to the submission of a Notice of Intent to collect data to support a mine-permit application. The proposed mine project will be operated by Noranda Minerals Wisconsin Corp.

Jump River Joint Venture, a consortium of companies active in exploration in Wisconsin in recent years, announced the discovery of a copper/gold massive sulfide deposit in the Chequamegon National Forest of north-central Taylor County in the town of Westboro. The discovery area, known as the Bend deposit, was reported to contain 3.6 million short tons of ore, averaging 2.7% copper and 0.05 troy ounce per ton of gold in one zone and 0.27% copper with 0.13 troy ounce per short ton of gold in another zone. Owners of the rights to develop the deposit, subject to federal and State approvals, were NDU Resources, a Canadian mining company, and Chevron Resources. A Notice of Intent to collect data to support a mine-permit application was expected to be submitted in mid-1991. The submission of the Notice of Intent will initiate what was expected to be a 3- to 4-year evaluation process by the State. Additionally, a Federal review will also be required before permission to develop a mine can be granted.

Interest in hard rock aggregate grew with the development of a major quarry near Mosinee in Marathon County by Mathy Construction Co. The expansion of operations at the quartzite quarry near Waterloo in Dodge County, operated by Gillen Construction Co., continued with the completion of a rail siding/loading facility.

During the year, a proposal by Edward Kraemer & Sons Inc. to expand its Lower Narrows quartzite mining operation in Sauk County was denied by the Sauk County Board of Adjustments. The plans to expand an existing quarry into an adjoining 40-acre parcel met with opposition from neighbors and special interest groups, such as the Ice Age Trail Foundation. In its decision denying the special-exception permit, the Board noted the presence of quartzite reserves on the existing permitted quarry land and left open the possibility of future consideration of a renewed application on the additional 40 acres. The proximity of the proposed Ice Age Trail to the Lower Narrows quarry stimulated interest in acquisition of the 40 acres by the Ice Age Trail Foundation to preclude minerals extraction. In a related action, Edward Kraemer & Sons Inc. was successful in acquiring the necessary permits for reopening the old La Rue quarry on the west end of the South Range of Baraboo Hills.

EMPLOYMENT

Employment in the State's mining industry averaged 2,276 workers during the year, an increase of about 1% compared with the 1989 work force. The average annual wage for all mine workers was $28,891, an increase of nearly 6% over that of the previous year.[3]

An estimated 90% of the nonfuel minerals produced in the State during the year was consumed by the construction industry. Increases in lime, construction sand and gravel, and crushed stone production during 1990, paralleled the trend set by the number of private and residential units authorized for construction in the State. Private and residential construction increased 1% over that of the previous year to 27,282 units.[4] The value of nonresidential construction rose 4% to $1,477 million.[5] State road contract awards increased 18% over the 1989 figure to $648 million.[6]

In 1990, one fatality occurred at a plant associated with mining operations conducted in the State. During the 2.9 million employee hours worked at surface mining operations during the year, 96 injuries were reported as resulting in lost workdays, and 80 injuries occurred with no workdays lost. At underground mines, a total of 14,000 employee hours were worked; 4 injuries with lost workdays and 1 injury with no lost workdays were reported. At mills and preparation plants associated with mining operations, an additional 41 injuries occurred to workers resulting in lost workdays and 36 injuries occurred with no lost workdays. A total of 903,000 employee hours were worked at the mills and plants during the year.[7]

REGULATORY ISSUES

Cornell University filed a lawsuit against Rusk County in an attempt to block the extinguishing of Cornell's severed mineral interest on land where the surface ownership was tax delinquent. The county was preparing to take ownership of a 160-acre parcel of land through a tax sale and asserted that in receiving a tax deed on the property, Cornell's severed mineral interests on the same property would be extinguished. The county cited previous opinions of the attorney general in support of its contention regarding the effect of a tax deed on previously severed mineral interests. Cornell filed the suit to protect its ownership of the mineral rights and to have the previous attorney general's opinions invalidated or the laws on which the opinions were based declared unconstitutional. In 1990, the Circuit Court ruled in favor of Cornell University; however, an appeal of the ruling was made which will result in further deliberations before the issues are resolved.

The Wisconsin Board of Commissioners of Public Lands (BCPL), responsible for the management of State trust lands, leased a 160-acre parcel in the town of Enterprise, Oneida County, in early 1990. This was the first such leasing action by the BCPL in its history. The BCPL manages about 80,000 acres of land for which it owns the surface and mineral rights and more than 100,000 acres of land for which it owns the mineral interests. Late in 1990, in response to additional requests for leases on trust lands in Oneida and Price Counties, the BCPL requested a discussion paper on the policy options regarding further leasing actions and requested the development of criteria to guide the BCPL in making decisions on leasing requests. The criteria and option papers remained under review at yearend.

EXPLORATION ACTIVITIES

Exploration activity in 1990 focused almost entirely on evaluation of the Lynne and Bend massive-sulfide deposits. A record number of 72 drill holes were completed during the year which included 68 holes that were designed to prove up the quantity of ore in deposits and were considered development drilling. The first two drill holes on the Lynne property and two drill holes near Enterprise, both in Oneida County, were the only holes considered true exploration drill holes in 1990. Three companies, including Chevron Resources Co., E.K. Lehmann & Associates of Wisconsin Inc., and Noranda Exploration Inc., were involved in drilling programs during the year. Drilling footage in 1990 totaled 29,973 feet in Oneida County and 5,902 feet in Taylor County.

Mineral leasing activity in 1990 was undertaken by two companies: E.K. Lehmann & Associates of Wisconsin Inc. (principally on behalf of, or in conjunction with, BHP-Utah) and Noranda Exploration Inc. These two companies leased 33,555 acres, the largest leasing activity since 1980. Leasing activity concentrated particularly on east-central and south-central parts of Price County and the eastern part of the Proterozoic Penokean volcanic belt in Forest, Marinette, and Florence Counties.

Metallic mineral lease agreements in 1990 did not vary significantly from those of previous years. For option-to-purchase type agreements, the annual rentals ranged from $5 to $10 per acre per year or included a lump sum equal to 0.1 to 1% of the ultimate purchase price as an annual payment to maintain the agreement. These option-to-purchase agreements generally include a 1 to 2% net return royalty as a retained royalty held by the landowners after the property has been purchased. Straight mineral leases have annual rental payments of $5 to $7.50 per acre per year, with modest escalation into the $12.50 to $15 per acre per year range in subsequent lease years. One recent trend is toward leases with shorter lease terms, 2 to 5 years as opposed to 10 years. The shorter-term agreements have given rise to the practice of re-signing on property of sufficient interest to keep the lease in effect but not resulting in an actual purchase. It is common now to see a lease on a property dropped and then re-signed shortly thereafter.

LEGISLATION AND GOVERNMENT PROGRAMS

The Wisconsin State Legislature had two bills introduced late in 1989 that carried over into the 1990 legislative session that were of particular interest to the mineral industry. The legislation contained in Assembly Bill (AB) 756 and Senate Bill (SB) 362 called for a prohibition on mining activity on certain lands managed by the Wisconsin Department of Natural Resources (DNR). AB 756 received some legislative attention in the form of hearings and committee action, but neither it nor its companion bill SB 362, received attention on the floor of the Assembly or Senate. However, in a last-minute amendment to SB 542, the 1990 budget adjustment bill, the legislature attached the substantive provisions of the two bills to the State budget. The governor vetoed that part of the budget bill, stating that the provisions in the legislation would, "take away the opportunity for DNR to consider requests to allow mining on DNR-owned land when the mining would not cause injury to the environment or damage the integrity of the public owned land." The April 1990 veto was not overturned by the legislature. New legislation was under preparation to be introduced into the next session in January 1991 to provide the same prohibition of mining on certain lands managed by the DNR.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Gemstones.—No commercial gem stone operations were reported in Wisconsin in 1990. No precise value is known for gem material that rock hounds, mineral collectors, and other hobbyists collected.

Lime.—Lime produced in the State reached a record high during 1990, increasing 5% in quantity and 36% in value compared with that of the previous year. Three companies operated four plants located in Brown, Dodge, Fond du Lac, and Manitowoc Counties. All of the plants reported production of both hydrated lime and quicklime. The average unit value of all lime produced in the State was $53.38 per short ton, an $11.89-per-short-ton increase in average value over that of 1989. The consumption of lime in Wisconsin during the year from all domestic sources totaled 175,000 short tons.

Peat.—Peat production decreased approximately 8% in quantity and 17% in value compared with 1989 figures. The average unit value for all types of peat produced in the State was about $21.33 per short ton, a decrease of $2.44 per short ton from the 1989 average.

Four companies harvested peat from bogs in Kewaunee and Waukesha Counties. Most of the peat produced was the reed-sedge type with the remainder principally sphagnum and small amounts of humus and hypnum. Bulk peat, the principal form of sales, was used most extensively for general soil improvement. The packaged peat was used mostly in general soil improvement and seed inoculant.

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 annual report contains actual data for 1988 and 1990 and estimates for 1989. Construction sand and gravel production rose significantly above the level attained in 1989. Production increased 36%, and value increased 31% compared with 1989 figures. Production was from 358 pits in 58 counties by 158 companies and government agencies. The average unit

value of the material mined in the State during the year was reported at $2.49 per short ton. The largest specified use of the sand and gravel consumed during the year was in road bases and coverings, followed closely by use in concrete aggregate, collectively accounting for one-third of the production. Construction sand and gravel statistics are compiled by geographical district as shown on the State map. Table 3 presents end use data for the eight districts covering the State. The leader in terms of value of sand and gravel output was Waukesha County, followed by Dane County and Walworth County, respectively.

Industrial.—Industrial sand was produced by three companies with operations in Columbia, Green Lake, Jackson, and Waupaca Counties. Production was down significantly both in quantity and value from the level attained in the previous year. The average unit value of the sand produced during the year was about $13.45 per short ton. The largest use of the sand produced was in foundry moldings, followed, respectively, for use in hydraulic fracturing and glass containers. Both truck and railroad transportation were used in shipping the material to consumers.

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 annual report contains estimates for 1988 and 1990 and actual data for 1989.

Crushed.—Crushed stone output was estimated to have increased less than 1% in quantity and 9% in value over that reported in 1989. The average unit value of the mined material was estimated at $3.42 per short ton.

Dimension.—Dimension stone production was estimated to have decreased 12% in quantity and 13% in value compared with that reported for the previous year. Granite, limestone, and dolomite were the principal types of dimension stone quarried.

Other Industrial Minerals.—Perlite obtained from out-of-State sources was expanded by Midwest Perlite Co. at its plant in Outagamie County. The expanded material was used in concrete aggregate, acoustic tile, and cavity fill insulation, and as a horticultural aggregate. Vermiculite mined in other States was exfoliated by Koos Inc. at its Kenosha plant. The exfoliated material was used for concrete and plaster aggregates, insulation, horticultural purposes, and numerous other uses. Sulfur was recovered by Murphy Oil Corp. at its refinery in Superior, Douglas County. The recovered sulfur sold or used increased significantly in quantity and value compared with 1989 figures.

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[1]Former State Mineral Officer. The author has 33 years experience in mineral-related work in private industry and government. Assistance in the preparation of the report was given by Wanda J. West, editorial assistant.

[2]Associate professor, Mineral Information, Wisconsin Geological and Natural History Survey, Madison, WI.

[3]Wisconsin Department of Industry, Labor and Human Relations (DILHR), 1989 and 1990 issues of Employments, Wages and Taxes Due Covered by Wisconsin's U.S. Law. (Table 209).

[4]Based on computer printouts received from U.S. Department of Commerce, Bureau of Census.

[5]Work cited in footnote 4.

[6]Highway and Heavy Construction. Market Update. Highway Construction Booming in New Heights. V. 133, No. 6, Apr. 1990, pp. 34-37.

[7]U.S. Department of Labor. Mine Injuries and Worktime, Quarterly, 1990. p. 17

TABLE 2

WISCONSIN: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	4,913	$14,593	$2.97
Plaster and gunite sands	80	506	6.33
Concrete products (blocks, bricks, pipe, decorative, etc.)	213	686	3.22
Asphaltic concrete aggregates and other bituminous mixtures	1,457	3,335	2.29
Road base and coverings[1]	5,000	11,313	2.27
Fill	1,948	2,760	1.42
Snow and ice control	156	492	3.15
Other[2]	134	338	2.52
Unspecified:[3]			
Actual	10,187	27,314	2.68
Estimated	5,484	12,411	2.26
Total or average	29,572	[4]73,750	2.49

[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.

TABLE 3

WISCONSIN: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, BY DISTRICT AND USE[1]

(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)	1,072	3,152	2,422	7,167	W	W	211	831
Plaster and gunite sands	11	50	W	W	2	8	W	W
Concrete products (blocks, bricks, etc.)	134	522	W	W	35	53	—	—
Asphaltic concrete aggregates and other bituminous mixtures	222	618	149	375	455	806	W	W
Road base and coverings[2]	508	1,020	1,543	4,570	773	1,547	285	653
Fill	158	231	1,199	1,825	244	274	214	247
Snow and ice control	11	45	84	298	12	58	1	7
Other miscellaneous[3]	61	122	138	653	491	980	95	280
Unspecified:[4]								
Actual	1,729	4,895	4,064	10,803	4	8	1,652	4,416
Estimated	200	397	1,552	3,947	1,933	4,068	469	821
Total[5]	4,106	11,052	11,151	29,637	3,948	7,804	2,928	7,254

	District 5		District 6		District 7		District 8	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	W	W	344	1,136	220	570	69	292
Plaster and gunite sands	—	—	—	—	2	11	—	—
Concrete products (blocks, bricks, etc.)	—	—	39	98	—	—	—	—
Asphaltic concrete aggregates and other bituminous mixtures	—	—	200	363	247	749	W	W
Road base and coverings[2]	—	—	876	1,822	715	1,261	300	440
Fill	W	W	69	77	35	51	W	W
Snow and ice control	8	13	14	24	17	34	9	14
Other miscellaneous[3]	103	510	—	—	—	—	106	166
Unspecified:[4]								
Actual	5	13	—	—	54	167	172	693
Estimated	34	52	355	1189	462	870	472	1,053
Total[5]	150	587	1,898	4,710	1,752	3,714	1,127	2,659

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."

[1]Excludes 2,514,316 short tons valued at $6,332,475 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.

TABLE 4
PRINCIPAL PRODUCERS

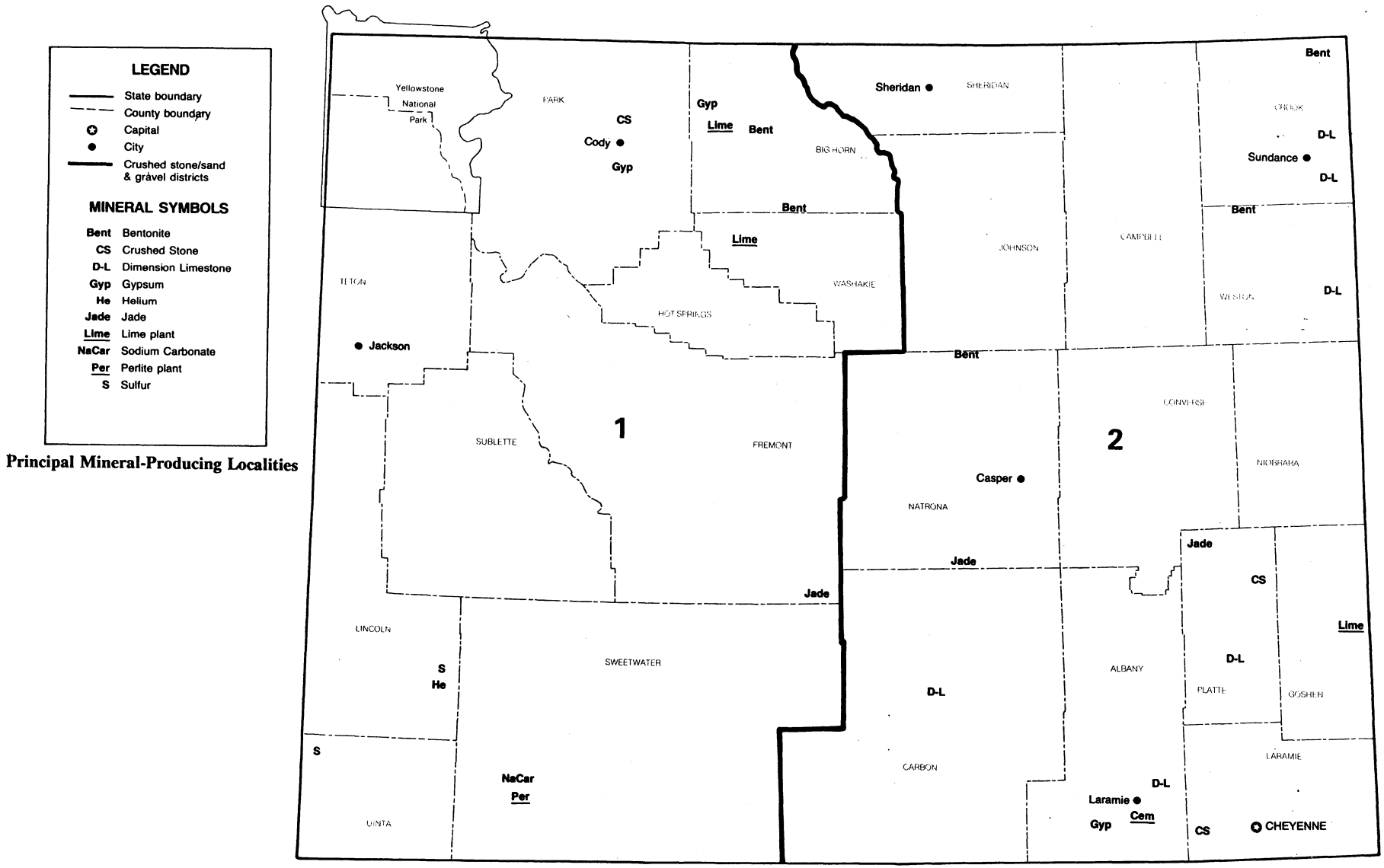
Commodity and company	Address	Type of activity	County
Abrasives (natural):			
Edward Kraemer & Sons Inc.	1 Plainview Rd. Plain, WI 53577	Quarry and plant	Sauk.
Iron oxide pigments (finished):			
DCS Color & Supply Co. Inc.	2011 South Allis St. Milwaukee, WI 53207	Plant	Milwaukee.
Lime:			
CLM Corp.	Box 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:			
Bogda's Top Soil & Excavating Co.	12600 West Cleveland Ave. New Berlin, WI 53151	Bog and plant	Waukesha.
Certified Peat & Sod Inc.	19000 West Lincoln Ave. New Berlin, WI 53151	do.	Do.
Liphatech Inc.	3101 West 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 Elkhorn, WI 53121	Pits and plants	Various.
Janesville Sand & Gravel Co., Lycon Inc.	Box 427 Janesville, WI 53545	do.	Columbia, Dane, Rock.
Mann Bros. Inc.	Box 48 Elkhorn, WI 53121	do.	Dane, Kenosha, Racine, Rock, Walworth, Waukesha, Waushara.
Mathy Construction Co., Patterson Quarries Div.	Box 18 Onalaska, WI 54650	do.	Adams and Juneau.
Tews Co. Inc.	Box 64 Colgate, WI 53017	do.	Various.
Wissota Sand & Gravel Co.	Box 1268 Eau Claire, WI 54701	do.	Barron, Trempealeau, Washington.
Industrial:			
Badger Mining Corp.	Box 97 Fairwater, WI 53931	Pits and plants	Green Lake and Jackson.
A. F. Gelhar Co. Inc.	Box 209 Berlin, WI 54923	do.	Green Lake and Waupaca.
Unimin Corp.	258 Elm St. New Canaan, CT 06840	Pit and plant	Columbia.
Stone (1989):			
Crushed:			
Granite:			
Roehl Granite Inc.	220 South Highway 107 Mosinee, WI 54445	Quarry and plant	Marathon.

TABLE 4-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Stone (1989)—Continued			
Crushed—Continued			
Granite—Continued			
Wimmer Granite & Supply Co.	1204 Starling Lane Wausau, WI 54401	Quarries and plant	Do.
Limestone and dolomite:			
4X Corp.	Box 509 Neenah, WI 53929	Quarries and plants	Calumet, Fond du Lac, Winnebago.
C. C. Linck Inc.	1226 North Center St. Beaver Dam, WI 53916	do.	Various.
Michels Pipeline Construction Inc.	Box 128 Brownsville, WI 53006	do.	Fond du Lac, Green Lake, Winnebago.
Mathy Construction Co., Patterson Quarries Div.	Box 18 Onalaska, WI 54650	Quarries and plants	Various.
Vulcan Materials Co., Midwest Div.	Box 6 Countryside, IL 60525	Quarries and plants	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 and Marinette.
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.
R. & T. Quality Stone Inc.	Box 182 Lannon, WI 53046	do.	Waukesha.
Valders Stone & Marble Inc.	Box 35 Valders, WI 54245	Quarries and plant	Manitowoc.
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.

WYOMING


LEGEND
State boundary
County boundary
Capital
City
Crushed stone/sand & gravel districts
MINERAL SYMBOLS
Bent Bentonite
CS Crushed Stone
D-L Dimension Limestone
Gyp Gypsum
He Helium
Jade Jade
Lime Lime plant
NaCar Sodium Carbonate
Per Perlite plant
S Sulfur
Principal Mineral-Producing Localities
Yellowstone National Park
PARK
CS
Cody
Gyp
Gyp
Lime
Bent
Sheridan
SHERIDAN
BIG HORN
Bent
Lime
JOHNSON
CAMPBELL
Bent
CROOK
D-L
Sundance
D-L
Bent
WESTON
D-L
TETON
WASHAKIE
HOT SPRINGS
Jackson
Bent
1
SUBLETTE
FREMONT
2
CONVERSE
NIOBRARA
Casper
NATRONA
Jade
Jade
Jade
CS
Lime
D-L
LINCOLN
S
He
SWEETWATER
ALBANY
PLATTE
GOSHEN
D-L
S
NaCar
Per
CARBON
LARAMIE
D-L
Laramie
Gyp
Cem
CS
CHEYENNE
UINTA

THE MINERAL INDUSTRY OF WYOMING

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

By. R. J. Minarik,[1] W. D. Hausel,[2] and R. E. Harris[3]

Nonfuel mineral production in Wyoming was valued at $910.8 million, a 10% increase over that of 1989. A gain in the production value of natural sodium carbonate (soda ash) accounted for the bulk of the increase. Other commodities that showed increased value included portland cement, clays, Grade-A helium, and crushed stone. Soda ash, clays, and Grade-A helium were the leading contributors to the State's mineral production value, accounting for 95% of the total. No metal production was reported.

In 1990, Wyoming ranked 13th among all States in nonfuel mineral production value, unchanged from that of 1989. The State was the Nation's leading producer of bentonite clay and soda ash. Wyoming ranked second nationally for total clay mined, Grade-A helium production, and the quantity of sulfur recovered.

According to the Energy Section of the Economic and Rural Development Division, Wyoming Department of Commerce, "The minerals industry is by far the largest single contributor to the economy of the State of Wyoming." The 1990 valuation on minerals produced represented 62% of the State's total assessed value.

TRENDS AND DEVELOPMENTS

Although there was no metal production reported during the year, 1990 was a promising year for both metals and industrial minerals. A number of companies showed interest in Wyoming's base metal, precious-metals, and ferroalloy resources. As would be expected, gold was the metal of choice.

The outlook for soda ash, Wyoming's highest valued nonfuel mineral commodity, was very promising. Owing to a growing domestic demand for soda ash and caustic soda produced from soda ash, all five soda ash producers had announced expansion plans by yearend; four were actively constructing new or expanded facilities. On the downside, production of limestone aggregate in the State continued to be plagued by land use controversies, most notably the proposed quarries near Casper and Laramie.

EMPLOYMENT

Employment in mining was relatively more important in Wyoming than in most States, accounting for more than 9% of total nonagriculture wage and salary employment. The Research & Planning Division of the Wyoming Department of Employment reported mining employment averaged 18.3 thousand workers throughout 1990, an increase of more than 5% from the State's revised benchmark number for 1989.

TABLE 1
NONFUEL MINERAL PRODUCTION IN WYOMING[1]

Mineral		1988 Quantity	1988 Value (thousands)	1989 Quantity	1989 Value (thousands)	1990 Quantity	1990 Value (thousands)
Clays[2]	metric tons	2,138,796	$72,174	2,166,497	$74,697	2,523,573	$76,082
Gemstones		NA	150	NA	157	NA	151
Lime	thousand short tons	26	1,640	W	W	W	W
Sand and gravel (construction)	do.	3,413	11,351	e4,500	e15,400	4,329	14,446
Stone (crushed)	do.	e2,500	e11,400	2,990	12,120	e2,200	e14,000
Combined value of cement, clays (common), gypsum (crude), helium (Grade-A), soda ash, and values indicated by symbol W		XX	613,097	XX	724,987	XX	806,169
Total		XX	709,812	XX	827,361	XX	910,848

eEstimated. 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.

In Wyoming, average weekly earnings reported for mining industry employees in December 1990 were $730, up by more than 9% from that of 1989. The U.S. average was $632. For the Wyoming mining industry in 1990, weekly hours worked averaged slightly more than 45 and hourly wages averaged $15.89.

REGULATORY ISSUES

A mineral examiner for the U.S. Forest Service determined that a deposit of green quartzite in the Telephone Lakes area of the Snowy Range cannot be extracted under the Mining Law of 1872. The quartzite was not considered unique enough to be defined as a locatable mineral under the established guidelines. Medicine Bow National Forest managers had recommended that 21,000 acres of land in the Snowy Range area, including the proposed quartzite quarry near Browns Peak, be withdrawn from mineral activity. The Geological Survey of Wyoming (GSW) reported that the region encloses Witwatersrand-type Proterozoic conglomerates and a large auriferous shear zone.

A lawsuit was filed challenging the Wyoming Department of Environmental Quality's authority to issue a permit for a proposed limestone aggregate quarry on Bessemer Mountain near Casper. The permit was issued to Rissler & McMurry Co. and later upheld in court under the 10-acre exemption rule, a rule that allows work at mining properties of 10 acres or less to commence without extensive environmental review. Opponents contended that the proposed quarry operation would ultimately exceed 10 acres after a new road, storage, parking spaces, scales, and other ancillary facilities were constructed. Rissler & McMurray proposed another quarry site at nearby Jackson Canyon that would be mined in place of the quarry on Bessemer Mountain, but the issue was unresolved at yearend. Limestone from either quarry would be used as aggregate for highway and other construction projects.

The Wyoming Board of Land Commissioners issued a controversial temporary use permit to Pete Lien and Sons to use a road east of Laramie to survey a chemical-grade limestone quarry. An Albany County judge upheld Lien's right of access for surveying and site evaluation. The company was expected to prepare an environmental impact statement because the property is on Bureau of Land Management (BLM) land.

EXPLORATION ACTIVITIES

Areas in which active exploration was reported throughout the State included the Laramie and Medicine Bow Mountains in the southeast, the South Pass area of the Wind River Range and in the Rattlesnake Hills of the Granite Mountains in the southwest, the Sunlight District of the Absaroka Mountains in the northwest, and the Bear Lodge Mountains in the Black Hills in the northeast. According to the GSW, interest was shown in a number of base and precious metals, including copper, gold, palladium, platinum, titanium, and zinc; diamond exploration by private industry also increased.

Exploration for industrial minerals increased slightly over that of 1989. Several companies expanded their ongoing industrial mineral operations, while others looked for new commodities. Exploration for construction aggregate, used primarily for highway construction and railroad ballast, remained active. Several companies explored for decorative stone, including green and red quartzite and various colors of granite and marble. Other industrial minerals of interest included garnet, gypsum, mica, vermiculite, and zeolites.

In the southeast region, three major mining companies reported that they were conducting exploration programs and developing feasibility studies directed at diamond potential in the region's kimberlites and lamproites. Also, the joint venture of Diamond Co. NL, a subsidiary of Ashton Mining Ltd. of Australia, and Moonstone Diamond Corp. reportedly discovered a new deposit of low-grade, good-quality diamonds. The diamondiferous kimberlites, called the Kelsey Lake intrusives, are along the Colorado-Wyoming border. In the same mining district, a Texas consulting firm collected data on the Sloan 1 and 2 diamondiferous intrusives.

A source of granite for railroad ballast was located by Railroad Stone Systems Inc. in Platte County, and another company drilled on a silica rock deposit near Glendo, both a result of cooperative exploration efforts with the GSW. Mountain Cement Co., operators of the cement plant in Laramie, explored for gypsum and limestone south of the city.

Medicine Bow Minerals Co. received approval to begin exploration drilling for gold in the French Creek area of the Medicine Bow National Forest. In the Keystone district of the Medicine Bow Mountains, Homestake Mining Co. sampled for gold at the Keystone and Florence Mines.

In the southeast, the GSW completed a preliminary reconnaissance map of the Seminoe Mountains, northeast of Rawlins, and reported that its studies indicate significant gold mineralization in certain portions of the area; zones of anomalous zinc and lead also were identified. In its investigation of possible diamond resources, the GSW looked in the central Laramie Range for kimberlite satellite minerals in stream-sediment samples; the project was later expanded into the Medicine Bow Mountains in the vicinity of Mullison Park. The GSW also studied historic mining districts and geology along the Snowy Range highway in the Medicine Bow Mountains.

In the southwest region, a number of companies conducted precious-metal exploration programs in the South Pass-Atlantic City and Lewiston mining districts. The joint venture of Goldstake Explorations Inc. and Sawatch Gold Placers Inc. began a major drilling program on its South Pass gold property, adjacent to the Atlantic City gold district, south of Lander. Gyorvary Mining Co. continued work at the Mary Ellen gold mine, an inclined shaft on a dipping quartz vein. In the Rattlesnake Hills, exploration by American Copper & Nickel Co. revealed widespread low-grade gold mineralization.

BWAB Inc. sought permission from the BLM to explore, test, and possibly develop trona resources near Eden, Sweetwater County. The Denver-based energy company proposed the drilling of exploratory wells in an attempt to locate black trona water (ground water containing dissolved trona and organic compounds) and determine its economic viability.

In the northwest region, American Mining and Milling Co. worked on permitting and lease agreements necessary to mine gold and silver near Clark's Fork River, near Clark, Park County. The company was attempting to lease mineral rights owned by Park County that are under a piece of private property. Two large porphyry copper deposits in the Absaroka Mountains, the Kirwin and Sunlight Basin, received attention during the year.

According to the GSW, several companies from the Black Hills, citing opposition toward mining in South Dakota, initiated exploration programs in Wyoming in search of minable gold deposits. In the northeast, interest was directed at epithermal gold mineralization in the Bear Lodge Mountains of the western Black Hills. CoCa Mines Inc. leased 1,480 acres of unpatented claims and drilled on its Sundance gold project in Crook County.

LEGISLATION AND GOVERNMENT PROGRAMS

The Wyoming Legislature passed four House bills that addressed the valuation of coal, uranium, bentonite clay, sand and gravel, and other solid minerals. The new valuations package was expected to provide the minerals industry and the State with a fair and predictable mineral tax system.

The exploration of a silica deposit near Lovell, Big Horn County, was funded by the State. Money for the exploration program was provided by the Town of Lovell to the GSW through a community block grant from the Wyoming Department of Commerce's Division of Economic and Community Development.

The Mining and Mineral Resources Institute of the University of Wyoming in Laramie received an allotment of $145,000 from the U.S. Bureau of Mines in 1990. The school had received a total of $1.94 million since inception of the Mineral Institute Program in 1978.

REVIEW BY NONFUEL MINERAL COMMODITIES

Industrial Minerals

Cement.—Although the quantity decreased by almost 3%, the value of Wyoming's cement production rose almost 15% from that of 1989. Mountain Cement Co., a joint venture of Lone Star Industries Inc. and Centex Corp., owned and operated Wyoming's only cement manufacturing plant, south of Laramie, Albany County. The company recently completed renovation of the dry-process plant, including mechanical upgrade of the clinker cooler and kiln drive.

The bulk of the cement produced was general use, moderate heat Types I and II gray portland cement. Lesser quantities of high-sulfate-resistant Type V portland cement, oil well cement, Type III high-early-strength portland cement, and masonry cement also were produced. Finished portland cement was used by the following: ready-mix concrete companies (61%), other contractors (23%), highway contractors (9%), and building materials dealers and concrete product manufactures (7%). The plant used gypsum, iron ore, limestone, sandstone, and shale from nearby quarries.

Clays.—Wyoming ranked second in the Nation for 1990 in the quantity of total clay produced and third in value. Production was reported for two types of clay, bentonite and common. The State was by far the Nation's leading producer of bentonite clay, accounting for almost 73% of the total bentonite mined and almost 89% of the swelling bentonite sold or used by producers nationally. Although oil and gas drilling, a major user of bentonite, was sluggish in 1990, the amount of bentonite produced in Wyoming increased almost 15%; total production value also showed a modest increase.

Bentonite was produced by five companies in seven counties. American Colloid Co. was the State's largest producer; others included Baroid Drilling Fluids Inc. (a subsidiary of NL Industries), Kaycee Bentonite Partnership, M-I Drilling Fluids Co., and Wyo-Ben Inc. The bulk of the bentonite was produced in Big Horn and Crook Counties; other counties where bentonite was mined included Hot Springs, Johnson, Natrona, Washakie, and Weston.

Bentonite has been one of Wyoming's major exports. It is the high-swelling sodium type, and when water is added, the bentonite increases from 15 to 20 times its dry volume. In 1990, the three major uses of swelling bentonite from Wyoming were drilling mud (32%), foundry sand (30%), and iron ore pelletizing (28%).

Common clay was mined by Mountain Cement in Albany County for use in cement manufacturing at its plant near Laramie and by Interstate Brick Co. in Uinta County for manufacturing building bricks.

Gemstones.—The value of State gem stone production in 1990 decreased slightly from that of 1989. Wyoming nephrite, commonly called jade, is a calcium-magnesium-aluminumsilicatethat is found in the Granite Mountains in the center of the State. Jade also occurs as veins in Precambrian metamorphic rocks in the southern end of the Wind River Mountain Range. Boulders and pebbles of jade are found around the southern end of the Wind River Mountains and on the north end of the Laramie Mountains to the east. Although the Wyoming jade industry is small, it is well known throughout the world. Some rubies and aquamarine also were recovered in small quantities.

Gypsum.—Gypsum production in Wyoming dropped almost 3% in quantity and more than 15% in value from that of 1989. Gypsum was quarried at three

locations. Two companies, Georgia-Pacific Corp., south of Lovell, Big Horn County, and the Celotex Div. of Jim Walter Corp., at Cody, Park County, mined and calcined gypsum to manufacture wallboard for the construction industry. Mountain Cement mined gypsum at Red Mountain and other locations in Albany County for use at its cement manufacturing plant south of Laramie.

Helium (Grade-A).—Grade-A helium production increased by almost 8% in quantity and value from that of 1989. Wyoming ranked second in the Nation in both production and value. Grade-A helium has been Wyoming's third most important nonfuel mineral commodity since 1987.

Exxon Co. U.S.A. was the only producer of helium in Wyoming; it was extracted from natural gas production at Shute Creek, in the Riley Ridge gasfield, Lincoln County. The southwestern Wyoming gasfield began helium production in 1986.

Lime.—Although the quantity of lime produced in Wyoming remained essentially unchanged, the value increased by two-thirds from that of 1989. Three sugar beet processing plants used limestone from Montana and South Dakota to make quicklime for refining sugar. The Great Western Sugar Co. used the sugar rock at its plant at Lovell, Big Horn County, and Holly Sugar Corp. used it in its plants at Worland, Washakie County, and at Torrington, Goshen County. All lime produced by these companies was used internally.

A newly developed limestone quarry 15 miles north of Guernsey, Platte County, provided the source for lime used in emissions control at Missouri Basin Electric's Laramie River powerplant north of Wheatland.

Perlite (Expanded).—Expanded perlite was produced by Harborlite Corp. at its processing plant near Green River, Sweetwater County. Perlite for this plant was shipped to Wyoming from Arizona. The company supplied perlite to the trona industry for use in filters at soda ash plants.

Phosphate.—Phosphate from Utah was transported to Chevron Chemical Co.'s fertilizer plant at Soda Springs, Sweetwater County, by slurry pipeline and reacted with sulfuric acid produced from Wyoming sulfur to make phosphoric acid and diammonium phosphate. There is currently no phosphate rock being mined in Wyoming.

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 1988 and 1990 and estimates for 1989. Surveyed production for 1990 decreased almost 4% from that estimated for 1989, but rose almost 27% from that reported for 1988. Likewise, the value of production reported in 1990 dropped 6% from that estimated for 1989, but increased by more than 27% from that reported in 1988.

Wyoming construction sand and gravel statistics were compiled by geographical districts as depicted on the State map. Sand and gravel was produced in 22 of the State's 23 counties; Fremont, Johnson, Laramie, Natrona, and Washakie were the leading counties. Production was reported by 46 companies and government agencies from 62 pits at 56 operations; the top 5 producers accounted for more than 50% of the total reported output.

Table 3 presents end-use data for the State's two districts. Three major use categories—road base and coverings, including stabilization; concrete aggregates, including concrete sand; and asphaltic concrete aggregates and other bituminous mixtures—accounted for about two-thirds of the construction sand and gravel sold or used in 1990.

Sodium Carbonate.—The world's largest known resource of trona, a natural sodium carbonate-bicarbonate, was in the Green River Trona District in southwestern Wyoming. With five of the Nation's six major trona mines and soda ash processing facilities within a few miles of Green River, Sweetwater County, Wyoming has been the source of the bulk of the Nation's output of soda ash. Soda ash production in 1990 increased by almost 3% in quantity and by more than 11% in value from that of 1989. The primary use of soda ash was in glassmaking, followed by the chemical industry, soap and detergent production, pulp and paper manufacturing, water treatment, and various other applications. The two growing uses of soda ash are as a substitute for chlorine in the production of caustic soda and as a substitute for caustic soda.

At Green River, FMC Wyoming Corp. operated the State's largest and oldest trona-producing mine, and in 1990, the company led the Nation in soda ash production and capacity. A giant, 92-ton Eickhoff longwall shearing machine, capable of cutting seams 7.5 to 11 feet high, was used at the recently modernized underground mine. The mine was the only noncoal longwall operation in the Nation and the only trona mine in the Green River Basin not using a mobile continuous conveyor to carry ore out of the mine.

In 1990, FMC commissioned three new plants: a 65,000-ton-per-year caustic soda plant, a 30,000-ton-per-year liquid sodium cyanide plant, and a 60,000-ton-per-year sodium bicarbonate facility. A major portion of the caustic soda was expected to be used on-site to manufacture sodium cyanide. FMC's interest in producing sodium cyanide was a result of the gold mining boom in the Western United States, especially Nevada. Sodium cyanide is used in the heap-leaching process to remove gold from ore. The new sodium bicarbonate facility will make baking soda for use in food processing and carpet fresheners. The new plant competes with Church & Dwight Co. Inc.'s Green River bicarbonate plant, which has been the only Wyoming facility converting the sodium carbonate to sodium bicarbonate. Church & Dwight manufactures and sells Arm & Hammer brand products.

General Chemical Co., the State's second largest soda ash producer, asked the State for permission to increase its nameplate capacity. The company continued to modernize and debottleneck parts of its Green River operation in an effort to boost capacity through process improvements. General Chemical continued mine development toward the south of its property and expanded its evaporation ponds. The company's largest customer is Church & Dwight, its next door neighbor.

Rhone-Poulenc of Wyoming Co., a joint venture of Rhone-Poulenc Basic Chemicals Co. (51%) and Union Pacific Resources Co. (49%), continued its debottlenecking project that is expected to increase capacity of its soda ash plant through process improvements. The French-based company purchased the State's third largest soda ash producer from Stauffer Chemical Co. in 1988. A continuous miner that automatically installs roofbolts as it cuts trona was used in the underground mine.

Tg Soda Ash Inc., the State's fourth largest soda ash producer, announced plans to build a new 150,000-ton-per-year caustic soda plant at its soda ash facility at Granger, northwest of Green River. Sodium carbonate-rich wastewater from the company's mine would be used as feedstock for the plant. The plant is a joint venture of Tg Soda Ash and Atochem North American Inc., both subsidiaries of Societe Nationale Elf Aquitaine Inc., a French company. Tg Soda Ash acquired additional leases south of its existing leases from Union Pacific Corp. The company indicated it may develop the new leases as a separate mine that would feed its existing refinery.

Tenneco Minerals Co. announced approval by the Wyoming Industrial Siting Council of a two-stage plant expansion that could possibly make the Tenneco operation the second largest soda ash producer in the Nation. The company entered a joint-venture agreement with Asahi Glass of Tokyo, Japan, to expand annual capacity at its soda ash plant by 600,000 tons. Asahi Glass provided the capital for the expansion, which earned it a 20% joint-venture interest in the expanded facility. In addition, Tenneco discussed plans to produce about 1 million tons annually of raw "calcined" trona, likely for use in caustic soda production, but which could be used also in the production of other sodium carbonate-based products such as soda ash and sodium sulfite. Tenneco began work on a new liquid caustic soda plant and a second plant to produce anhydrous sodium sulfite, with startup expected in 1991. Sodium sulfite is used as a brightener in pulp and paper processing and for water treatment.

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 1988 and 1990 and actual data for 1989.

Although the quantity of crushed stone production was estimated to have dropped by more than 26% from that reported in 1989, the estimated value increased by almost 16% from that surveyed in 1989. Albany, Laramie, and Sweetwater were among the larger producing counties. Meridian Minerals Co. produced railroad ballast at a quarry west of Cheyenne, Laramie County. The ballast was used by both the Burlington Northern Railroad, Meridian's parent company, and the Union Pacific Railroad. Reportedly, the company was attempting to sell the operation.

The Town of Guernsey, through the Wyoming Division of Economic and Community Development, awarded Sunrise Stone Inc. a community development block grant to study occurrences of gray, pink, red, black, and green-and-pink marble near Sunrise in northeastern Platte County and a black granite (amphibolite) in northern Albany County. The company will sample these locations to determine the quantity and quality of marble and granite.

Georgia Marble produced white marble at Wheatland, Platte County. The company also shipped river rock from a quarry east of Guernsey; it was packaged and sold as landscape gravel. According to the GSW, other companies also shipped red clinker (baked and fused shale), pink feldspar, and green serpentine.

Sulfur.—Wyoming ranked second in the Nation in quantity and fourth in value of elemental sulfur recovered in 1990; all of it was produced as a byproduct of natural gas and petroleum processing. The State accounted for more than 14% of total U.S. sulfur production. Six companies in seven counties produced elemental sulfur primarily in the Overthrust Belt of southwestern Wyoming. Three companies—Amoco Production Co., Chevron U.S.A. Inc., and Exxon Company USA—accounted for the bulk of State production.

Other Industrial Minerals.—Wyoming Red Rock, a Gillette-based company, mined and sold feldspar from a pegmatite deposit on Casper Mountain, Natrona County. It was the first time since 1982 that feldspar was mined in Wyoming. It was used as decorative aggregate.

Rocky Mountain Zeolites Inc., in partnership with Colorado Lien Co., was developing a zeolite deposit near old Fort LaClede, in the Washakie Basin in Sweetwater County. The company was planning to market natural clinoptilolite, a product used in the cleanup of various types of environmental waste.

Metals

Although there have been some nuggets and flakes recovered at several stream placers in recent years, no significant gold production was reported in Wyoming in 1990. Four historic gold districts lie at the southern tip of the Wind River Mountain: (1) South Pass-Atlantic City, (2) Lewiston, (3) McGraw Flats, and (4) Oregon Buttes. The entire 150- to 200-square-mile South Pass gold-belt area has been mapped by the GSW. Several commercial-grade gold anomalies were identified during the mapping project; chromium, copper, iron ore, silver, tin, and tungsten anomalies also were found. In addition to the South Pass-Atlantic City area, the Medicine Bow, Sierra Madre, and Laramie

Mountain ranges in southeastern Wyoming and the Bear Lodge Mountains in northeastern Wyoming were believed to have potential for gold production.

According to the newly released GSW report "Strategic Mineral Resources in Wyoming—Titanium," titanium-bearing deposits are relatively common in Wyoming, and as a whole, they make up one of the greatest titanium resources in North America. The known titanium deposits also include important accessory metals such as chromium, gold, iron, rare-earth elements, vanadium, and zirconium. In the report, deposits have been identified in 10 counties.

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[1]State Mineral Officer, U.S. Bureau of Mines, Spokane, WA. He has 16 years of mineral-related experience in industry and government and has covered the mineral activities in Wyoming since 1989. Assistance in preparation of the chapter was given by W. A. Lyons, editorial assistant.

[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.

TABLE 2

WYOMING: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1990, BY MAJOR USE CATEGORY

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	1,027	$3,025	$2.95
Plaster and gunite sands	5	47	9.40
Concrete products (blocks, bricks, pipe, decorative, etc.)	W	W	2.20
Asphaltic concrete aggregates and other bituminous mixtures	424	2,119	5.00
Road base and coverings[1]	1,448	4,421	3.05
Fill	72	222	3.08
Snow and ice control	34	57	1.68
Railroad ballast	W	W	1.33
Other[2]	56	210	3.75
Unspecified:[3]			
Actual	386	1,358	3.52
Estimated	877	2,988	3.41
Total or average	4,329	[4]14,446	3.34

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules and 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.

TABLE 3

WYOMING: SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN 1990, BY DISTRICT AND USE

(Thousand short tons and thousand dollars)

Use	District 1		District 2	
	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	216	889	811	2,136
Plaster and gunite sands	5	47	—	—
Concrete products (blocks, bricks, etc.)	W	W	W	W
Asphaltic concrete aggregates and other bituminous mixtures	254	944	170	1,174
Road base and coverings[1]	752	2,634	696	1,787
Fill	13	39	59	183
Snow and ice control	—	—	34	57
Railroad ballast	—	—	W	W
Other miscellaneous[2]	6	34	50	176
Unspecified:[3]				
Actual	381	1,340	5	18
Estimated	80	221	797	2,767
Total[4]	1,708	6,149	2,622	8,297

W Withheld to avoid disclosing company proprietary data; included with "Other miscellaneous."
[1]Includes road and other stabilization (cement and lime).
[2]Includes roofing granules and 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.

TABLE 4
PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Cement:			
Mountain Cement Co.[1]	Box 40 Laramie, WY 82070	Plant	Albany.
Clays:			
American Colloid Co.	1500 West Shure Dr. Arlington Heights, IL 60004	Pits and plants	Big Horn, Crook, Weston.
Black Hills Bentonite	Box 9 Mills, WY 82644	do.	Johnson, Natrona, Washakie.
M-I Drilling Fluids Co.,	Box 42842 Houston, TX 77242	Pits and plant	Big Horn.
Baroid Drilling Fluids Inc.	Box 1675 Houston, TX 77251	Pits and plants	Big Horn and Crook.
Wyo-Ben Inc.	Box 1979 Billings, MT 59103	do.	Big Horn.
Gypsum:			
Celotex Corp.	Box 590 Cody, WY 82414	Surface mine and plant	Park.
Georgia-Pacific Corp.	133 Peachtree St., NE Atlanta, GA 30303	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	Plant	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	Natrona.
Gilpatrick Construction Co.	714 West Monroe Riverton, WY 82501	Pits	Fremont.
McGarvin-Moberty Construction Co.	Box 1166 Worland, WY 82401	Pit	Washakie.
Teton Construction Co.	Box 3243 Cheyenne, WY 82003	Pit	Laramie.
Western Mobile Pre-Mix Co.	Box 1230 Laramie, WY 82070	Pit	Do.
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	Underground mine and plant	Sweetwater.
Rhone-Poulenc of Wyoming	Box 513 Green River, WY 82935	do.	Do.
Tenneco Minerals Co.	Box 1167 Green River, WY 82935	do.	Do.
Tg Soda Ash Operations	Box 100 Granger, WY 82934	do.	Do.

See footnotes at end of table.

TABLE 4-Continued

PRINCIPAL PRODUCERS

Commodity and company	Address	Type of activity	County
Sulfur (recovered):			
Amoco Production Co.	Box 2520 Casper, WY 82602	Plant	Unita.
Chevron USA Inc.	Box AA Evanston, WY 82930	do.	Do.

[1]Also gypsum and crushed stone.
[2]Also recovered sulfur.

*U.S. G.P.O.:1992-332-990 WYOMING—1990