Material from Glacial geology course - Geology 143 - 2. 1921-1955

Thwaites, F. T. (Fredrik Turville), 1883-1961
[s.l.]: [s.n.], 1921-1955

Exam 2nd Sat.

DIAGRAMMATIC REPRESENTATION OF SUCCESSIVE POSITIONS OF ICE BORDER.

By Frank Leverett, F. B. Taylor, W. C. Alden, and Samuel Weidman.

1 Kraemer 11⁰⁰
2 Bauman
3 Eberhardt
4 Bauer
5 Kellinger
6 Hendelifer
7 Tietjens
8 Hunzicker
9 Thompson
10 Pirsche
11 Brown
12 Lauer

Glacial Geology. Erosion as a time measure.
Quadrangles: Superior, Milo, Camp Dodge, McComb, Mt. Olive, Boone

(1) Superior, Boone and part of Camp Dodge are in area of latest glaciation; suggest factors which have led to formation of postglacial valleys in each.

(2) Contrast the eroded and uneroded portions of each.

(3) Read legend on back of Camp Dodge.

(4) Comment on age of valleys near the Camp.

(5) Contrast topography of south part of this quadrangle with that of Milo quadrangle in Kansan drift.

(6) Contrast the Milo area with McComb and Mt. Olive in the Illinoian drift.

(7) What factors might confuse the time question?

(8) Be prepared to discuss factors which influence speed of erosion.

Glacial Geology Erosion as a time measure.
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Glacial geology---Geology 143

Erosion as a time measure: Superior, Wis., Boone, Camp Dodge, and Milo quadrangles, Iowa, Macomb and Mt.Olive quadrangles, Ill.

(1) Read the legend on the back of Camp Dodge quadrangle.

(2) Superior, Boone, and much of Camp Dodge are in the Wisconsin drift. Compare relative amount of stream work.

(3) Compare dissection of Milo and the Illinois maps.

(4) Study the original stream gradients before erosion, the relation of the streams to glacial drainage, the probable nature of the soil, and any other factors which may have influenced the speed of erosion.

(5) Comment on differences between postglacial valleys and interglacial valleys overridden by later advance of ice. See Camp Dodge quadrangle.

Geology 143 Pitted outwash.

Brainerd Quadrangle, Minn.
(1) What was direction of ice movement in southern part of ar ea? How determined?

(2) Make a sketch map of area of Towns of Klondyke, Nokay Lake, and Oak Lawn as directed for St.Croix Dalles Quadrangle.

(3) What direction did ice probably move in northwest part of area? Consult Leverett's map of Minnesota.

(4) Account for the moraine-like features along Long and Upper Long Lakes?

Determine direction and slope of outwash plain here.

Geology 143. Pitted outwash. St.Croix Dalles Quadrangle.

(1) Which way did the ice move in this area?

(2) What parts of the area are terminal moraine?

(3) How known?

(4) Look up relation of moraines to border of Wisconsin drift on model of Wisconsin on 3rd floor.

(5) Locate outwash plain of the moraine east of St.Croix valley.

(6) Explain origin of depressions.

(7) Why do some of these contain lakes while others do not?

(8) Why does the plain end so abruptly north of Big Horse-shoe Lake and East Lake?

(9) Would a similar plain be found outside of the outermost moraine of Wisconsin age? Why?

(10) What would be nature of drift in bottom and sides of pits? (in outwash)

(11) Make a sketch map of the Towns of Garfield and Osceola. Rule squares for section and be sure to show definite lines between different kinds of drift deposits. Note the hill just south of Sand Lake and south of Deer Lake and account for them. Use symbols adopted by Wisconsin Geological Survey.

Terminal moraine. Ground moraine.
Outwash plain, flat. do, pitted.

(12) Account for the plain south and southeast of Osceola and the channels such as that leading northeast from Osceola.

(13) Comment on the age of St.Croix valley with respect to the drift.

(14) Suggest origin of valley of Rock Creek northwest of Deer Lake.

Outwash plains Geology 143.
Janesville, Shopiere, Delavan, Wis. and Rockford, Ill. Quadrangles.

(1) Compute the slope in fett per mile of the outwash plain as it existed before erosion between the following points:
Terminal moraine directly north of Janesville.
SE part of Janesville.
NE part of Beloit.
Harlem School north of Rockford.

Darien moraine where it crosses Turtle Creek.
Mouth of Turtle Creek in Beloit.

(2) Compute slope of present streams in feet per mile between the same points

(3) State the conclusions you can draw from this data.

(4) Account for the corse of Rock River at present as compared to its preglacial location. See map of preglacial topography in Prof. Papers 34 or 106.

(5) Account for the rock outcrops in the bed of Rock River and their economic importance.

(6) What controlled the size of stones in the gravels?

(7) What factors led to location of gravel pits at both Janesville and Beloit?

(8) Explain relation of valley trains in Rock and Pecatonica valleys.

(9) What kind of material in each?

	elev		
Plain at moraine N. of J.	900		
SE part of J.	860	miles 4	ft per m. 10.0
NE part Beloit	780	12	6.7
Harlem School	735	12	3.75
Present stream, moraine	750		
Harlem Sch.	710	39	1
Darien moraine	960		
Beloit	780	19	9.5
Present stream, moraine	870		
Beloit	720	24	6.25

Geology 143--Drumlins.

Sun Prairie quadrangle, Wis.

(1) Define "drumlin".

(2) Locate a number of drumlins on this sheet. Tabulate their lengths, widths, heigths, angles of slope of sides and ends. If slope is shorter than 1/10 mile use half values for 1/20 mile. Table gives feet slope for 1/10 mile.

1°	9
5	46
10	93
15	142
20	192
25	248
30	305
35	370

(3) Contrast typical drumlin shape with that of an ice worn hill.

(4) Suggest reason for difference.

(5) Examine some of the drumlins which depart from the typical form and classify differences. See U.S.G.S. Bull.273.

(6) Examine areas between the drumlins. Most of these are ground moraine or marsh Measure slopes common to groud moraine.

(7) Are there any terminal moraines on this sheet? Where? How known? Are they continious?

(8) What evidence is there as to the relative age of the drumlins and the terminal moraines? See Bull. 273.

Map questions-terminal moraines, Geology 143.

Vergas Quadrangle, Minn.

(1) Locate this area on map of U.S.

(2) Describe the topography of the Towns of Burlington, Candor, Dunn, Lida, and Maplewood. Note elevations of hill tops, size, shape and slope of hills.

(3) Measure the maximum slope of the hills using following scale. If hill is less than 1/10 mile on slope use half of values for 1/20 mile.

Slope 1^{o} equals 9 ft in 1/10 mile

5	46
10	93
15	142
20	192
25	248
30	305
35	370

(4) Suggest three or more possible explanations for the undrained depressions and tell how you could distinguish examples of each.

(5) Which way did the ice move which made this moraine? How known? Additional field observations required?

Urbana Quadrangle, Ill.

(1) Yankee Ridge is a terminal moraine. Contrast with other maps. Explain why it may be different

(2) To what extent has its topography been altered by postglacial work?

Marseilles Quadrangle, Illinois.

(1) How, where, and to what extent has the topography of this area been altered in postglacial time?

(2) What part of the area is terminal moraine?

(3) Contrast with the rest of the map in slope, size of hills, ~~etc~~ etc.

(4) Contrast this moraine with that of the Vergas quadrangle.

(5) Suggest reasons for difference

Mechanical analyses of till, 1922

Malt house, Madison from weathered part of drumlin.

	Total	ls + ct	foreign	
On 2"	8.8%	67%	33%	
1½	1.2	100	0	
1	2.4	89	11	
3/4	1.6	84	16	
½	1.9	93	7	
¼	3.5	92	8	sand
n 10 mesh	4.2	84.5	15.5	8.5
20	2.7	67	12	21
50	24.4	19	5?	76
silt	38.6	22	5?	73
clay	10.7	39	5?	

Drumlin near Waterloo.

On ¼" total	3.7%	ls 96%	
10m	2.9	73	1.651 mm
20	2.5	68	.833
50	14.4	15	.295 = 48 m
finer	76.5	22	

Clay Till Kumbem

#11. above lobe

1 mm	3.0	ls 14.1	
gravel ½ mm	1.4	sh & sl 81.1	
¼	2.0	fine 3.2	
⅛	3.4	10.1	mine. 1.6
1/16	3.3		
silt 1/32	5.4	27.6	
1/64	9.2		
very clay 1/128	13.0		
clay 1/250	11.5	69.3	
1/1000	23.4		
below	24.4		

.05 = 1/20

.005 = 1/200

#1 ls 79.2

10.0		
13.6	2.6	
3.6	3.9	16.0
3.6	4.8	
	4.7	
	9.9	
	11.9	35.1
	13.3	
	10.2	
	12.9	38.9
	15.8	

SOIL SERIES IN WISCONSIN

Miami Series: This series includes the light colored, timbered soils within the glaciated region where there is sufficient limestone material incorporated with the till to have an influence on the agricultural value of the resulting soils. In some instances there is a thin covering of loess-like material over the glacial till. While soils of all textures may occur within this series, the sand types are of limited extent. Where the lime carbonate has been leached from these sand soils or where the amount is not sufficient to influence the agricultural value the sands and fine sands are included with the Coloma series. The silt loam is the predominating type. The surface soils of the series may be slightly acid, but the subsoils are usually clacareous.

Rodman Series: This series includes the light colored, timbered soils within the glaciated region where the material has been assorted and deposited chiefly beneath the ice sheet, usually in the form of kames and eskers. Limestone may or may not be present. The surface is rolling to bumpy and hilly, the structure loose and open, the drainage excessive, and the agricultural value low. The series is of limited extent and is confined chiefly to the rough morainic regions.

Coloma Series: This series includes the light colored, timbered soils within the glaciated region where the till has been derived chiefly from sandstone and contains no limestone material, or only such a small amount as to have no appreciable influence upon the agricultural value of the resulting soils. The sandy types are by far the most extensive. The heavy members of the series are limited in extent. Both soil and subsoil of the types in this series are usually in an acid condition.

Kennan Series: This series includes brown or light brown soils which sometimes have a very slight reddish or pinkish tinge, with subsoils which are lighter brown than the surface or yellowish-brown. The material forming the soils has been derived largely from crystalline rocks, chiefly granites and gneiss, by the action of the Late Wisconsin Ice Sheet. The glacial debris is largely unassorted drift material, though stratification is sometimes seen in deep cuts. The surface varies from undulating to rolling and hilly, and stones and bowlders are common, with here and there stone-free tracts of varying extent. The soil and subsoil are acid. The heavier types predominate in this series, and it is seldom that material lighter in texture than a fine sandy loam is included with the Kennan series.

Chelsea Series: This series includes light colored upland timbered soils, the chief characteristics of which are the rough broken topography, the loose open subsoil, and the low agricultural value. Stones and bowlders are often plentiful. The Chelsea soils are of glacial origin derived in part from crystalline rock formations and in part from sandstone. These soils are confined to the morainic belts of northern Wisconsin and while the texture of some of the material is as heavy as a loam or silt loam, the predominant texture is probably sandy loam.

Vilas Series: This series includes light brown or grayish soils with yellowish or light brownish subsoils, where the material consists of glacial debris derived partly from crystalline rocks and partly from the Keweenawan sandstone formation. The light textured soils predominate and it is seldom that material heavier than a sandy loam is included with the Vilas series. This glacial debris is not calcareous and both soil and subsoil of all the types are acid. As with the Kennan soils, this material is largely unassorted drift, bytvarying amounts of stratified material is included with it.

Mellen Series: This series includes brown, or slightly reddish-brown soils with brown, reddish-brown, or slightly pinkish subsoils, where the material consists of glacial debris derived from the Huronian iron bearing rocks and mixed with sandstone material from the Keweenawan sandstone formation along Lake Superior. The gravel and small rock fragments which are present consist of 40 percent or more of sandstone, with varying amounts of basic igneous rocks. The dark colored rocks predominate in this series. The heavy members of the series predominate. The agricultural value is practically the same as the Kennan series. Both soil and subsoil are acid in all of the types.

Colby Series: The Colby series includes brown, light brown, or grayish soils with subsoils which are highly mottled with brown, rusty brown, gray, yellow, and drab. The surface soil is also mottled in places. The material forming this series consists of glacial debris from crystalline rocks which was doubtless deposited by the Pre-Wisconsin and Early Wisconsin Ice Sheets, and is therefore much more thoroughly weathered than the more recent drift. Such material may be found within the area covered by the Late Wisconsin Drift Sheet, in places where but little, or not, drift was deposited by the last ice invasion. It seems very probable that the surface soil may be in part of loessial origin. The surface is level to gently rolling, the subsoil is compact, and the internal drainage is deficient, which accounts in part for the mottled condition. Soil and subsoil are very acid. The silt loam is the predominating type.

Superior Series: This series includes lacustrine material, a portion of which has been influenced by glacial action. The clay, which is the predominating type, has a red color, compact structure, and is calcareous. There is but little difference in color and texture between the soil and subsoil. The lighter types of the series have light colored soils but are always underlain at varying depths by the red clay. The material overlying the clay may have been washed or blown in from adjoining areas or it may have been deposited and mixed with the clay by the action of the ice. The soil was originally timbered. Where the soil is largely lacustrine and where glacial action has been limited, the surface is usually level or has only a gentle slope, except where streams have cut deep channels through the material. Where glacial action has been more pronounced the surface may vary from undulating to rolling.

Poygan Series: This series consists of dark colored, lacustrine soils high in organic matter (from 5 to 15%, and underlain by red lacustrine material identical with that forming the Superior soils. It occurs chiefly as old lake beds and the areas represent regions which were once covered by waters tributary to the Great Lakes. The heavy members of the series predominate. It is closely associated with the Superior series.

Carrington Series: This series includes the dark colored prairie soils of the glaciated region where the material consists of glacial till. There may be a thin covering of loess-like material over the glacial till. The surface varies from level to gently rolling. The surface soil is usually acid. The silt loam is the predominating type.

Marshall Series: This series includes the dark colored, prairie soils of the unglaciated region where the material consists chiefly of loess or loess-like material. The subsoil may be in part residual from the underlying limestone. The silt loam is the predominating type.

Dodgeville Series: This series includes the dark colored, prairie soils of the unglaciated region where the material has been derived chiefly from the weathering of limestone. The surface material very much resembles the Marshall series and may be loessial in part. The subsoil, however, is residual, is usually of a red color, and heavier than the subsoil of corresponding types in the Marshall series. The silt loam is the predominating type.

Knox Series: This series includes the light colored timbered soils in the unglaciated region where the material consists of loess or loess-like silt which may be, in part, residual from shale associated with the Potsdam sandstone or from limestone. The surface is gently rolling to hilly and broken and exposed slopes erode rapidly. On steep slopes rock outcrops are common. The silt loam is the only type recognized. The surface soil may be slightly acid but the subsoil is usually somewhat calcareous.

Boone Series: This series includes light colored, timbered soils where the material has been derived from the weathering of sandstone formations. In some places the surface material has been influenced by wind action, and it seems very probable that some of the material has also been somewhat influenced by stream action. The soil and subsoil are usually acid.

Fox Series: This series includes the light colored, timbered soils within the glaciated region where the material has been reworked by the action of water and deposited as overwash plains, river terraces, or filled in valleys. Limestone material is present, especially in the subsoil in sufficient amounts to influence the agricultural value of the resulting soils. The silt loam is the predominating type. While sand types may occur within the region of reworked glaciated limestone material, the limestone is usually entirely absent or is present in such small amounts as to have no appreciable influence on the agricultural value of the soils. In such cases the sand types should be classed with the Plainfield series.

Plainfield Series: This series includes the light colored, timbered soils which occur as overwash plains, river or lake terraces, or filled in valleys, where the material contains no limestone or only such a small amount as to have no appreciable influence upon the agricultural value of the soils. While it is possible to have soils of all textures in this series, it is found that the sandy types are by far the most extensive. Soils of this series occur in the non-limestone glaciated region and also in the unglaciated portions of of the state. They are also found to a limited extent in the glaciated

limestone region where the lime carbonate has been removed from the soil material by the action of water. Both soil and subsoil are usually in an acid condition.

Antigo Series: This series includes light brown soils, underlain by brown or yellowish brown subsoils which grade into beds of stratified sand and gravel at from 1 to 3 feet below the surface. The material was derived largely from crystalline rocks, ~~reworked by glacial action~~, and deposited as outwash plains or stream terraces. The surface is level to very gently undulating. No calcareous material is present and both soil and subsoil are acid.

Lintonia Series: This series includes light colored, timbered soils in the unglaciated region where the material is largely colluvial and represents the wash from the loessial uplands. It may also occur as high or low terrace formation in which case it has been reworked to some extent by stream action, though it is not subject to overflow at the present time, except in a very few instances. The surface is level or has only a gentle slope from the foot of the bluffs along which it occurs, toward the lower land adjoining stream courses. In a few places erosion has cut channels across terraces causing the surface in such instances to be somewhat irregular. The silt loam is the predominating type.

Waukesha Series: This series includes dark colored soils, usually prairie where the material occurs as overwash plains, stream terraces, or filled in valleys. The subsoil consists of stratified sand or sand and gravel. The soils are usually strongly acid. This series may occur either in the glaciated or unglaciated region.

Wabash Series: This series includes dark colored soils in the unglaciated region where the material is of alluvial, and sometimes partly colluvial origin and occurs as first bottom land along streams within, or bordering, the loessial region. The silt loam and loam types predominate.

Clyde Series: This series consists of dark colored, timbered soils within the glaciated limestone region. The material is calcareous and occurs as old lake beds, low-lying poorly drained tracts, and as narrow strips of wet land adjoining streams. The surface soils contain large amounts of organic matter (from 5 to 15%) and the subsoils have a characteristic grayish or bluish color. The heavier types predominate.

Whitman Series: This series includes dark gray or black low-lying poorly drained soils in the glaciated or unglaciated crystalline rock region where the material occurs as first bottom land along streams, as low depressed areas in the upland, or as flat semi-marshy tracts where the drainage is poor. This series occupies a topographic position similar to the Clyde soils, but differs from the Clyde by being derived from non-calcareous material and being strongly acid. It differs from the Dunning series by being in a region of crystalline rocks instead of a region of sandstone. Heavy types predominate in the Whitman series.

Dunning Series: This series includes the dark colored soils outside of the glaciated limestone region which are comparable with

the Clyde, except that no limestone is present and they are always in an acid condition. The material occupies old lake beds and other poorly drained low land, either in the unglaciated region or in the non-limestone glaciated portion of the state. The heavy members of the series are of very limited extent; the sandy types are the most extensive.

Muck: This classification includes decaying vegetable matter in varying stages of decomposition, but differs from the Peat in that it contains a much larger amount of mineral matter. The amount of organic matter in Muck ranges from 15 to 50%. It may be considered as forming a gradation from material classed as Peat to the soils of the Clyde series. The Muck is often associated with Peat and the Clyde soils and is most extensive in the glaciated regions. The Muck is not as extensive as the Peat.

Peat: This classification includes decaying vegetable matter in varying stages of decomposition. It may be black or brown and very fibrous or thoroughly decomposed. It occurs in old lake beds and marshes in all parts of the state, but is most extensive in the glaciated regions. The amount of organic matter is always extremely high, always amounting to 50 % or over, and the mineral content is low. It varies in depth from 2 to over 10 feet.

Prof Whitson

finer textured soils have greater value.
organic content. Topography Stratigraphy
Soils series — groups - each having given geological origin

Table giving the Texture of Soils by Classes as shown by their Average Mechanical Analysis

Class of soil	Mechanical analysis giving the average percentage of soil separates in each class						
	2-1 mm fine gravel	1-.5 mm Coarse sand	.5-.25 mm Medium sand	.25-.1 mm Fine sand	.1-.05 Very fine sand	.05-.005 Silt	.005 — Clay
1 Coarse sand	10	23	21	23	9	9	5
2 Medium sand	3	13	20	38	12	9	5
3 Fine sand		2	12	49	20	11	4
4 Coarse sandy loam	9	24	16	10	10	22	9
5 Medium sandy loam	3	12	12	27	13	20	11
Fine sandy loam	1	2	3	29	28	27	10
6 Loam	3	4	4	14	15	40	20
7 Silt loam	1	1	1	3	9	68	17
8 Clay loam	3	4	4	11	11	37	30
Sandy clay	1	6	7	27	15	14	30
Silty clay		1	1	2	5	60	31
9 Clay	1	2	2	5	7	41	42

not occur as farm soil in Wis.

used as soil

not mapped usually mapped with medium sdy-l

sharply drawn line in field

does not usually occur alone.

trying Not to map in soil classification

GEOLOGY 143
Preglacial topography problem

Well records furnished by J. J. Faust and Sons., Kaukauma

T. 20, R. 19 E.
NENE1 John Brooks Drift 40 to shale
SWSW 3 Emery Beach Drift 33 to shale, total 300.
NENE 4 John Lappen Drift 106 (bored).
NE NE 5 Meyerhoffer Drift 130, limestone 24, total 154
SWNE 9 Mrs. Schreck Drift 50, shale 132, limestone 104, total 386.
SESW 10 Herman Bloy Drift 84, shale 50 total 134.
NWNW 10 Fink, Drift 103, shale 30, limestone 216, sandstone 33, total 382.
NENW 11 Jno. Gerrites Drift 69.
SWNW 11 Obenschur Drift 96, shale 90, limestone 113, total 289. Water at 142.
SWSW 11 Plotz Drift 100, shale 163, total 263.
SESE 11 Henry Fink Drift 76 to gravel.
NENE 12 B. Mickey Drift 72, shale 30, total 103.
W¼ post 14 Frank Wolfinger Drift 127, shale 61, total 188.
Center 15 Gust. Bloy Drift 100, shale 95, limestone 423, total 618. Very little water.
NWNW 34 Will Wolff Drift 58, rock?, total 111.
N¼ post 3 Drift 20, shale 160, total 180
NENE 34 St. John creamery Drift 28, shale 244, limestone 253, sandstone 10, total 535.
SESe 17 Nittekoven Clay 104, peat with logs 4, drift including gravel 72.
SWSW 4 Drift 75 to shale
NWNW 5 Drift 115 to rock
¼ post 5 Drift 130 to limestone
NENE 5 Drift 128 to rock
NWNW 8 Drift 148 to limestone
Center 8 Drift 163 to limestone
SESE 8 Drift 110 to shale
SWSW 10 Drift 105 to rock
NENE 13 Drift 150 to rock
NENW 16 Drift 113 to rock
SESE 17 Nittekoven, see above.
SE 20 Drift 80 to shale
NWNW 35 Drift about 10 to limestone.
SESE 4 Henry M. Beach Drift 53, shale 88, limestone 204, sandstone 57, total 402.
NWSW 2 Backer Canning Co., Dundas Drift 43, shale 225, limestone 192, sandstone 375, total 835.

T. 20, R. 20 E.
SENW 5 Drift 100. Big gas pressure blew out 60 yards of sand.
SESE 6 Harry Stanell Drift 98 big gas pressure.
SWSW 6 H, Mickey Drift 50, shale 80, total 130.
NWSW 7 John Flatly Drift 80, shale 31, total 111.
NWNW 7 M. Flatley Drift 56, shale 61, total 117.
SENW 7 Al. Ott Drift 115, shale and lime 132, total 247.
NWSE 7 Aug. Icke Drift 120, shale 61, total 181. Big gas pressure
NWNW 8 Art Stanell Drit 108 to sand
NWNW 8 Mrs. Stanell Drift 121.
SWSW 9 Emil Dickfuss Drift 135 to sand with gas.
SWSE 9 Julius Krueger Drift 133, rock 167, total 300.
NWNE 16 Chas Parsons Dift 123, rock 445, sandstone 5, rock 95, total 663.
NWNW 16 Mrs. Wolfmeyer Drift 349½ to gravel.

T. 20, R. 20 E., cont.
NENE 17 Otto Weigert Drift 325 to gravel
NESW 18 Brahm Drift 124, limestone 4, total 128. Drift contained wood and moss.
NENE 19 Schubring Drift 152 to hardpan (bored).
WP post 21 J. Slineback Drift 401, rock 402, [illegible] sandstone 81, total 884.
SW 25 Brillion village Drift 115, limestone 55, shale 315, limestone 200, sandstone 128, total 813.
NWSW 19 Frank Dix Drift 72, shale 72½, toral 144½.
NWSE 8 Gus Huebner Drift 313, limestone 72, total 385.
NENE 33 henry Mischler Drift 2, shale 202, limestone 211, sandstone 71, total 486.
NWNW 27 Drift 450 to shale---clay 90, sand 21, clay 115, muck and sand 8, clay 216, shale 10, limestone 6, total 466.
N 28 Peter Reuther Clay 100, rotten wood, moss, small shells, gas 4, fine sand 30, red clay with some white streaks and a few stones 238, shale 6, total 378. Drift 372 to shale.

T. 21, R. 20 E.
SWNE 6 Jno. Brittnacher Drift 40, limestone 139, total 179 (flow).
SENW 5 Jno. P. Brittnacher Drift 191, rock 22, total 213.
SWSE 5 Gilson Drift 117 (sand and gravel).
Store Drift 140 to sand.
NWNE 8 High School. Drift 175, shale 89, limestone 189, sandstone 65, total 318 Gravel in drift from 155 to 175.
NWNW 8 Ed. Ellis Drift 203 (clay 120, gravel 15, sand and gravel 65), shale 11, limestone 208, sandstone 22, total 444.
S½ post 6 Mc Gown Drift 178, limestone 27.
N½ post 7 H. Roloff Drift 190, limestone 22, total 212.
E. ½ post 7 Spitz Drift 160, shale 43, limestone 9, total 212.
SWSE 8 Jno. Clancy Drift 128 bored.
NENE 16 Adolph Meyer Drift 72, limestone 18, total 90.
NESE 17 Pat. Hanaway Drift 155, shale 157, limestone 212, sandstoen 51, total 575.
SWNE 17 Wm. Clancy Drift 79 bored.
SP post 18 A. J. Summers Drift 128 (sand and gravel)
SESE 6 Drift 190 to limestone
NWNW 29 Askerton Drift 200 to shale.
Continued on next page

T. 21, R. 19 E.
NENW 4 Drift 100, rock 35, total 135.
NENE 5 Drift 115, rock 12, total 125.
SENE 5 Drift 98, rock 10, total 108.
SENW 18 Drift 87, rock including sandstone 213, total 300.
NESW 18 Drift 74, rock including sandstone 240, total 314.
NE 22, Hugh Finnegan Drift 97, shale 61, limestone 209, sandstone 16, total 383.

T. 20, R. 18 E.
NENW 1 Drift 90 to limestone
W½ post 12 Drift 110 to limestone
SESW 12 Drift 200 to limestone
SESW 13 Drift 185 to limestone

T. 19, R. 20 E.
SWSE 16 Drift 80 to limestone
NWNW 15 Potter Drift 70 to lime.

T. 19 R. 19 E.
NENE 4 Drift 30 to limestone

Well records, cont.

E¼ post 19 Jim Finnerty Drift 100, rock? 139, total 239
SESE 19 Summers Drift 70, bored. to sand.
SENE 20 Jim Wall Drift 103, limestine 1, total 104
SWSW 20 RR. Drift 250, rock 50, sandstone thin, rock about 250, sandstone about 450 Tamarac log in sand at 90. Salt water. Inf. from C.L.Green.
SESW 21 Mrs. Hart Drift full of bowlders 76, limestone 41, total 117.
SESE 22 Henry Cowell Drift 72, limestone 8, total 80.
NWSW 28 Tom Farrell Drift 35, limestone 39, total 74.
NESE 29 Jno Brick Drift 48, limestone 127, total 175.
SESE 30 Fox Cheese Fact. Drift 218, shale 86, limestone 200, sandstone 30, t.534
Center 30 M. Summers Drift to gravel 70. bored.
NWSE 30 Meehan Drift to gravel 68 bored.
Center 31 Geo. VanDe Wettering Drift 67 to gravel.
E¼ post 31 Mike Haase Drift 120 bored.
NWNW 32 Drift 130, shale 190, total 320. Mrs. Fox.
NWSW 32 J.J.Fox Drift 130 bored.
NWNE 32 Drift 107 to gravel.
SE 32 Dennis Keating Drift 67.
NWNW 33 John Brick Drift 60, limestone 13, total 73.
NWNE 33 Tom.Brick Drift 80, limestone 34, total 114.

T. 21, R. 19 E.

SENW 2 High School Drift 90.
NWNE 10 Scall Drift 108 , limestone 22, total 130.
NWNW 11 Pete Berken Drift 128, limestone 12, total 140.
NWNE 13 Dan Summers Drift 134, rock 366, sandstone 34, total 544.
NENE 14 Wm.Boartz Drift 140, limestone 69, total 209.
SESE 14 Ed.Kerner Drift 109, shale 65, limestone 202, ss and sh 97, total 473.
NWNW 14 Drift 127, rock 8, total 135. Dexheimer.
NENE 15 Leibergen Drift 130, rock 58, total 188.
SWSW 14 Freeman Drift 100, rock 7, total 107.
SESE 15 Pat.Golden Drift 113, rock 261, total 374 in sandstone.
SWNW 16 Verbeten Drift 110, limestone 200 to ss, total 310.
SENW 17 Arnold Biese Drift 120 to hardpan.
NENE 19 Mike Nytes Drift 112, limestone 5, total 117.
SWNE 19 Matt.Feldkamp Drift 100, limestone 16, total 116.
SWSE 19 Louis Schermitzler Drift 112, limestone and sandstone 141, total 253.
S½ post 20 Fahrman Drift 131, limestone 6, total 137.
SESE 20 Mitchler Drift 111, limestone 200, sandstone 14, total 325.
SWNW 21 Chas.Clune Drift to hardpan 120.
SWSE 21 Tom.Clune Drift 67½, rock 272, total 339½.
NENE 22 Hugh Finnegan Drift 95, rock inc. ss 286, total 381.
E¼ post 22 Wolfgang Pritzal Drift 90, rock inc. ss, 227, total 317.
NESW 22 Hefner Drift 70, shale 90, limestone 201, sandstone 18, total 379.
NWNW 23 Frank Maloney Drift 94, rock 64, total 158.
SESE 23 Jno.Flynn Drift 86, shale 108, limestone 215, sandstone 32, total 441.
NWNW 24 Frank Schmidt Drift 123 to shale.
NENW 24 Rudolph Sejultz Drift 95, rock inc. ss 321, total 416.
NENW 24 Frank O8Neil Drift 81, rock inc. ss. 328, total 409.
NENE 24 Edgar Borneman Drift 95, rock 115, total 210.
SESE 25 Tom Cox Drift 156, shale 37, total 193.
E¼ post 25 Van Den Wettering Drift 67 to gravel.
NENE 25 Jno.Beyers Drift 92, shale 17, total 109.
SWSE 26 Tom.Rohan Drift 61, shale and limestone 182, total 243.
SESE 26 Jim Moffet Drift to shale 76 bored.
NENE 26 [illegible] Drift to shale 82 bored. Ed.Finnegan.
SWNW 26 Adam Holzschu Drift 14, shale 80, total 94.
NESW 27 Keuntjes Drift 14, shale 72, total 86.
E¼ post 28 Fox Drift 2, shale 78, total 80 Shale outcrop.

21-19E cont.
E¼ post 28 Fox Drift 2, shale 78, total 80 Shale outcrops here.
S½ post 28 Pat. Rohan Drift 8, shale, limestone, sandstone 441, total 449.
N¼ post 28 John Powers Drift 89, shale 40, total 129.
SWNE 29 Barney Wilpolt Drift to gravel 108 bored.
Center 29 Theo.Barber Drift and rock 153.
N½ post 29 Dan.Glaschine Drift 114, rock inc. ss. 258, total 372.
E¼ post 30 Rupert Drift 131, limestone 22, total 153.
NESE 30 Levi Rupert Drift 123. limestone 16, total 139. Very little water.
NWNE 30 Wm.Rohan Drift 120, limestone 28, total 148.
SWSE 30 Jim.O'Connor Drift 131, limestone 13, total 144.
NWSW 30 Adam Killian Drift 131, limestone 28, total 159.
W¼ post 31 Mike Loderhaner Drift 142, limestone and sandstone 209, total 351.
NWNW 32 Wm.Kobbusen Drift 120, limestone 20, total 140.
NENW 32 A.Keating Drift 131 to hardpan.
SENE 31 Frank Thilman Drift 136, limestone 19, total 155.
SESW 32 Frank Schmidt Drift 150, limestone 200, sandstone 23, total 373.
NESW 33 Mike Maloney Drift 6, shale 200, limestone 200, sandstone 55, total 461. In road W. of house shale outcrops.
SENW 33 Mike Weiss Drift 6, shale 84, total 90.
SESE 28 Henry Penterman Drift 12, shale 138, total 150.
SWNW 34 Theo.Eiting Drift 20, shale 55, total 75.
NWSW 34 Wm.Biese Drift 18, shale 66, total 84.
SENW 34 A.Tiesling Drift 15, shale 85, total 100.
E¼ post 34 Fassbender Drift 14, shale 208, limestone 214, sandstone 69, total 505.
SWSE 35 Mrs. Williams Drift 40, shale 60, total 100.
SENW 36 C.Keller Drift 71, rock 93, total 164.
SWNE 36 Stabonic Drift 99, shale 213, limestone 3, total 315.
SWNW 36 Amy Knoesph Drift 70

T. 21, R. 18 E.
SESE 25 Meyer Bros. Drift 126, limestone 18, total 144.
SWSE 25 Jos. Lehrer Drift 56, limestone 179, sandstone 130, total 365. In ravine flow.

Kaukauna city well No. 4
0-4 drift, 4-170 limestone, 170-220 St.Peter ss and sh, 220-340 limestone, 340-380 St.Lawrence red sandy limestone, 380-510 Mazomanie ss and sh, 510-726 Dresbach sandstone.

T. 19, R. 20 E.
Well in Hilbert. 0-47 clay, 47-52 sand, 52-58 hardpan, 58-88 Niagara limestone, 88-132 shale.

Aneroid elevations-F.T.Thwaites, 1922.
T. 21, R. 20 E.
SE cor. 4 850 SE cor. 3 900. E¼ post 3 895. Center 17 730 E¼ post 17 745
SE cor. 17 780 SE cor. 20 850. SE cor. 21 900 Se cor. 22 900, S¼ post 23 885

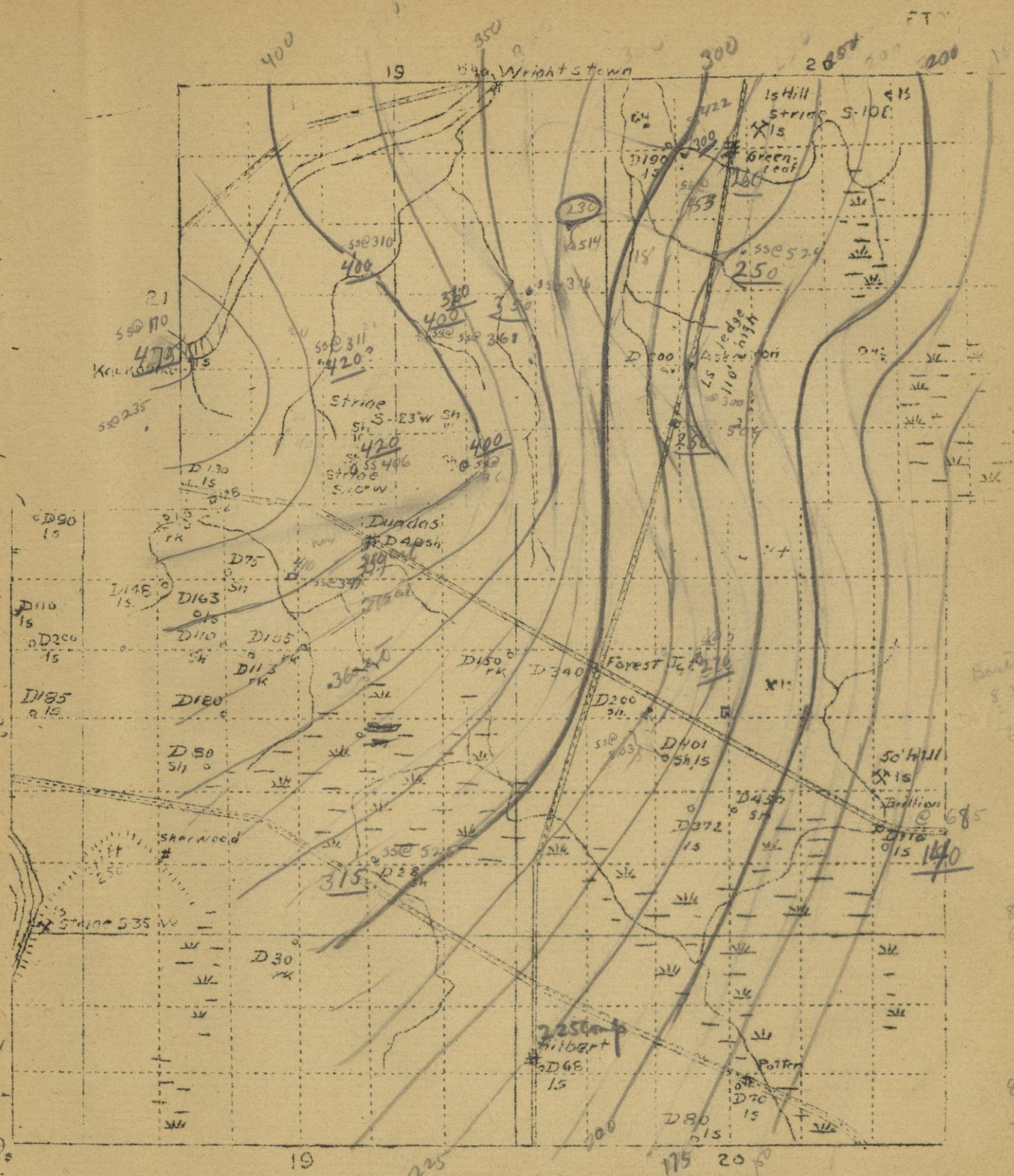
Draw a geological section from Kaukauna to Brillion and forecast complete log of a well 1500 ft deep at Brillion.

Well 2m. W. of Brillion. NW 27, 20-20 E. 0-90 clay, 90-111 sand, 111-226 clay, 226-234 muck and sand, 234-450 clay, 450-460 soft shale, 460-466 Ls.

Peter Reuther well, North part of 28,20-20 E. 0-100 clay, 100-104 rotten wood,moss,small shells,gas. 104-134 fine sand, 134-372 red clay with white streaks and a few stones, 372-378 shale,

Nittekoven well. SE corner 17, 20-19 E.0-104 clay, 104-108 burned swamp with logs. 108-180 drift and gravel.

DIRECTIONS Draw 50' contours, sea-level datum, on bed-rock surface. Get elevations from Wis. State Survey,Vol.II; Bulls. 20 and 36. Draw geological section from Brillion to Hilbert. Forecast log of well in SE SE 33, 20-20 E.



Well 2m. W. of Brillion. NW 27, 20-20 E. 0-90 clay, 90-111 sand, 111-226 clay, 226-234 muck and sand, 234-450 clay, 450-460 soft shale, 460-465 Ls.

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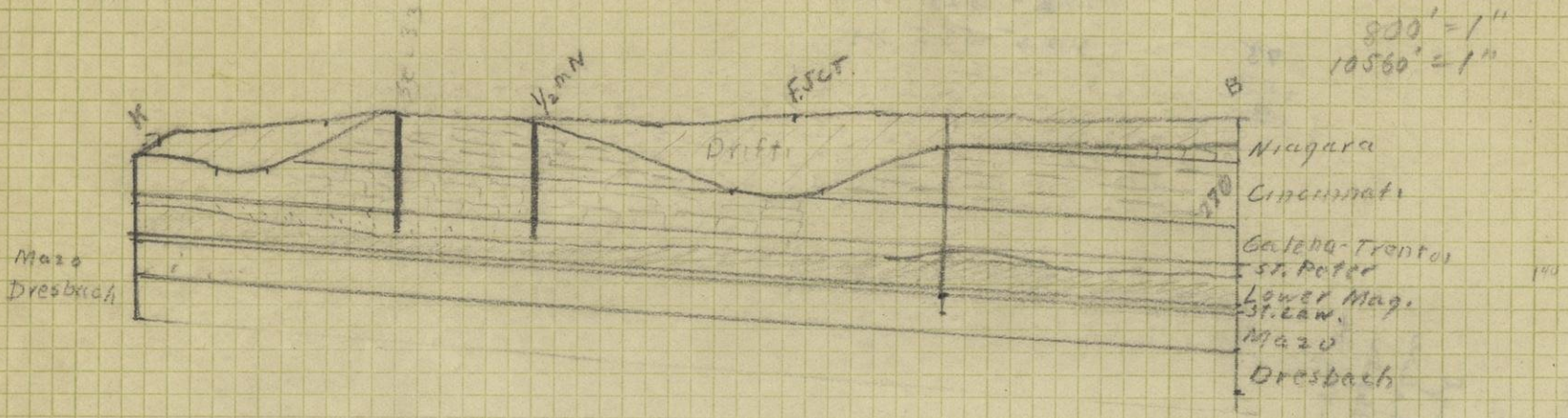
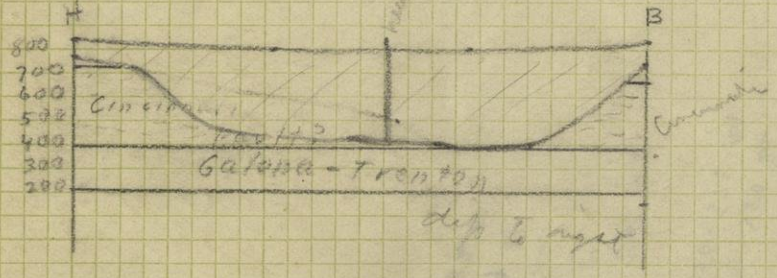

800' = 1"
10560' = 1"
A
B
½ mi N
F.SCT.
Drift
Niagara
Cincinnati
Galena-Trenton
St. Peter
Lower Mag.
St. Law.
Maquoketa
Maquoketa
Dresbach
Dresbach


A
B
800
700
600
500
400
300
200
Cincinnati
Galena-Trenton
Cambrian

NWNE 13 - 21-19E
shale at 510ft

SESE 14, 21-19
Drift 0-109
sh 109-174
ls 174-376
ss 376-473

SENW 16 - 21-19 shale ss at 310

SESE 20, 21-19 0-111 drift.
111-311 ls
311-325 ss

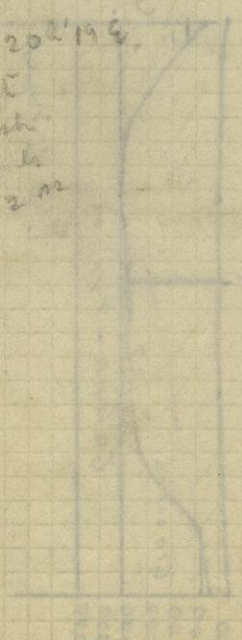
NESE 22 - 21-19.
0-70 drift
70-160 shale
160-361 ls
361-379 ss

SESE 23 - 21-19E
0-86 drift
86-194 sh
194-409 ls
409-441 ss

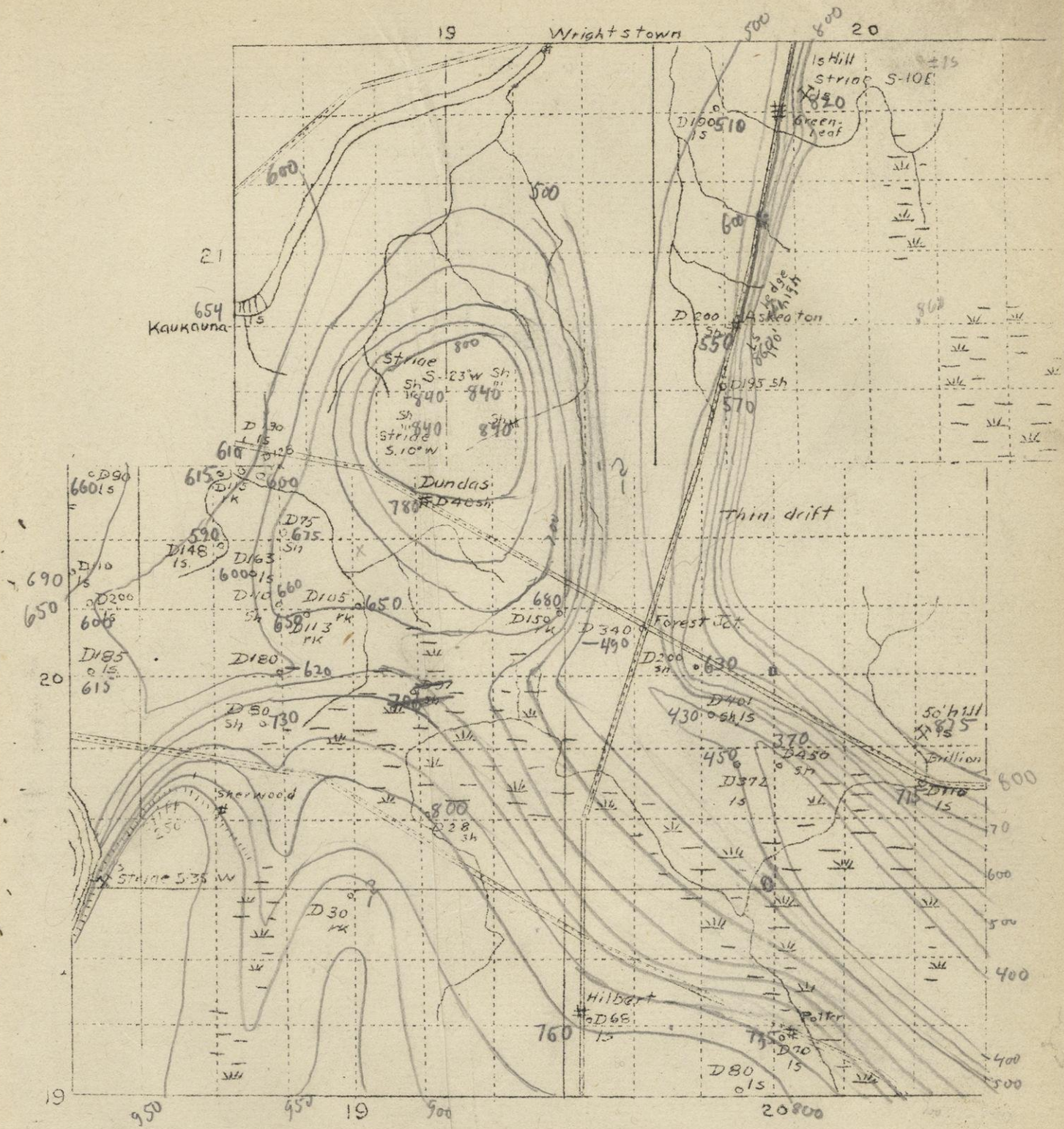
SWSE 22 in ranna - 21-19W
0-56 drift
56-235 ls
235-365 ss

SE SW 32 0-150 drift
150-350 ls
350-373 ss

NWNW 10 - 20-19E.
0-103 drift
103-133 sh
133-349 ls
349-382 ss



St Johns shale from
0 to 26
26-272 shale
272-525 ls
525-535 ss



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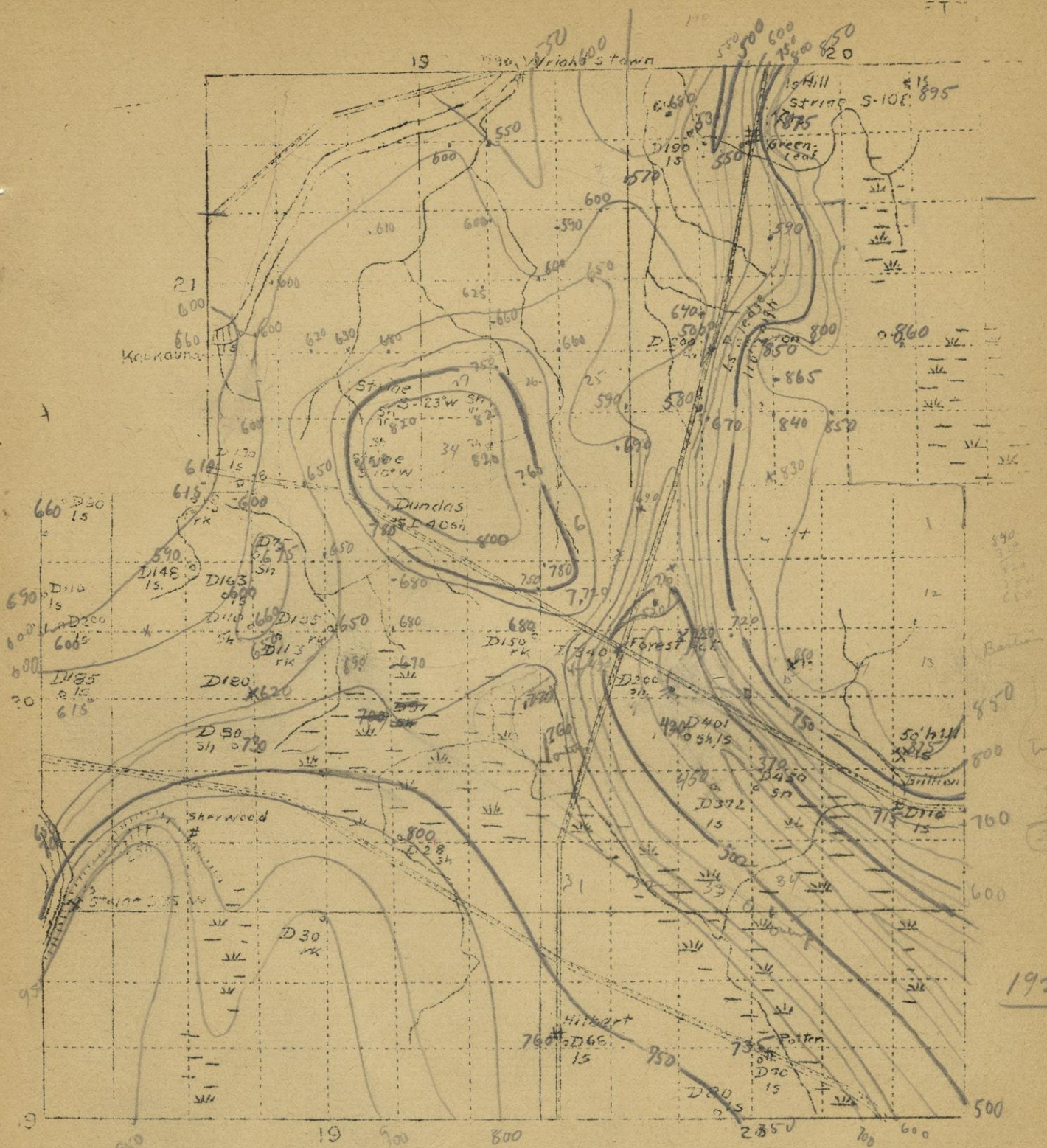

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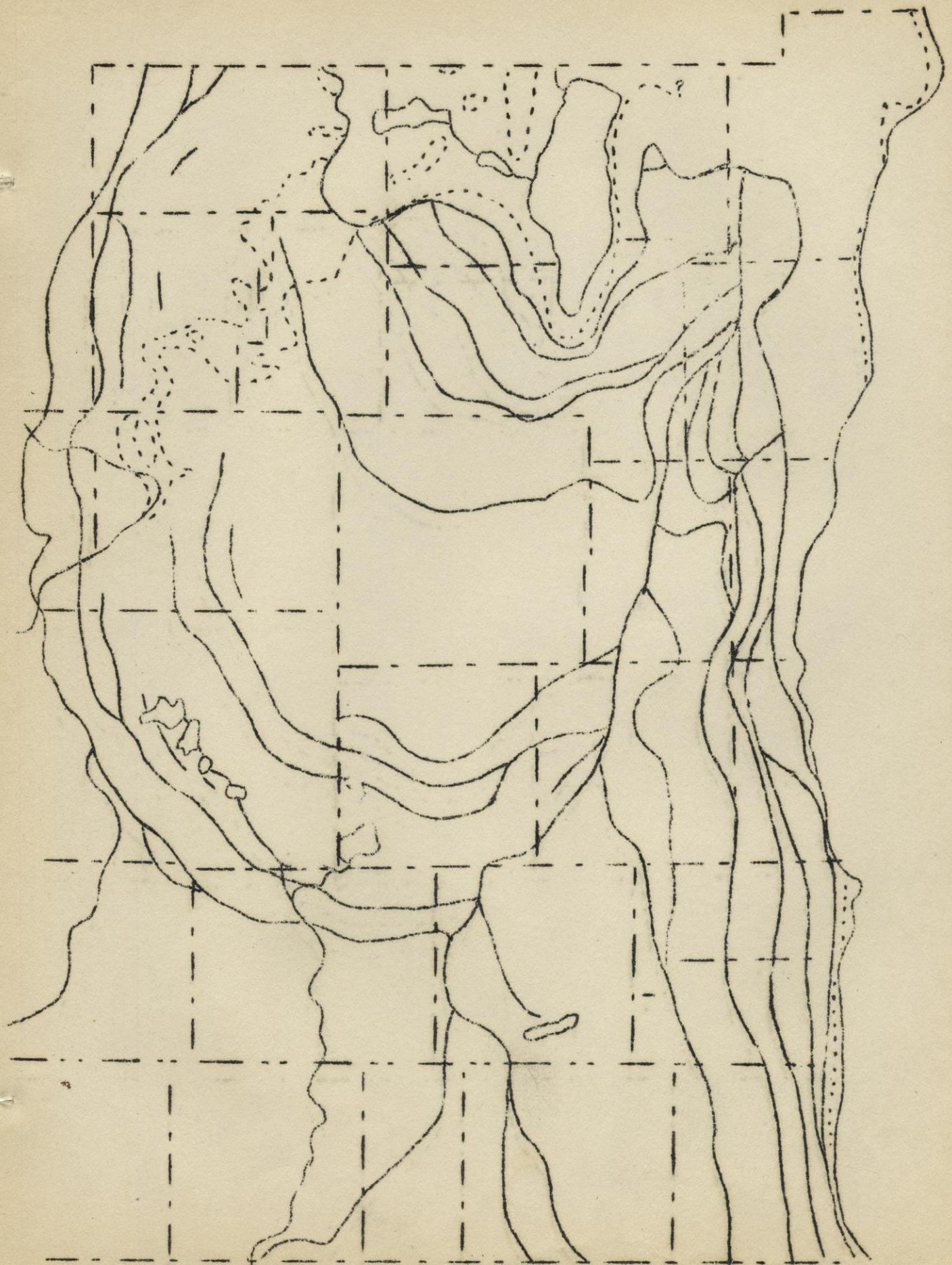
GEOLOGY 143
GLACIAL GEOLOGY
100 Review Questions

1. Where and what evidences have you seen in the field which bear on the origin of drumlins?
2. Outline the history of the differentiation of the drifts in northern Illinois from the Darien or West Chicago Moraine west giving (a) reasons for changes in interpretation and (b) where the evidences were seen in the field
3. Outline the proofs that the Illinoian drift of northern Illinois and southern Wisconsin is really much older than the adjacent Wisconsin drift and state where examples of each kind of evidence were seen in the field
4. Explain the origin and significance of the postglacial rock gorges of the Old Drift region
5. Discuss the nature and origin of gumbotil and state where seen in the field
6. Outline the evidences which demonstrate the subdivision of the Wisconsin stage of glaciation into three substages and tell where examples of evidence were seen in the field
7. Should or should not the Wisconsin be divided into separate stages instead of substages?
8. Define (a) interglacial interval, (b) glacial stage, (c) cirque, (d) nevé, (e) postglacial
9. Discuss the origin of the basin of Lake Genova
10. Discuss the significance of the outline of the Niagara escarpment of eastern Wisconsin on the question of glacial erosion
11. Discuss the progressive change in the relative sizes of the Green Bay and Lake Michigan or Illinois Lobes
12. Discuss the origin, material, and topography of the Interlobate or Kettle Moraine of eastern Wisconsin and tell where studied in the field
13. Discuss the origin and nature of the glacial drainage channels which cut the Interlobate Moraine in eastern Wisconsin and give examples seen in field
14. Discuss the origin and distribution of the glacial outwash terraces of the Oconomowoc-Eagle region in eastern Wisconsin
15. Give the succession of deposits at the Two Rivers Forest Bed and discuss the history of events which they demonstrate
16. Outline the steps in the glacial history of northeastern Wisconsin stating very briefly where evidence demonstrating them was seen in the field
17. Outline the steps in the glacial history of northern Illinois stating very briefly where evidences which demostrate them were seen in the field
18. Outline the history of the lateglacial lakes in the Michigan basin and state where examples of each were seen in the field
19. Outline the history of the lateglacial lakes of the Fox-Wolf-Winnebago Valley and state where examples demonstrating this history were seen in the field
20. Account for the color of the Late Wisconsin Drift in northeastern Wisconsin
21. Discuss the methods of correlation of varved clay deposits citing examples of varved clays seen in the field
22. Discuss with diagrams the errors in estimating a gravel deposit from too shallow test pitting
23. How do you distinguish between a delta and cross-bedded outwash citing examples seen in the field
24. How do you differentiate between beach gravel and outwash gravel giving examples seen in the field
25. Account for the fact that east of Beloit the Illinoian drift is little eroded and near Monroe the topography of the same drift is just like that of the Driftless Area
26. Discuss the causes of the formation of the Driftless Area
27. Discuss the causes of the formation of the Green Bay and Lake Michigan Lobes
28. What is the result on drumlins of a change in direction of ice movement and give examples seen in the field

29. What is the significance of the exposures of drift and striae at Valders, Wis.?
30. Describe the succession of material formed by the weathering of till under (a) poorly drained, (b) fairly well drained, and (c) well drained conditions
31. Give the commonly recognized glacial succession in the Mississippi Valley and mention which drifts you have seen in the field and where
32. Account for the fact that pits at Janesville find very sandy gravel and those at Beloit, farther downstream, are in stony gravel
33. You are running a traverse through dense timber and brush and note irregular topography, kettle holes, some flat summits, sand and gravel shown by uprooted trees, boulders in low ground and kettles. Interpretation? Where seen in field?
34. You are running a traverse through dense brush and timber and note irregular topography, no flat summits, coarse gravel, sand, and till shown by overturned trees, boulders everywhere. Interpretation? Where seen in field?
35. You are running a traverse through dense brush and timber and note level topography, fine sandy soil as shown by uprooted trees and nature of vegetation, no stones or boulders, area lower than adjacent tracts. Interpretation? Where seen in field?
36. You are running a traverse through dense brush and note level topography except for a few ravines, sand and gravel shown by uprooted trees and in banks, few boulders. Interpretation? Seen in field?
37. Discuss the conditions requsite for the formation of varves (not their correlation). Where seen in field?
38. Discuss the Delavan Lobe in the light of present knowledge
39. Discuss the time relations of the retreat of the Lake Michigan and Green Bay Lobes giving evidences seen in the field
40. Discuss the Iowan drift giving its location, history of nomenclature, material, topography, and correlation with respect to other drifts
41. Discuss the Toronto giving subdivisions, nature of evidence, interpretation
42. Discuss the use of loess deposits as time markers in Pleistocene geology
43. Give two theories of the mode of deposition of loess with evidences bearing on this question including facts seen in the field
44. Discuss and compare two theories of the source of the material of the loess deposits of the Mississippi-Missouri Valley
45. What features in a terminal moraine guide you in looking for stony gravel in the associated outwash plain? Examples seen in field?
46. What features of kames and eskers tell of the kind of material without having to see any exposures?
47. Discuss any of the recognized interglacial or interstage intervals giving the history of nomenclature, materials and other evidences, interpretation, correlation, examples seen in field
48. Discuss any of the several commonly recognized glacial stages on same basis as above question
49. Name the several centers of continental glaciation and what drifts came from each
50. Discuss two principal theories of the origin of drumlins
51. Distinguish between (do not discuss origin in detail): (a) varved clay and laminated clay, (b) kame and esker, (c) kame and pitted outwash, (d) drumlin and roche moutonnee, (e) fresh water glacial lake clay and marine glacial clay
52. Outline points of difference between lake terraces and outwash terraces
53. What glacial and glacio-aqueous deposits require moving ice for their formation?
54. What glacial and glacio-aqueous deposits require or might equally well be formed by stagnant ice?
55. Discuss two different theories of the origin of eskers and locate eskers seen in field citing any observations which may bear on this question
56. Discuss the origin of the basins of the Great Lakes
57. Discuss the origin of the basins of the Finger Lakes of New York

58. Compare glacial and stream erosion of a valley by a mountain glacier as to efficiency and results; compare normal stream and continental glacial erosion in same way
59. Discuss the origin of cirques
60. Discuss different methods of the formation of hanging valleys
61. Discuss the formation of fiords
62. What is the cause and mechanism of the motion of ice in glaciers?
63. What evidences prove very long duration of the Pleistocene?
64. How have attempts been made to measure postglacial time in years?
65. Discuss Crolls hypothesis of the cause of glaciation
66. Discuss the CO_2 hypothesis of the cause of glaciation
67. State the primary requisites of any theory to explain glaciation
68. Discuss evidences of lateglacial and postglacial earth movements in the eastern U. S. Do not discuss cause of movement
69. Remains of temperate climate animals and plants are discovered in a bed of gravel between two tills. Discuss (a) criteria by which the origin of the gravel might be determined independently of the remains, and (b) significance which might be attached to the remains
70. How may postglacial erosion be used as a time measure of the age of drift? Postglacial weathering?
71. Under what conditions may glacial tills of different ages have distinct lithological characters? Examples seen in the field?
72. State the best single diagnostic feature which will tell the difference between (do not discuss origin): (a) beach gravel and outwash gravel, (b) lake bar and esker, (c) esker and ridge between two kettles of pitted outwash, (d) delta and outwash, (e) outwash and sandy lake bed
73. Name five different important causes of the formation of outwash terraces and give examples seen in the field
74. State in a single sentence the most important single conclusion drawn from (do not discuss origin in detail): (a) presence of scattered glacial boulders in interlaminated clay and silt, (b) plain of sand and gravel having kettle holes in it and located next to a ridge composed of knobs of till, (c) greater depth of water inside of a fiord than just outside its mouth, (d) very abundant granite boulders in drift of a given region, (e) till overlying with irregular contact horizontally stratified sand and gravel
75. Give one outstanding difference which enable you to distinguish between: (a) continental and mountain glacial till, (b) striae and artificial scratches, (c) till and weathered gravel, (d) fiord and drowned valley, (e) striae and slickensides
76. Explain and contrast the methods of nourishment of mountain and of continental glaciers
77. Explain fully two distinct and positive methods by which you can tell the direction along striae that the ice moved
78. Account for the observed fact that most glacial material was derived from a comparatively short distance from where it is now found
79. It was argued at one time that since very old drifts are deeply oxidized the Red Drift of northeastern Wisconsin is very old. Discuss this hypothesis citing evidences seen in the field
80. On an outline map of eastern Wisconsin mark the area occupied by ice at (a) maximum of Illinoian, (b) maximum of Early Wisconsin, (c) maximum of Late Wisconsin, (d) glacial lakes at each time and their names
81. On an outline map show (a) routes followed on field trips, (b) regions where you saw drumlins, (c) location of the interlobate moraine of eastern Wisconsin, (d) regions of large areas of pitted outwash seen on trips, (e) shoreline and outlet of Later Glacial Lake Oshkosh
82. Tell where or locate on outline map where you saw in field (a) kames, (b) eskers, (c) outwash terraces, (d) varved clays, (e) gumbotil

83. (a) In what kinds of glacio-fluvial deposits would you search for stony gravel? (b) Discuss the origin and nature of one of these, (c) In which would you expect to find the largest deposits of well-sorted gravel and why?
84. Define in (a) terms of fact or observation and (b) in terms of interpretation or origin (do not discuss origin in detail) using two parallel columns: (a) varve, (b) till, (c) esker, (d) gravel, (e) kame, (f) hanging valley, (g) hinge-line, (h) loess, (i) drumlin, (j) isobase
85. Discuss the statement once used as evidence of equivalent age: "The extreme weathering and the advanced erosion of the drift at Marshfield (in the granite region of northern Wisconsin) is at least equal to that of the oldest drift sheet in Iowa and Kansas" (where the bed rock is Coal Measures).
86. Account for the difference in compsition of the Darien and Marengo Moraines
87. Account for the origin of Lake Winnebago
88. What decisive evidences tend to show that the ice caps of Canada disappeared entirely at least once during the Pleistocene?
89. Logs of wood are found in digging a well through the glacial drift. State what investigations must be made in order to determine their significance
90. Discuss the evidences of interglacial man in North America
91. Account for the quite general presence of a silt covering on outwash plains and give locations where this was seen in the field
92. It is desired to find a water-bearing gravel bed of considerable horizontal extent at or near Manitowoc. Reasoning from observations on the glacial history of this region discuss fully the chances of finding such
93. A well is being drilled through the drift and several feet of coarse gravel is found with till above and below. Bailing exhausts the water in a few minutes. Interpretation?
94. A well was drilled through the drift and found several feet of coarse gravel with till above and below. A short test gave considerable water but when a permanent pumping plant was put in operation the capacity soon fell off to a very slight production. Explanation? (Assuming no failure in well itself)
95. In what type or types of glacial or glacio-fluvial deposits do most relatively small lakes occur?
96. Discuss the significance of the Brooklyn moraine and all other similar features you have seen in the field
97. State in a single sentence a single line of evidence which definitely proves: (a) former presence of a glacial lake in a given area, (b) a topographic evidence which shows the course of former valleys in a region now covered by pitted outwash, (c) whether a moraine is the terminal moraine of a glacial stage or a readvance after some time or a recessional moraine outside of which the ice lay not long before its formation, (d) that a given lake basin was due to glacial erosion, (e) that [illegible] an area was covered by the continental ice sheet
98. Discuss fully the cause and effects of lateglacial earth movement in the Great Lakes region
99. Outline briefly the history and drainage changes of the glacial Great Lakes
100. Account for the difference in topography of the Darien and Johnstown Moraines and the moraines of central Illinois



GLACIAL GEOLOGY OF SOUTHEASTERN WISCONSIN AND NORTHEASTERN ILLINOIS
Scale 1:1,000,000

Outline for field trips, 1926.

General. The long field trip will start May 6 regardless of weather and will last at least four days. There will also be at least one afternoon trip. This year the work will be divided into three phases: (1) reading and taking of notes before going on the trips, (2) field work, and (3) preparation of the report. Graduates not completing a report will receive only two credits for the course.

Subjects of study. The following subjects will be studied:
(1) The relative ages of the Wisconsin and the older or pre-Wisconsin drifts,
(2) Possible subdivisions of the young drift into either the Early and Late Wisconsin stages of Leverett(previous to 1915),or into two stages divided by the Forest Bed of northeastern Wisconsin,
(3)The debatable area in northern Illinois which has been classed in several glacial stages by various authors.
(4) The relief features of the Wisconsin drift such as drumlins, terminal moraines, and eskers.
(5) Beaches and deposits of glacial lakes including an attempt to study the varved clays by the methods of DeGeer and Antevs.

Maps. Maps will be furnished to half of the class so that each person receiving a set will have to share it with another student. These maps are to be used in the field. In order to understand their relation to the geology a copy of Alden's map has been placed in Room 225 on which the prospective route and the boundaries of the quadrangles have been indicated. Copy the terminal moraines, drumlins, eskers, etc. onto the topographic sheets for a mile or two on both sides of the route. Use red for moraine, blue for outwash, green for drumlins, yellow for limit of the "red drift", purple for beaches, black for eskers. Crayons can be obtained in Room 224 if you have none. Do this work carefully taking account of the contours and it will be a great help in the use of the maps in the field. Number the sections near the route where not already done. Section lines will have to be drawn on a few of the maps. It will be expected that whenever a stop is made you will be able to place a pencil point on the exact location. Watch the speedometer for distances and the sun for directions. It is not possible to stop at all interesting points but keep your eyes open and follow the geology on the maps at all times.

Notes. All students are expected to keep notes. Give locations by township, range, and section and by distance from nearest town. Read the outline on field methods before starting. Not all of the route is covered by topographic maps. In such regions locations will be furnished.

Suggestions. It is hoped that the following suggestions will be of help both in reading and in the field. From Madison to Dane the region is ground moraine with a few drumlins. Account for the smooth topography near Dane as contrasted with the high hills near Lodi and Prairie du Sac. What bearing has this on the question of the determination of the age of different drifts? Note evidences of amount of glacial erosion in this rugged region contrasting it with the hills west of the terminal moraine. Observe the nature of the deposits in the valley bottoms. Note the terraces at Prairie du Sac and suggest reasons for their formation. Account for the relation of the moraine to the outwash. Observe the edge of the moraine from Prairie du Sac northward. Account for the valley through the moraine and for the larger kettles in it. Also account for the kettle in the outwash at the residence of the late ex-Gov. Phillipp. State general conclusion from this data.
Suggest origin of the fan-shaped hill on S.T. H. 12 at the foot of the quartzite bluffs. What formed the soil on the top fo the quartzite ranges? What was the condition in the valley above Baraboo during the maximum of the last ice? What was the origin of the sandy plains west of the terminal moraine in both the Baraboo and the Wisconsin valleys? Consider two hypotheses of the origin of the scattered bowldors west of the moraine.

What evidence would you seek for to settle this question? Account for the Dells. Make a sketch showing preglacial and present drainage in the region of the Dells and Devils Lake. Account for the dissection of the edge of the outwash plain northeast of Kilbourn.
Explain the lake deposits. An attempt will be made to establish correlation of several exposures. What caused the drainage of the large lake? What was the name and outlet of the lake east of the moraine? What led to its extinction?
Account for the "Red Till Moraine" northeast of Fisk and for its difference from the drift farther south. Could evidence of the ice recession be found outside of the area of the Red Till? Account for the color of the younger till.
What surface indications are there of the course and outlet of the Brillion preglacial valley?
Consider not less than two possible explanations of the Two Creeks forest bed. How can evidence as to the minimum recession of the ice during its formation be obtained?
Look for beaches of higher lake levels near Manitowoc. Comment on the cemented gravels.
Examine the striae at Valders for direction of ice movement. Suggest reasons for the change. Where is the interlobate moraine within the red drift area? Why were the red drift lobes different from those of the gray drift? Comment on the inferences as to the age of the drifts.
Account for the character of the gravels in the pit at Brothertown.
Note the red drift moraine south of Fond du Lac and compare it with the moraines of central Illinois. What is the bearing of this on the question of discrimination of different stages of drift? Observe the outline of the Niagara escarpment and compare it with (a) other glaciated escarpments, and (b) unglaciated escarpments. Account for the existence of outliers in some places and not in others. Account for the paucity of caves in the Niagara dolomite.
Account for the relation between eskers and drumlins.
In the Oconnomowoc district explain the several levels of the hill tops. Account for the greater smoothness of the lower terraces and for the lakes. Find several residuals on the terraces. Examine the terrace scarps and comment on their shapes as contrasted with lake cliffs. With the aid of the map draw a sketch showing the approximate ice margin and outlets for each terrace. Make similar observations at Eagle and another sketch.
Note the nature of the till in the interlobate moraine southeast of Whitewater. Suggest explanation. Why is one side of the moraine masked by outwash and the other not? Comment on Alden's moraines near Lauderdale Lakes. Suggest an explanation of the broad till-covered plateau around Elkhorn. Account for the basins of Lakes Delavan, Como, and Geneva and for the morainic topography around them. Suggest an alternative explanation for the large area mapped as terminal moraine east of Lake Geneva.
Account for the difference between Marengo ridge and Darien Moraine. Note Leighton's southeastward extensin of the latter. Suggest an alternative explanation for Alden's Genoa moraine. Discuss the existence of a "Delavan Lobe." Assemble evidence of a dual maximum of the Wisconsin ice in Wisconsin. What evidence is there as to the duration and extent of the recession?
In the "Debatable Area" compare the several correlations of the drifts and the evidence on which each was based. Consider different explanations of the Irene fossils. Is there evidence that the marginal Wisconsin of Leighton is very much older than the Marengo Ridge? Contrast the relative ages of the Marengo Ridge and the Darien Moraine. Discuss the factors that control the amount of leached drift. Discuss factors that influence the rate of leaching. Compare the merits of the several hypotheses.

How does the Illinoian drift north of Belvidere differ from that near Monticello and Albany? Into what three belts can the extra-morainic drift of southern Wisconsin be divided? Discuss reasons for differences and comment on the question of the discrimination of drifts of separate stages. What lobe deposited the Illinoian drift? Suggest possible explanations for the lesser development of the Green Bay lobe at that time. Account for the course of Rock River at Rockford; at Janesville; north of Janesville. Suggest explanation of the terraces in the outwash. Suggest reasons for the large commercial gravel pits at Beloit and Janesville.

Referemces. Aldon, W. C., Quaternary geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, pp. 132-325, 1918. This is the most important work on the region and should be read carefully.
Aldon, W. C., The Delavan glacial lobe: U. S. Geol. Survey Prof. Paper 34, pp. 22-66, 72-87, 1905. Gives details on southern part of area not included in the final report given above.
Leighton, M. M., The differentiation of the drift sheets of northwestern Illinois: Jour. Geology, vol. 31, pp. 265-281, 1923. Important.
Baker, F. C., Pleistocene mollusca from northwestern and central Illinois: Jour. Geology, vol. 30, pp. 46-47, 1922. On Irene cut.
McClintock, Paul, The Pleistocene history of the lower Wisconsin River: Jour. Geology, vol. 30, pp. 680-689, 1922. On terraces only.
Thwaites, F. T., A glacial gravel seam in limestone at Ripon, Wisconsin: Jour. Geology, vol. 29, pp. 57-65, 1921.
Bretz, J. H., Geology and mineral resources of the Kings quadrangle: Illinois Geol. Survey, Bull. 43, pp. 239-260, 277-296, 1923. Mainly a repetition of Leighton but contains a good map.
Martin, Lawrence, Physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 36, pp. 110-128, 221-254, 1916. Read mainly on glacial erosion otherwise a summary of Aldon. Also 290-295.
Salisbury, R. D., and Atwood, W. W., The grography of the region about Devils Lake and the Dells: Wisconsin Geol. and Nat. Hist. Survey Bull. 5, pp. 73-146, 1900. Mainly old ideas but gives a good summary.
Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, pp. 131-140, 1899. Hard reading but important.
Trowbridge, A. C., The history of Devils Lake, Wis.: Jour. Geology vol. 25, pp. 344-372, 1917.
Goldthwait, J. W., The abandoned shore lines of eastern Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 17, pp. 58-62, 1907. On forest bed.
Weidman, Samuel, The Baraboo iron-bearing district: Wisconsin Geol. and Nat. Hist. Survey Bull. 13, pp. 99-102, 1904. Interesting for unique theories.
Other references bearing on problems can be obtained from the Outline.

Construction of report. The report must not be a narrative. It should be divided into (a) sections each devoted to a particular problem and denoted by center headings, and (b) paragraphs each devoted to a particular phase of each problem and denoted by underlined paragraph headings. No complete outline will be furnished that being left to the judgment of the student but it is suggested that under each main heading the material be arranged in paragraphs as follows: (a) general statement with references to authors, (b) description including field observations on the trip, and (c) discussion of interpretation. Keep facts and interpretations separate. Use diagrams freely. Photographs are generally of little value; sketches are better. Be brief and to the point. Eliminate all unessentials and the report will not be unduely long. Rewrite after first draft is "cold".

Date due. Reports must be in not later than June 15 but it is urged that as many as possible be handed in before that time.

1926.

Each car $30.00

total 90.00

my total 4.95

or total 95.00

14) 95 (6.80 + transportation each trip

London 70¢ each

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short trips Burton 3.00

Jersey 3.00

mile 3.00

12 / 9.00 (7.5 each

Burton Jersey $25 / 3.00

Roe Jersey 33.00 / 7.35 / $25.45

Roe Akron 30.00 / 6.80 / $23.20 ✓

Burton 5.25 ✓

Brewer ✓

Chapman ✓

Fleitman ✓

Fowler ✓

Deering ✓

Hopley ✓

Sleeter ✓ - due $25.45 / $24.75 net

Sentell ✓

Wannemacher ✓

Wilson ✓

Wheeler ✓

Fish ✓

680 long

75 short

7.55 normal

70

8.25 total

100
200
40
40
25

GEOLOGY 143- Route for long field trip, 1928

The following route directions are given to everone so that drivers will always be informed of the correct route. If delayed by trouble there will then be no excuse for not regaining contact with the rest of the party as soon as possible. Points where all cars will endeavor to meet are indicated below. In case of doubt as to whether or not you are behind the leader ask at filling stations and garages for cars with red flags. The trip is not a speed contest. Drivers are requested to not exceed the legal speed limits by more than 5 m.p. h. Watch out for Arterial Highways and Through Streets. Stop signs must be scrupulously observed except those at railway crossings in Illinois which seem never to be observed by anyone. Whenever stops are made by the leader please do not change the order of cars but park behind where room will be left. CARS MUST ALWAYS BE PARKED CLEAR OF PAVEMENT OR TRAVELLED PART OF ROAD, so as to leave room enough for two other cars to pass one another without danger. Violation of this rule is exceedingly dangerous where traffic is heavy. Drivers must see that their brakes are tight enough to enable them to stop as qu ickly as the leader. Always be careful! We do not want to be delayed in police courts. Do not loiter in towns; they are all alike. Do not stop for meals unless scheduled. In small towns it takes a very long time to get the slightest refreshment. The leader will not wait for other cars more than a reasonable length of time. Drivers are instructed not to wait for stragglers. Stick together or you may be left in a strange town. Although every effort will be made to make the trip pleasent it is not a pleasure excursion but an essential part of the course. Do not forget to use the maps. Your bearing on the trip will have an important effect on your grade. Students who appear to be interested, who look at things, instead of waiting to hear about them, and who take an active part in the work of test pitting and drilling are generally rated higher than those who sit by the roadside or indulge in play. The reaction of students on a trip frequently has an important part in decisions as to recomending them for some job. This does not apply to times when there is no work but staying out late to such an extent as to interfere with work the next day is decidely undesirable. Please avoid talking when the instructor is addressing the class. Keep all notes so that they can be handed in at once. Locations should be made from your maps.

First day, Thursday, May 17, 1928.
Drivers must obtain gas and oil before meeting at Science Hall. Park cars facing south. It is absolutely necessary for all cars to be off not later than 7:45 in order to avoid the 8 O'clock traffic jam. NO WAITING, NO GOING FOR GAS, REPAIRS, OR PASSENGERS after the hour of departure. Each person will be assigned to a car in advance but this arrangement need not be kept afterward. Space is limited so bring only things absolutely needed.
Start south on Park St. and pick up Wis. 13. Follow 13 to Leyden. We pass out of the Johnstown terminal at Evansville and follow the outwash plain from then on. Turn south at Leyden on C.H.H. All cars meet here. Lunch at Janesville
Go south until C.H.A is reached and then follow it into Janesville. Stops enroute to see the old drift. Pick up Wis. 20 and go east across outwash plain (stops at gravel pits) to a point east of Emerald Grove where the leader will wait. Thence follow leader on town roads to Allen Grove. Stops to see outwash terraces. Be sure you can explain the reason for these. Pick up Wis. 14 and follow to Clinton where turn south on Wis. 140 to Illinois line. Thence follow town roads south and east to Harvard where all cars will meet (usually meetings will be at a filling station or garage). Go south on Ill. 23 to a point to be selected where the leader will turn east on a town road. Go east to Ill. 19; follow this northwest and north through Harvard to Walworth. Supper at Wayside Inn. If time permits side trip to Fontana in evening. It is best to store cars in a garage here

Friday, May 18, .

went N of lake on Wis 36

All will be called only once. Hour of departure will be 7:30 sharp. Follow C.H. B and C. H. B. B. east to Lake Geneva. Thence Wis. 36 to Springfield. Thence C. H. G to East Troy and C. H. K to junction with Wis. 67. Watch for stops and take particular care on grades to look out for stops in such places. Much of this days route is new and so exact points for stops cannot be given. All cars will meet at this junction. Follow Wis. 67 north to junction with U. S. 18; thence go east on U. S. 18 to junction with Wis. 83. Thence follow Wis. 83 north with possible detours on town roads ~~if time permits~~ to Hartford. All cars meet there. Go east on Wis. 60 to Wis. 55. Thence north on Wis. 55 to Barton. Thence Wis. 144 to junction with Wis. 28. Wis. 28 north to junction with Wis. 57. Thence Wis. 57 north to Plymouth. Stop at new brick hotel north of railway station. ~~If time in evening go out to gravel pit.~~ Curtis Hotel - cars stored in yard

Lunch at Eagle (Wooffa

Town road cutoff

Saturday, May 19.

Go to gravel pit - E on Town road to Elkhart Lake & 141 north

Hour of departure 7:30 sharp. Follow Wis. 23 to Sheboygan; thence U. S. 141 north to Manitowoc. Watch for possible stops to see beaches, etc. Pick up Wis. 17 and follow north to point about one mile east of Two Creeks. At this point the highway turns form east to straight north and there are some ruins of old buildings. Park cars and walk south along beach to Forest Bed. All tools will be needed here. When work is completed backtrack on Wis. 17 to Manitowoc. Thence follow detour of Wis. 31 to Valders. If hours are right early supper may be had in Manitowoc. Detour to see clay pit before leaving Manitowoc. Follow leader. At Valders make sidetrip north on Wis. 148 to quarry. The quarry is on first side road to west. If Wis. 148 is closed wait for leader at junction and another route will be taken. Then follow Wis. 31 to Chilton. Stop at Hotel Chilton on main street. Cars stored in yard

Lunch at Two Rivers

Sunday, May 20.

Hour of departure 8:00 sharp. Pick up Wis. 57 and follow north to Hilbert. Thence Wis. 114 and town road to High Cliff Park. Backtrack to Wis. 55 and follow same south to Fond du Lac. Watch for stops or detours to see beach gravels. ~~It is not certain where these will be made.~~ Pick up Wis. 23, ~~possibly~~ east of the city, and follow it west to Montello. Stop at granite quarry just east of business district on north side of street. Then continue on Wis. 23 to junction with U. S. 51. Follow U. S. 51 south to ~~Madison~~ Portage. There is a long detour north of Madison but this can be minimized by either (a) turning west at DeForest to Norway Grove and thence south on County trunk to Wis. 113 or by going straight south at the turn east toward Token Creek and following an unsurfaced town road to Wis. 113. Instead of following detour ~~in the suburbs of Madison~~ continue on Wis. 113 into the city. Be sure that all tools are returned to Science Hall on Monday.

Lunch at Rifor

W from Arlington on Wis 60 to Lodi - Thence

GEOLOGY 143, GLACIAL GEOLOGY Outline for field trips, 1928.

General. The long field trip will start May 17 regardless of weather and will last four days. This trip is a continuation of the short trip. Work will be divided into three phases: (1) reading and taking of notes before going on the trip with assignment of some special subject to each member of the class, (2) field work, and (3) option of either writing a report on the field trips or taking a final exam on the same subject.

Subjects of study. The following subjects will be studied: (1) comparison of the relative ages of the Wisconsin and the older drift, (2) how these drifts are subdivided with criticism of the evidence, (3) comparison of the relief features of clay and stony drifts, (4) glacial lake deposits and topographic features.

Maps. The entire route is not covered by U. S. G. S. maps but such as are published will be furnished to half the class so that everyone will have to share maps with someone else. Copies of Alden's maps will be placed in each car. The driver of each car will be responsible for the safe keeping of these. The topographic maps may be retained by students if desired. Take pains to study each of the topographic maps and map the route. Note how the terminal moraines, drumlins, etc. are shown by the contours. Use the maps to get locations for notes. A few older sheets do not show section lines. It will be expected that whenever a stop is made you will be able to place the point of a pencil on the exact location, Keep your eyes open and follow the geology at all times; stops cannot be made everywhere.

Tools and work. Shovel, pick, auger with accessories, and a bottle of acid will be provided. Each one of these will be given into the special charge of a student who will be held personally responsible for loss. If you are in charge of a certain tool it is up to you to see yourself that it is loaded up safely after every stop. Certain students will also be assigned to definite tasks.

Suggestions for notes. Notes should always start with the location by section, town, and range where you map will permit of determination in this way. A system of private "locality numbers" is convenient but is a bad habit which has to be outgrown in regular field work. If you cannot get the land description describe by reference to highway number, towns, etc. Much of the 1928 route has not be previously travelled so that some things will be seen which are not mentioned here.

The route to road to Brooklyn was previosly seen. Southeast of here the highway runs through terminal moraine as far as Evansville. Here we leave the terminal and follow the outwash plain outside. Is this plain pitted? Explain. Turning south from Leyden note difference in topography of the hills as contrasted with terminal of Wisconsin drift. What makes up the larger part of these hills? How can glacial deposits be distinguished by their topography in this region? At the Janesville gravel pit explain the dark colored zone near the surface. Account for the clay soil on top of much of the outwash. Account for the dissection of the outwash plain. What was the source of the outwash? Describe the bedding and sizes of stones.

What are the hills southeast of Janesville? Explain the terraces of outwash north of Alton Grove. Comment of the shapes of the lines dividing different levels. Where would be good places to find gravels concentrated during the terracing?

Select a good place to examine the weathering of the area outside of the terminal moraine. Comment on results. Has this area once covered entirely by drift? Cite evidence seen which bears on this question. Into what three belts can the drift of southern Wisconsin outside the Johnstown moraine be divided? Which one has been previously studied? Account for differences. What covers much of this drift?

Contrast Marengo Ridge and the Darien Moraine and account for differences. Discuss the "Delavan Lobe" in light of modern knowledge. Account for the origin of the gravels at Fontana and the origin of the basin of Lake Geneva. Compare with conditions near Brooklyn. Account for the uplands east and northeast of Lake Geneva. Suggest alternative mapping for some areas previosly regarded as terminal moraine. Give criteria.

Account for the deep valleys which cut the upland northeast of Lake Geneva. Account for the terraced pitted outwash plains seen near Eagle. Which lobe retired first from the [illegible] interlobate moraine in this region. Comment on the nature of the interlobate in the Oconomowoc district. Account for the lakes in this region. Comment on Alden's mapping. Explain difference of interpretation. Account for the terrace levels and the absence of the moraine over long distances. Account for some of the high hills farther north. Why are outwash gravels found at elevations higher than adjacent ground moraine? How can pitted outwash be distinguished from kames?

At Plymouth account for the Red Drift moraine and contrast it with the Johnstown moraine and Darien moraine. Also compare with Marengo Ridge. Comment on the ground moraine of the Red Drift and compare with central Illinois and with area of old drift east of Rock River before erosion.

Look out for beaches and beach gravels. What was the outlet of the lake in which these were deposited? Explain the terraces on tributaries of Lake Michigan. Account for the cemented gravels near Manitowoc. What value is such evidence in determining age of drift? Explain the Forest Bed and comment on the climatic significance of the organic remains. What was the outlet of Lake Michigan when the forest was growing? Draw conclusion form this on the use of the Forest Bed to divide the Wisconsin drift. State briefly the history of Wisconsin glaciation at this locality. How can this be checked?

Examine the striae at Valders for direction of ice movement using all the criteria you know. Account for the change. How can age of striae be checked? Comment on the true location of the Interlobate moraine in this region.

Locate the Red Drift margin along the east shore of Lake Winnebago. Examine the form of the Niagara escarpment and account for it. Account for the paucity of caves in the Niagara. Account for the large amount of postglacial erosion. Look at the site of the deep buried valley studied in the problem on preglacial topography. Where did this river go to? Study the beach gravels along the east side of Lake Winnebago. State the Wisconsin glacial history of this district and account for changes in level of the glacial lakes. Why do these beaches show so little tilting? Compare with beaches in Lake Michgan basin. Discuss proposed change of name of glacial lake in Fox-Wolf basin.

Comment on the gravel seam at Ripon. Look for beaches of glacial lakes in upper Fox valley. Comment on results. Describe the markings on granite at Montello and the deposits above the rock. Describe events during retirement of Wisconsin ice from this area. Note the rough topography south of Portage.

What is the feature south of here called, viz the divide between the Wisconsin and the Yahara? South of the divide note the character of the topography.

Construction of report. The report must be neither a narrative nor an abstract of the literature. It should be divided into (a) sections denoted by center headings each of which is devoted to a particular problem or general subject, as for instance, Drumlins, and these should (b) in turn be divided into paragraphs each devoted to a particular phase of each problem or subject; paragraphs should have underlined side headings. No attempt is here made to give a complete outline but this is left to the judgment and initiative of each student. It is suggested that the order of paragraphs be (1) general statement of problem, (2) description of facts seen which can be much abbreviated by incorporating the actual field notes if desired, (3) statement as to where further information has been published, and (4) discussion of interpretation or interpretations of the facts with reasons for differences of opinion if such occur. Great care must be taken to separate facts from interpretations. Use diagrams freely but explain clearly and place in text near point where mentioned. Isolated diagrams not mentioned in text are worthless. Photographs are for the most part of little value; it is hard to get the time to take really good photographs with the confusion which necessarily accompanies the presence of so many others. Be brief and to the point. Eliminate unessentials and the report will not be unduely long. Make final copy after first draft is "cold". Reports on previous trips may be consulted at the office.

Date due. All reports just be in by the last day of exams, June 12.

References. Alden, W. C., Quaternary geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, 1918. This is the most important work on the region and should be run through with reasonable detail. Omit chapter on rocks and parts not seen on trip and this will not take so long.
Alden, W. C., The Delavan glacial lobe: U. S. Geol. Survey Prof. Paper 34, especially pp. 22-66, 72-87, 1905. Gives somewhat fuller discussion of features in souther part of same area as described in previous reference.
Leighton, M. M., The differentiation of the drift sheets of northwestern Illinois: Jour. Geology, vol. 31, pp. 265-281, 1923.
Thwaites, F. T., A glacial gravel seam in limestone at Ripon, Wisconsin: Jour. Geology, vol. 29, pp. 57-65, 1921.
Martin, Lawrence, Physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 36, pp. 110-128, 221-254, 290-295, 1916. Must be borrowed from office or library as cannot be kept in Seminary. Refer to chiefly for ideas on glacial erosion otherwise a summary of other works.
Goldthwait, J. W., The abandoned shore lines of eastern Wisconsin: Wisconsin Geol and Nat. Hist. Survey Bull. 17, pp. 58-62, etc., 1907. Describes forest bed and beaches of Lake Michigan basin.
Other references bearing on problems can be obtained from the Outline.
Please do not quote opinions of the instructor as evidence! Opinions are never evidence.

GEOLOGY 143, GLACIAL GEOLOGY Outline for field trips, 1927.

General. The long field trip will start May 19 regardless of weather and will last four days. The work will be divided into three phases: (1) reading and taking of notes before going on the trips, (2) field work, and (3) preparation of the report. Option is offered of writing a report instead of final exam.

Subjects of study. The following subjects will be studied:
(1) The relative ages of the Wisconsin and the older or pre-Wisconsin drifts,
(2) Possible subdivisions of the young drift into either the Early and Late Wisconsin stages of Leverett (previous to 1915) or into two stages divided by the Forest Bed of northeastern Wisconsin.
(3) The debatable area in northern Illinois which has been classed in several glacial stages by various authors.
(4) The relief features of the Wisconsin drift such as drumlins, terminal moraines, and eskers.
(5) Beaches and deposits of glacial lakes.

Maps. Maps will be furnished to half of the class so that each person receiving a set will have to share it with another student. These maps are to be used in the field. In order to understand their relation to the geology a copy of Alden's map has been placed in Room 225 on which the prospective route and the boundaries of the quadrangles have been indicated. Copy the terminal moraines, drumlins, eskers, etc. onto the topographic sheets for a mile or two on both sides of the route. Use red for moraine, blue for outwash, purple for drumlins, yellow for limit of the "red drift", black for beaches, green for eskers. Crayons can be obtained in Room 224. Do this work carefully taking account of the contours and it will be a great help in the use of the maps in the field. Number the sections near the route where not already done. Section lines will have to be drawn on a few of the maps. It will be expected that whenever a stop is made you will be able to place a pencil point on the exact location. Keep your eyes open and follow the geology on the maps at all times.

Notes. All students are expected to keep notes. Give locations by township, range, and section and by distance from nearest town. Read the outline on field methods before starting. Not all of the route is covered by topographic maps. In such regions locations will be furnished.

Suggestions. From Madison to Dane the region is ground moraine with a few drumlins. Account for the smooth topography near Dane as contrasted with the high hills near Lodi and Prairie du Sac. What bearing has this on the question of the determination of the age of different drifts? Note evidences of amount of glacial erosion in this rugged region contrasting it with the hills west of the terminal moraine. Observe the nature of the deposits in the valley bottoms. Note the terraces at Prairie du Sac and suggest reasons for their formation. Account for the relation of the moraine to the outwash. Observe the edge of the moraine from Prairie du Sac northward. Account for the valley through the moraine and for the larger kettles in it. Also account for the kettle in the outwash at the residence of the late ex-Gov. Phillipp. State general conclusion from this data.

Suggest origin of the fan-shaped hill on U. S. 12 at the foot of the quartzite bluffs. What formed the soil on the top of the quartzite ranges? What was the condition in the valley above Baraboo during the maximum of the last ice? What was the origin of the sandy plains west of the terminal moraine in both the Baraboo and the Wisconsin valleys? Consider two hypotheses of the origin of the scattered bowlders west of the moraine.

What evidence would you seek for to settle this question? Account for the Dells. Make a sketch showing preglacial and present drainage in the region of the Dells and Devils Lake. Account for the dissection of the edge of the outwash plain northeast of Kilbourn.
Explain the lake deposits.
. What cused the drainage of the large lake? What was the name and outlet of the lake east of the moraine? What led to its extinction?
Account for the "Red Till Moraine" northeast of Fisk and for its difference from the drift farther south. Could evidence of the ice recession be found outside of the area of the Red Till? Account for the color of the younger till.
What surface indications are there of the course and outlet of the Brillion preglacial valley?
Consider not less than two possible explanations of the Two Creeks forest bed. How can evidence as to the minimum recession of the ice during its formation be obtained?
Look for beaches of higher lake levels near Manitowoc. Comment on the cemented gravels.
Examine the striae at Valders for direction of ice movement. Suggest reasons for the change. Where is the interlobate moraine within the red drift area? Why were the red drift lobes different from those of the gray drift? Comment on the inferences as to the age of the drifts.
Account for the character of the gravels in the pit at Brothertown.
Note the red drift moraine south of Fond du Lac and compare it with the moraines of central Illinois. What is the bearing of this on the question of discrimination of different stages of drift? Observe the outline of the Niagara escarpment and compare it with (a) other glaciated escarpments, and (b) unglaciated escarpments. Account for the existence of outliers in some places and not in others. Account for the paucity of caves in the Niagara dolomite.
Account for the relation between eskers and drumlins.
In the Oconnomowoc district explain the several levels of the hill tops. Account for the greater smoothness of the lower terraces and for the lakes. Find several residuals on the terraces. Examine the terrace scarps and comment on their shapes as contrasted with lake cliffs. With the aid of the map draw a sketch showing the approximate ice margin and outlets for each terrace. Make similar observations at Eagle and another sketch.
Note the nature of the till in the interlobate moraine southeast of Whitewater. Suggest explanation. Why is one side of the moraine masked by outwash and the other not? Comment on Alden's moraines near Lauderdale Lakes. Suggest an explanation of the broad till-covered plateau around Elkhorn. Account for the basins of Lakes Delavan, Como, and Geneva and for the morainic topography around them. Suggest an alternative explanation for the large area mapped as terminal moraine east of Lake Geneva.
Account for the difference between Marengo ridge and Darien Moraine. Note Leighton's southeastward extensin of the latter. Suggest an alternative explanation for Alden's Genoa moraine. Discuss the existence of a "Delavan Lobe." Assemble evidence of a dual maximum of the Wisconsin ice in Wisconsin. What evidence is there as to the duration and extent of the recession?
In the "Debatable Area" compare the several correlations of the drifts and the evidence on which each was based. Consider different explanations of the Irene fossils. Is there evidence that the marginal Wisconsin of Leighton is very much older than the Marengo Ridge? Contrast the relative ages of the Marengo Ridge and the Darien Moraine. Discuss the factors that control the amount of leached drift. Discuss factors that influence the rate of leaching. Compare the merits of the several hypotheses.

Why does the Illinoian drift north of Belvidere differ from that near Marshall and Albany? Into what three belts can the extra-morainic drift of southern Wisconsin be divided? Discuss reasons for differences and comment on the question of the discrimination of drifts of separate stages. What lobe deposited the Illinoian drift? Suggest possible explanations for the lesser development of the Green Bay lobe at that time. Account for the course of Rock River at Rockford; at Janesville; north of Janesville. Suggest explanation of the terraces in the outwash. Suggest reasons for the large commercial gravel pits at Beloit and Janesville.

Referemces. Alden, W. C., Quaternary geology of southeastern Wisconsin U. S. Geol. Survey Prof. Paper 106, pp. 132-325, 1918. This is the most important work on the region and should be read carefully.
Alden, W. C., The Delavan glacial lobe: U. S. Geol. Survey Prof. Paper 34, pp. 22-66, 72-87, 1905. Gives details on southern part of area not included in the final report given above.
Leighton, M. M., The differentiation of the drift sheets of northwestern Illinois: Jour. Geology, vol. 31, pp. 265-281, 1923. Important.
Baker, F. C., Pleistocene mollusca from northwestern and central Illinois: Jour. Geology, vol. 30, pp. 46-47, 1922. On Irene cut.
McClintock, Paul, The Pleistocene history of the lower Wisconsin River: Jour. Geology, vol. 30, pp. 680-689, 1922. On terraces only.
Thwaites, F. T., A glacial gravel seam in limestone at Ripon, Wisconsin: Jour. Geology, vol. 29, pp. 57-65, 1921.
Bretz, J. H., Geology and mineral resources of the Kings quadrangle: Illinois Geol. Survey, Bull. 43, pp. 239-260, 277-296, 1923. Mainly a repetition of Leighton but contains a good map.
Martin, Lawrence, Physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 36, pp. 110-128, 221-254, 1916. Read mainly on glacial erosion otherwise a summary of Alden. Also 290-295.
Salisbury, R. D., and Atwood, W. W., The grography of the region about Devils Lake and the Dells: Wisconsin Geol. and Nat. Hist. Survey Bull. 5, pp. 73-146, 1900. Mainly old ideas but gives a good summary.
Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, pp. 131-140, 1899. Hard reading but important.
Trowbridge, A. C., The history of Devils Lake, Wis.: Jour. Geology vol. 25, pp. 344-370, 1917.
Goldthwait, J. W., The abandoned shore lines of eastern Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 17, pp. 58-62, 1907. On forest bed.
Weidman, Samuel, The Baraboo iron-bearing district: Wisconsin Geol. and Nat. Hist. Survey Bull. 13, pp. 99-102, 1904. Interesting for unique theory. Other references bearing on problems can be obtained from the Outline.

Construction of report. The report must not be a narrative. It should be divided into (a) sections each devoted to a particular problem and denoted by center headings, and (b) paragraphs each devoted to a particular phase of each problem and denoted by underlined paragraph headings. No complete outline will be furnished that being left to the judgment of the student but it is suggested that under each main heading the material be arranged in paragraphs as follows: (a) general statement with references to authors, (b) description [illegible] field notes taken on the trip, and (c) discussion of interpretation. Keep facts and interpretations separate. Use diagrams freely. Photographs are generally of little value; sketches are better. Be brief and to the point. Eliminate all unessentials and the report will not be unduly long. Rewrite after first draft is "cold".

Date due. Reports must be in not later than June 13 but it is urged that as many as possible be handed in before that time.

GEOLOGY 143-Running orders for field trips, 1927.

The following orders are given to everyone so that drivers will always be informed of correct route. If delayed by trouble there will now be no excuse for not regaining contact with the rest of the party as soon as possible. In case of doubt ask at filling stations and garages for cars with red flags. The trips are not speed contests. Please do not exceed the legal speed limits by more than 5 m. p. h. Watch out for Arterial Highways which are called Through Streets in Illinois. Stop signs are posted at many Illinois railway crossings but seem not to be observed by anyone. Stop signs at Illinois State Highways are important as traffic is very heavy. When stops are made room for all will be left behind the leader. Please do not change the order at stops as it is dangerous in heavy traffic. CARS MUST BE PARKED CLEAR OF PAVEMENT OR TRAVELLED PART OF ROAD, leaving room enough for two other cars to pass one another. Violation of this rule is exceedingly dangerous where traffic is heavy. Drivers must see to their brakes. Look out for stops not scheduled below and leave enough headway to permit of stopping as quick as the leader. Always be careful. We do not want to be delayed in police courts! Do not loiter in towns; they all look alike. Do not stop for meals at restaurants unless scheduled. There will be absolutely no waiting for stragglers. Stick together or you may be left through someone else's neglect.

Afternoon trip.

Meet in front of Science Hall in time to leave at 12:45 SHARP. Drivers must be there not later than 12:40. In following directions both new and old Wisconsin State Highway numbers are given, the latter in ( ).
Leave on Wis. 13 going south on Park St. Follow to junction with Wis. 92. Stops enroute, watch the leader.
Wis. 92 with detour west of Brooklyn on outwash plain, to junction with C. T. E. Follow C. T. E. to junction with Wis. 59 north of Albany.
Wis. 59 to junction with Wis. 39. Wis. 39 to Babler School, thence south on poor town road, thence north and back to Wis. 39 after stop at sandstone hill. Dont hurry on this road; look out for high centers and deep ruts.
Wis. 69 (31) to Montocello , thence C. T. C to junction with C. T. E.
C. T. E. to Dayton. Detour west to see old lake bed. Wis. 92 to Belleville. Supper may be either (a) eaten at Camp Ground on river bank, (b) obtained at hotel or restaurant, or (c) postponed until Madison is reached.
No stops between Belleville and Madison. Follow Wis. 69 (31).

Long trip-first day, May 19.

Meet in front of Science Hall unless arrangments are made individually to be picked up by one of the drivers before. It is absolutely necessary for all cars to be off not later than 7:30 in order to avoid the 8 o'clock traffic jam. NO WAITING, NO GOING FOR GAS OR REPAIRS, no picking up of passengers after the hour of departure. Space is limited so bring only what things are absolutely necessary.

Start east on Langdon St., to Gilman, east to Sherman Ave. and pick up Wis. 113 at Tenny Park Bridge. Follow Wis. 113 to junction with C. T. J north of Lodi. All cars will meet there if possible.
C. T. J. west-watch out for stops and follow leader. Detour north of Blackhawk Bluff near Prairie du Sac. Cross Prairie du Sac bridge and turn right on main street into U.S. 12 (Wis. 12). Follow leader for detour into terminal moraine about 2 miles north of the city and then past the Phillipp Farm back to U. S. 12 (Wis. 12). U. S. 12 (Wis. 12) to Baraboo Camp Ground. Lunch. Hour for departure to be announced.

U. S. 12 (Wis. 12) to clay pit about one mile south of Kilbourn. Cars may drive into the pit. Cross River at Kilbourn on Wis. 13 and pick up Wis. 23. Follow Wis. 23 east to Montello. Stop at granite quarry just east of the business district. Continue on Wis. 23 to Ripon and all meet in front of brick hotel on north side of little square. Turn left on diagonal street up a hill to reach this place otherwise turn left into it from the State Highway one block south of hotel. Side trip will be made to the Kroll quarry while waiting for supper. After supper follow Wis. 44 to Oshkosh. Stop at Tremont Hotel east of Main St.

Second day.

Start will be made at 7:45 sharp. Follow U. S. 41 (Wis. 26) north. Caution: do not follow pavement where it turns east but go north on gravel road stopping at an esker not far to the north. Thence follow leader into Neenah where pick up Wis. 114. Follow Wis. 114 to Sherwood. Detour to HighCliff, returning through Sherwood. Follow town road to north past station to junction with U. S. 10 (Wis. 18). Go east on U. S. 10 (Wis. 18) to Brillion where stop will be made at quarry. Look out for blasting at noon. Continue east on U. S. 10 (Wis. 18) to Manitowoc. Pick up Wis. 17 and go north to Camp Ground where lunch will be eaten. Continue on Wis. 17 to Two Creeks or Nero which is about a mile east of the present Two Creeks store. At this point the road which has set over east turns north again. Drive in by side of a ruined warehouse. The forest bed is south on the beach. Picks, shovels, and drills will be needed here. Back track to Manitowoc where an early supper may be obtained. Follow Wis. 31 with sidetrip on Wis. 148 at eastern outskirts of Valders. Turn in first town road to left on Wis. 148 and park cars near piles of kiln wood above quarry. Cars may be first turned around for return to Wis. 31. Follow Wis. 31 to Chilton. Stop at Hotel Chilton which is just to right of Soldiers Monument on main street.

Third day.

Start at 7:45 sharp. Wis. 31 to Brothertown. There turn right a short distance to see beach gravel. Cars may be parked at turn to save time. Wis. 31 to Fond du Lac. Watch out for Park Avenue and turn south to avoid main street with heavy traffic, stop- and-go signs, etc. Follow Park Ave. to end of pavement to south, then turn right to main street and pick up U. S. 41 (Wis. 15). Follow U. S. 41 (Wis. 15) to Theresa. Watch out for stop at a kame ~~south~~ of Byron and DO NOT STOP ON PAVEMENT for traffic is very heavy on this road and the place is just over a rise. At Theresa turn right on Wis. 67 and follow that to big highway junction at Neosho. Stop here to see esker. Turn left into Wis. 60 and follow to Hartford. Pick up Wis. 83 and go south. Stop for lunch at a school house. Continue on Wis. 83 to its junction with U. S. 18 (Wis. 41). Turn right until Wis. 67 is again reached and then turn south on that following it to Eagle. Here detour will be made to east. CAUTION: LOOK OUT FOR ARTERIAL STOP AT FOOT OF STEEP HILL ON ENTERING EAGLE. Return from trip east on Wis. 99 and follow Wis. 67 southwest until near where it joins U. S. 12 (Wis. 12). Follow C. T. K to corners north of East Troy. Turn south and follow C. T. G to Spring Prairie. There pick up Wis. 20 and follow same to Delavan. Stop at Delavan Hotel for supper.

Fourth day.

Start at 8:00 sharp unless otherwise informed. Follow Wis. 20 west to junction with Wis. 89. Wis. 89 southeast to Walworth. Detour to Fontana gravel pit on Wis. 36. Return on town road to east and on C. T. E for short distance, then turn south on moraine into Illinois. Follow leader on town roads in Illinois. For a short distance follow Ill. 19 turning right off it to west across low outwash plain. Go due west to Ill. 23 which is paved. Follow Ill. 23 into Marengo where pick up Ill. 5 and go west to Belvidere. At School House on Ill. 5 west of Belvidere turn south on town road to Irene. Park cars just east of overhead railway crossing. Lunch will probably be eaten here. Go west and thence due north at first turn north across Ill. 5. Caution: look out for heavy traffic in crossing. Follow leader on town roads to north to Rosco, Ill. Here pick up old Ill. 2 which is paved and follow until Wis. 13 is picked up south of Beloit. If time permits a stop will be made at Janesville to see one of the large gravel pits. Return to Madison on Wis. 13, no stops. Supper may be had at Janesville or postponed until Madison is reached.

CAUTION. Although this trip will be made as pleasant as possible please remember it is not a pleasure excursion. Do not forget to use the maps. Your bearing on the trip will have an important effect on your grade. Last year one student was given a very low grade because he always sat down and never helped in any work. PLEASE DO NOT TALK WHEN THE INSTRUCTOR IS TALKING TO THE CLASS. All notes are to be handed in even if you elect to take the examination instead of writing a report. This exam will mainly be on things seen on the trips including some where no stop could be made.

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GEOLOGY 143 Field trips, 1929

General. The first long field trip will start from Science Hall at 7:45 sharp on Saturday, May 11. Work on field trips is divided into three parts: (a) reading of references before going on trip each student making a five to ten minute report on some feature to be seen on the trip at the last meeting of the class before the start, (b) field work in which every student is expected to keep notes, and (c) review at next meeting of class after return followed by either writing of a report on the trip or taking a written examination on features studied on the trip including related subjects studied in class or in reading. It is urged that as many as possible write reports.

First long trip. On the first long trip the following will be studied: (a) proofs that the glaciation of southern Wisconsin and northern Illinois occured at not less than two distinct stages which differ greatly in age, (b) the Waterloo bowlder train in its relation to possible stages of glaciation, (c) evidence of oscillations of the margin of the young or Wisconsin ice sheet, (d) topographic differences of the older drift area in relation to possible division into drifts of different ages, (e) relief features of the different drifts-drumlins, eskers, moraines, etc., (f) the nature and topography of the outwash deposits, and (g) loess deposits and soils.

Maps. Maps are furnished to approximately half the class so that everyone can be able to see a map all the time. Use the maps and follow the route. It is a good idea to mark the location of moraines, etc. on the maps using Aldens map as a guide. One Alden map will be supplied in each car. These must be returned after the trip as must also the maps of the Harvard quadrange, Illinois. Except for these students may keep the maps.

Notes. So many features will be seen that it is not possible for anyone to carry all the information in his head. Therefore notes are needed. In taking notes give locations by section, town and range. Private systems of "locality numbers" are a bad habit which will later have to be outgrown so these should be avoided if possible. Time prevents stops at all points so keep eyes open to see what can be taken in on the run. Remember that those who appear to be interested and who look at things instead of waiting to hear about them make the best impression. Tools will be given in charge of students who will each be help personally responsible for seeing that whatever is given to him to look after is safely loaded up after every stop and is returned at the end of the trip.

Route. Directions as to route are given to everyone so that if one car should be delayed there will be no excuse for not regaining contact with the others as soon as possible. If in doubt as to where the rest of the party is on the route ask at service stations for cars with red flags.

Leave Madison on U. S. 18 and follow this routeto Junction with Wis. 67 near Dousman (church on N.W. corner, Masonic home to S. W.) This route takes us through the drumlin-ground moraine district. At several points there are weak moraines-watch for them and note the gravel deposits. Note particularly one just east of Cambridge near Lake Ripley; suggest what this deposit really is. What criteria did Alden use? Suggest origin of Golden Lake. Going on along U. S. 18 to junction with road north to Delafield note and account for the terraces which are higher than the land to the west. What made the west bank of the streams which deposited these? Comment on Aldens criteia used in his mapping. Turn north to Delafield and go around Nagawicka Lake following the leader. Explain the lake basins. Pick up Wis. 19 (look out for heavy traffic) and turn east. Turn south on Wis. 83. Stops will be made

Geol 143 Trips

GEOLOGY 148 Field trips, 1929

Generally The first long field trip will start from Science Hall at 7:45 sharp on Saturday, May 11. Work on field trips is divided into three parts: (a) reading of references before going on trip each student giving a five to ten minute report on some feature to be seen on the trip at the last meeting of the class before the start, (b) field work in which every student is expected to keep notes, and (c) review at next meeting of class after return followed by either writing of a report on the trip or taking a written examination on features studied on the trip including related subjects studied in class or in reading. It is urged that as many as possible write reports.

First long trip. On the first long trip the following will be studied: (a) proofs that the glaciation of southern Wisconsin and northern Illinois occured at not less than two distinct stages which differ greatly in age, (b) the Waterloo bowlder train in its relation to possible stages of glaciation, (c) evidence of oscillations of the margin of the young or Wisconsin ice sheet, (d) topographic differences of the older drift etc. in relation to possible division into drifts of different ages, (e) relief features of the different drifts—drumlins, eskers, moraines, etc., (f) the nature and topography of the outwash deposits, and (g) loess deposits and soils.

Maps. Maps are furnished to approximately half the class so that everyone can be able to see a map all the time. Use the maps and follow the route. It is a good idea to mark the location of moraines, etc. on the maps using Aldens map as a guide. One Alden map will be supplied in each car. These must be returned after the trip as must also the maps of the Harvard quadrangle, Illinois, except for those students may keep the maps.

Notes. So many features will be seen that it is not possible for anyone to carry all the information in his head. Therefore notes are needed. In taking notes give locations by section, town and range. Private systems of "locality numbers" are a bad habit which will later have to be outgrown so these should be avoided if possible. Time prevents stops at all points so keep eyes open to see what can be taken in on the run. Remember that those who appear to be interested and who look at things instead of waiting to have them shown them make the best impression. Those who will be given the charge of students who will also be held personally responsible for seeing that whoever is given a job to look after is safely loaded up after every stop and is returned at the end of the trip.

Route. Directions as to route are given to everyone so that if one car should be delayed there will be no excuse for not regaining contact with the others as soon as possible. If in doubt as to where the rest of the party is on the route ask at service stations for cars with red flags.

Leave Madison on U. S. 18 and follow this route to junction with Wis. 67 near Pearsons Church (on N.W. corner, Masonic home to S. W.) This route takes us through the drumlin-ground moraine district. At several points there are weak moraines—watch for them and note the gravel composition, particularly one just east of Cambridge near Lake Ripley; suggest what this deposit really is. What criteria did Alden use? Suggest origin of Cambridge lake. Going on along U. S. 18 to junction with road north to Delafield note and account for the terraces which are higher than the land to the west. What made the wash bank of the streams which deposited there? Comment on Aldens criteria used in his mapping. Turn north at Delafield and go around Nagawicka Lake following the leader. Explain the basins. Pick up Wis. 19 (look out for heavy traffic) and turn east. Turn south on Wis. 83. Stops will be made

to see outlet valleys. Comment on kettles in bottoms of these. Continue south of Wales on Wis. 83 to junction with C.H.E. Follow this to North Prairie. Note character of outwash and terraces. Pick up Wis. 59 and follow to Eagle. Turn east on Wis. 99 and follow to junction with Wis. 83 near Muckwanago. Study outwash terraces. Comment on changes in glacial drainage which produced these. ~~Pay special attention to the possible occurence of higher terraces than those mapped by Aldon.~~ Go south on Wis. 83 to junction with C.H.J. and thence west on latter to Junction with U.S. 12. Follow U.S. 12 west to Whitewater with stops to study the Interlobate. Comment on the pitted plains south of the moraine in reference to time of ice occupation by the two lobes. Account for difference of moraine between here and near Wales. Explain the method of formation of the Interlobate. Pick up Wis. 89 and go south to interlobate angle near Richmond. Look for kettles in outwash outside the Johnstown Moraine. Are such common? Why? Continue on 89 southeast to Walworth. Visits en route to glacial outlet and terraces along it. Watch the leader. ~~If time permits~~ a visit will be made to the Fontana gravel pit. Stop at Wayside Hotel, Walworth where rooms have been reserved.

Second day. ~~If Fontana gravel pit was not visited before it is reached~~ via ~~Wis. 36.~~ ~~Side~~ trip east on C.H.B to overhead R.R.X. ~~Backtrack~~ to west. The southeastern extension of the Darien Moranine will be considered. Should the weather be dry trip south into Illinois will be in part on town roads but if it is wet follow Ill.23 to Harvard and thence Ill. 19 southeast to point where the continuation of the Darien can be seen on the northeast side of the road. If dry take town road west to Ill. 23, if not backtrack and pick up same route at a filling station south of Harvard. Go south on Ill. 23 to Marengo. Note the topography and material of Marengo Ridge and comment on its extension northward into Wisconsin and relation to Lake Geneva valley. From Marengo go west on Ill. 5 (U.S.20) to Cherry valley. Stops to study depth of weathering in this oldest Wisconsin drift. What was this drift first called? At Cherry Valley turn right on town road and follow leader north across country to Roscoe. Observations of the deeply eroded and loess-covered drift will be made along this route. Contrast with drift seen between Marengo and Cherry Valley. Examine the old eroded drumlins found on uplands. At Roscoe pick up old Ill.2 which is paved and follow north to Beloit. ~~If time permits go northeast on Wis. 14 to Clinton through old drift area, thence north on Wis. 140 to Junction Wis. 20, thence west on Wis. 20 over eroded outwash plain to Janesville. Detour near Janesville to see a gravel pit.~~ In case of lack of time route will be north from Beloit on U. S. 51 with trip to gravel pit at Janesville. Go north of Janesville on Wis. 13 ~~and take C.H.A west on ridge to Junction with C.H.H. Note the old moraines crossed on this route.~~ Study depth of weathering. Go north on H. to Wis. 13 and follow that to Madison. As far as Evansville this route is on or close to the outer edge of the Johnstown Moraine. Route as far south as junction with Wis. 92 will be visited on another trip.

Second long trip

First day-Saturday, May 25
Class will meet at Science Hall, front steps at 7:45 SHARP. Follow U. S. 151 to Columbus. Route is mainly on ground moraine with two faint terminals. Note how these can be distinguished. At Columbus pick up U. S. 16, follow to turn south, thence east on Wis. 60 through Hartford. Note drumlins and eskers. East of Hartford turn south (dangerous turn if missed as it is just over a rise) on town road to big kame. Turn cars south of the kame and return to Wis. 60. At or near junction with U. S. 41 pick up C. H. J and go north to Wis. 68 through Interlobate Moraine. Go east on Wis. 68 to West Bend where north on Wis. 55 to Barton. Thence east on Wis. 144 until Wis. 28 is picked up. Follow 28 along the Interlobate to beyond Cascade where turn straight north on C. H. E to Plymouth. Go west into interlobate terraces on Wis. 23. North on C. H. P to gravel pit near Glenbeulah, Thence C. H. A to Elkhart Lake. East on C. H. A (with stops at edge of red drift and at gravel pit) to junction with U. S. 141. North on 141 to Manitowoc. Detour to clay pit-follow leader. Take Wis. 17 to Two Rivers. Hotel Hamilton on west side of main street. Watch for stop at beach gravel pit south of Manitowoc. ~~If time excursion to beaches and sand dunes near Two Rivers.~~

Second day-Sunday, May 26. off 8:35
Time for departure will be announced. It is important to make an early start. Go north on Wis. 17 to east of Two Creeks where road turns from east to straight north. Park cars at turn and walk to beach near ruins of old dock. Go south on beach to see forest bed. Good exposures are found on creek back from shore as well as in lake cliff. All tools will be needed here. What is object of boring here? Be prepared to discuss significance of the forest bed. Backtrack to Manitowoc and go west on Wis. 31 to Fond du Lac. Note the area of gray drift near Chilton. At point to be determined leave 31 for detour on "The Ledge" east of Fond du Lac visiting drumlins, Niagara Escarpment, moraines of gray and red age, lake beach gravel pits, etc. Pick up Wis. 23 and follow through Fond du Lac west to Montello. Watch for the moraine of the red drift. Account for its large size. Watch for eskers west of Fond du Lac. At Ripon make a detour to Kroll or Ripon Limestone quarry to see the gravel seam. Compare explanations of it. West of Ripon note the escarpment. Most of the remainder of the distance to Montello is through the bed of Glacial Lake Oshkosh. Account for lack of sediments and beaches. At Montello examine the drift above the quarry and the chatter marks and striae on the granite. Proceed west on 23 to U. S. 51. Go south on 51 and note the sandy nature of the drift and the imperfect drumlins north of Portage. Near Portage note the old outlet of Glacial Lake Oshkosh. At Arlington turn right on Wis. 60 and pick up C. H. G. Go south on G to C. H. V, thence west to C. H. E and on that to Wis. 113 and on 113 to Madison. This area south from Portage is nearly all ground moraine but a few eskers may be seen.

820 see 16

44 to 73 to 151 Madison

Report. Option is offered of either writing a report on all the field trips or taking an exam on same subject plus class work bearing on same things. It is urged that as many as possible write the report. The report must be neith a narrative nor an abstact of reading. It should be divided into (a) sections denoted by center heading each of which is devoted to a particular problem or a general subject, as for instance, Drumlins. Each section should be in turn subdivided into paragraphs each of which is devoted to a particular phase of each problem or subject; paragraphs should have underlined side headings. It is suggested that paragraphs be (a) general statement of problem, (b) description of facts as briefly as possible with regerences to literature and field notes for fuller data, (c) interpretation and discussion of opinions of different authorities. Great care should be taken to separate facts from interpretations. Do not cite opinions as evidence but give the reasons.

Do not say"this drift is ------ because ---said it was" but instead "---- concluded that this drift is of ----age because of the following reasons." Be brief and to the point. Do not put in diagrams unless they are made an essential part of the discussion; isolated drawings or maps which are not mentioned in the text are a detriment. Diagrams are in general better than photographs but if latter are used care must be taken to indicate clearly on each with ink or a key sketch just what features are shown. Avoid useless repetion of literature but summarize and be sure to state clearly where you saw the evidence in the field. For instance it is enough to say " Drumlins were seen along highways ----- between ----- and ----. They are described in detail by ---- in -------. Their origin is discussed in ---------- and ---/ ~~No information on origin was obtained in the field.~~" "The -----drift is locally overlain by gumbotil as proved by a boring made by the class at -----." Eliminate all unessentials and the report need not be very long but it must state where you went and the reasons for the interpretation of what you saw. It is best to make a rough draft and later rewrite when this is "cold". Rewriting will enable you to condense the first version. Reports by other students in previous years may be seen at the office. This year an outline map showing moraines and lake borders will be furnished. Use several copies coloring them from published maps. Use one for present geology and others to illustrate different stages of glaciation in area seen. On these show lines of glacial drainage inferred from data on maps or seen in field and submerged areas. These maps should save a great amount of writing. Maps will probably also be used in the examination for those who do not write reports.

References. Alden, W. C., Quaternary geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, 1918. This is the most important work on the region and should be run through with reasonable detail. Omit the chapter on bed rocks and the description of regions not seen on trips and it will not be a very long task.

Alden, W. C., The Delavan glacial lobe: U. S. Geol. Survey Prof. Paper 34, pp. 22-66, 72-87, 1905. Use the maps showing stages in glacial retreat but remember that more recent unpublished work in Illinois modifies the Delavan lobe to a small protuberance of the Lake Michigan lobe. (map)

Leighton, M. M., The differentiation of the drift sheets of northwestern Illinois: Jour. Geology, vol. 31, ~~pp~~; 265-281, 1923.

Thwaites, F. T., A glacial gravel seam in limestone at Ripon, Wisconsin: Jour. Geology, vol. 29, pp. 57-65, 1921.

Martin, Lawrence, Physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 36, pp. 110-128, 221-254, 290-295, 1916. ~~Not in seminary.~~

Goldthwait, J. W., The abandoned shore lines of eastern Wisconsin: Wis. Geol. and Nat. Hist. Survey Bull. 17, pp. 58-62, etc., 1907.

Other references can be obtained in the Outline. A map of northern Illinois showing older interpretation is found in U. S. Geol. Survey Mon. 38, p. 24.

Subjects of second long trip include (a) the red drift, (b) the forest bed, (c) evidence of glacial erosion in eastern Wisconsin, (d) Glacial Lake Oshkosh, (e) eskers, (f) chatter marks. More information on Glacial Lake Oshkosh in Wis. Bull. 69, pp. 37-42, 1928.

GEOLOGY 143
GLACIAL GEOLOGY
Directions for Southern Field Trip, 1930

Introduction. Work on field trips is divided into three phases: (a) reading and reporting on references before going on trip, each student making an oral and a written report on something which will be seen on the trip, (b) field work during which every student is expected to keep notes, and (c) review of things seen on the trip to be taken up at first meeting of the class after return from each of the long trips. Note that option is offered of either (a) writing a report on all the field trips or (b) taking a written examination on features studied on the trips including related subjects studied in class and in readings. It is strongly urged that as many as possible write the report.

Maps. Topgraphic maps where available will be furnished to approximately half the class since it has been found that such is enough. Students desiring to keep a set of maps may do so but copies of Alden's map and of the Harvard quadrangle, Illinois must be returned as the number available is very small. Students to whom these maps are given will be held responsible for their safe return. Cost of maps will be prorated.

Conduct on trip. So many things will be seen on field trips that it is impossible to stop at all of them. It is impossible for anyone to carry in his head all the ideas gained on the trips and therefore written notes are essential. In taking notes give locations by section, town, and range where possible for a system of "stop numbers" or locality numbers is most undesirable. It is a bad habit which will have to be outgrown in long continued field work. Keep eyes open on the run. Questions will be asked on things at which stops were impossible. Students who appear to be interested and who look at things themselves instead of waiting to hear about them make the best impression on the instructor. Please remember that you are representatives of the University and do not indulge in any conduct which might tend to lessen the respect of anyone for that institution.

Tools. Tools will be given in charge of students who will each be held personally responsible for seeing that his charge is safely loaded up after use and returned in good condition at the end of the trip. Do not take anyone elses word that something is loaded up but see yourself that this has been done every time even if the tool in question has not been removed from the car to your knowledge. It is not the value of the tool which counts but the fact that on Sunday it could not be replaced in time to do necessary work which would make a loss serious. Students will also be assigned to definite tasks in connection with drilling and test pitting.

Route and driving. The trips are not speed contests. Please do not overtake the leader without permission. Please do not change order of cars at stops unless there is some definite reason for so doing. A place to park will be left behind the leader at every stop if it is reasonably possible to do so. PLEASE DO NOT PARK ON PAVEMENT OR ON TRAVELLED PART OF ANY ROAD. On all main roads room must be left for TWO other cars to pass oneanother without danger. Note state laws. Everyone is supplied with these directions which tell what highways are to be followed. In case of detours which are not mentioned through lack of information follow them unless otherwise directed at the time. No attempt will be made to "follow the leader" except on side roads. In case of delay you might be in doubt as to whether you are ahead or behind the leader; in such case ask at service stations for cars with red flags. Use judgment as to probable time that rest of party will pass the spot where you are. There is no excuse for failure to rejoin the party within a reasonable time. Please drive carefully. Please observe all stop signs and traffic rules.

Details. The trip will start from the back door of Science Hall at 7:30 A. M. SHARP on Saturday, May 3. Drivers must have cars ready at that time. Please do not go after gas or passengers after that hour. Go south on Park St. and follow Wis. 13 (detour in South Madison) to Janesville. Portion south to Brooklyn will be seen also on a later trip. From Oregon south notice the morainic topography. Suggest reason for low relief of the moraine here. The moraine will be left at Evansville. Note gravel pits just outside. From Evansville on for a considerable distance the highway follows close to the outside edge of the Johnstown moraine being in some places on the moraine and in others on the outwash. Hills south of the outwash are of rock with a thin cover of Illinoian drift. South from where the moraine is left note the depth of erosion in the outwash. Part of the route will be along the foot of the rock hills. Note the erosional topography. At Janesville a detour will be made to see a gravel pit. Contact with the leader will be made in outskirts of Janesville. Follow leader until Wis. 20 is picked up east of Janesville. Follow that to junction with Wis. 140. Follow that south to Clinton. Stops will be made to see Johnstown moraine to north, outwash plain, old or Illinoan drumlins, etc. Attention will be directed to the proof that the last are really older than the Middle Wisconsin drift to the north. Take Wis. 14 southwest to Beloit. There pick up old Ill. 2 (paved but not now marked) and follow that south to Roscoe. This part of the route is mainly on Wisconsin outwash. Note gravel pits and terraces at and near Beloit. Contact with leader will be regained at Roscoe in side road to left near a store. From here follow leader for route will depend upon weather and condition of roads. Route will show (a) Illinoian drift plain with highly eroded edge, (b) Illinoian drumlins, (c) gumbotil, (d) silttil, (e) loess, (f) deep erosion topography in drift, and (g) rock gorges due to drift superposition, and (h) oxidized gravels. If weather permits route will continue east over the earliest Wisconsin of Leighton which is largely covered with loess. Drill hole will show depth of leaching. In case of bad roads Ill. 5 (U. S. 20) will be picked up at either Cherry Valley or Belvidere and followed to Marengo from whence Ill. 23 will be taken north to Junction with Ill. 19 south of Harvard. In case of good road conditions route will be on gravel road north of Ill. 5 to and across Ill. 23 until Ill. 19 is reached. Either route will take the class across or along Marengo Ridge which is an important moraine of the Lake Michigan lobe of the Early Wisconsin stage(or substage). Stop will be made to examine and account for the color and composition of the till. Ill. 19 will be reached in case of bad weather by going southeast from its junction with Ill. 23. Ill. 19 lies on the continuation of the Darien moraine of the Middle Wisconsin drift of Wisconsin but in Illinois this is called the West Chicago Moraine. Be prepared to account for its different composition and to discuss the probable lapse of time between the deposition of this moraine and Marengo Ridge. Continue north on Ill. 19 and Ill. 23 to Walworth. Rooms have been reserved at the Wayside Hotel, north side of park. Supper and rooms will be paid for by the treasurer. It is possible that a part of the above program might have to be moved to the next day.

Hour for departure will be announced at supper. Go east from southeast corner of park on C. H. B. to overhead railway crossing. Stop to see relation of moraines and different interpretations. Follow leader on town roads to Fontana where the gravel pit will be visited and origin of lake basin considered. Return to Walworth on Wis. 36 and continue south on same (+ Wis. 89) to junction with gravel road west to Sharon. Discuss age of outwash here. Go west to Sharon where the Sharon moraine will be seen. This is considered by some as the boundary of the earliest Wisconsin drift. Follow C.H. C. (paved) north to Darien, thence Wis. 89 north to Whitewater. Side trip near Richmond to see the interlobate angle. Note the eroded drainage outlet of Turtle Creek and the terraces along it. At Whitewater pick up U. S. 12 and go southeast with stops to see drumlin topography and interlobate moraine. At filling station turn left and take C. H. K east to East Troy. Contact with leader will be regained near there. Thence follow leader on town roads north to Eagle. There the terraces in the outwash will be studied. From Eagle take Wis. 59 to North Prairie. Thence take C. H. E. north

to junction with Wis. 83. Continue north on Wis. 83 to junction with Wis. 19. Slight detour to gravel pit. This district shows the interlobate moraine. Attention will be directed to the several drainage channels and their interpretation. Go west on Wis. 19 (U. S. 16) following leader around Lake Nagawicka to Delafield. Be able to account for the several outwash terraces. Return to Madison on either Wis. 30 or U. S. 18 (latter is paved but will have heavy traffic on Sunday.

Summary. The southern trip is to bring out the following: (a) proofs that the glaciation of southern Wisconsin and northern Illinois occured at not less than two distinct times (stages) separated by a considerable interval, (b) proofs that the young or Wisconsin glaciation is subdivisible into at least two distinct substages between which there was a marked retreat of the ice border, (c) suggested subdivisions of the older or Illincian drift into several distinct stages, (d) the form and nature of the various glacial and glacio-fluvial deposits, such as drumlins, moraines, outwash, etc, and (e) the distribution and relationships of loess deposits

Name	Reading	Duties on trip
Ashley	Marengo Ridge	Water boy
Dauschard	Terraces at Eagle	log keeper
Burkhead	Interlobate Moraine	asst. driller
Gottschalk	Outwash	driller
Ickes	Johnstown Moraine	driver
Karges	N.W. Illinois	driver
McLaughlin	Old drumlins	asst. driller
Marsden	Boulder trains	growler
Ostrander	Soil Profiles	tool dresser
Riley	Lake Geneva	pick
Schini	[illegible] Criteria	shovel
Schuehle	Drumlins	interpreter
Wilson	Brooklyn Moraine	chemist
Wright	Old Drift	historian

Wakefield

Northern field trip, 1930

General. Deposit before going on trip will be $7.00 Be prepared for cold weather as we are going north and near to the cold lake. Meet behind Science Hall for departure at 7:30 A. M. SHARP, Saturday, May 17. Maps will be supplied to approximately half the class. Part of the route is not covered by quadrangles but is shown on either the large or small Alden maps.

Objects of trip. Objects of study are (a) the Late Wisconsin or Red Drift readvance, (b) the Forest Bed, (c) glacial erosion along the Niagara escarpment, (d) Glacial Lake Oshkosh, (e) glacial lakes of the Michigan basin, (f) eskers, (g) drumlins, (h) interlobate moraine and associated glacial drainage, and (i) gravel seen in the limestone at Ripon.

Route. There will be no waiting for stragglers, going for gas or supplies after the hour for departure. Go east on Langdon St., down Wisconsin Ave. to Johnson, east on Johnson to pick up Wis. 19. Follow Wis. 19 east to Watertown. Route is nearly all ground moraine but look for faint terminals of which there are several. Some good drumlins will also be seen. At Watertown pick up U. S. 16 and follow that north to junction with Wis. 60. Follow 60 east through Hartford. Watch for stop at a drumlin and at an esker near Clyman Junction. East of Hartford turn south (dangerous turn if missed as it is just over a rise) on town road to a big kame. Cars must be turned around south of the kame. Ascent will then be made. Backtrack to north and continue east on Wis. 60 until C. H. J is picked up. Go north on that through interlobate moraine. Discussion of proper classification of deposits will follow. When Wis. 68 is reached go east to West Bend. Watch for traffic lights! Pick up Wis. 55 and go north to Barton. Here go east on Wis. 144 until Wis. 28 is picked up. Follow 28 along the Interlobate to and beyond Cascade where turn straight north on C. H. E to Plymouth. Lunch will be eaten by roadside somewhere along this route. At Plymouth go west on Wis. 23 into the interlobate terraces until C. H. P is reached. Go north on that with stop at Glenbuhla gravel pit. Take C. H. A to Elkhart Lake. Continue on A east with stops at edge of the Red Drift and at a gravel pit near Franklin. Pick up U. S. 141 and go north to Manitowoc with stop at a buried beach deposit. At Manitowoc continue on Wis. 17. Supper will be eaten early in either Manitowoc or Two Rivers. Individuals will pay for supper as we may have to go to different places. No attempt will be made to regain contact until north of Two Rivers on Wis. 17. Continue north on 17 to Two Creeks where the highway turns east. Go east until road turns north again close to ruins of an old warehouse and dock. Here drive in toward lake shore and park cars on bank. All tools will be needed here. Walk south on beach to the Forest Bed. Return to Hotel Hamilton, Two Rivers when too dark to see.

Second day. Breakfast at 7:00 55 cent club breakfast will be paid for out of general fund. Departure 8:15 Back track to Manitowoc. Here follow leader to clay pit. Then pick up Wis. 31 and go west. Detour at Valders on Wis. 148 north, thence west on first town road to quarry. Study of crossing striae in relation to drift deposits. Shovel needed here. Return to Wis. 31 and go west noting the interlobate and the absence of red till on parts of it. Lunch at restaurant near station in Chilton. Reach this by going right on main street at monument; it is on right side of street. Turn around and continue on Wis. 31. At 890 corners in Sec. 16 north of Fond du Lac turn left and stop to see the buried beach of Lake Oshkosh. Continue detour on town roads to see Niagara escarpment, drumlins, red and gray drift. Pick up Wis. 23 and note thin edge of red drift overlying the gray. At foot of long hill turn left into entrance to gravel pit. Continue on Wis. 23 through Fond du Lac to Ripon. Note the supposed red terminal west of Fond du Lac. Account for its size. Watch for eskers here. At Ripon follow leader to Kroll quarry. Pick up Wis. 7[illegible] 44 and follow that south to junction with Wis. 73. Follow that watching for a fine esker on east side near junction, to junction with Wis. 33. Follow that west to junction with Wis. 44, that south into U.S. 51 and that south to Madison. No stops scheduled after the esker.

Afternoon trip, 1930

Meet at back door of Science Hall at 1 P.M. SHARP. Go south on Park St. and pick up Wis. 13. Route through South Madison is largely along the Wingra deltaic moraine. Stop on hill south of Nine Spring Creek. Watch leader. Continue on 13 to junction with Wis. 92 Stops enroute. Turn right on 92 and go through Brooklyn. Detour on outwash plain to west. Here the matter of the Brooklyn Moraine will be taken up. Go west on 92 to junction with C. H. E. Follow that south to junction with Wis. 59. Follow that to junction with Wis. 39. Go west on 39 (this junction is a sharp right turn) to Babler School. There take town road. Stop at sandstone crags. Return to 39 following leader. At Montecello pick up Wis. 69. Stop at old mill north of city. Continue on C. H. C. to junction with C. H. E, a sharp left turn. Follow E. to Dayton. Detour to west to see terminal moraine of Illinoian and old lake bed. Follow Wis. 92 to Belleville. Thence take Wis. 69 to Verona and U. S. 18 to Madison. Hour of return not guaranteed.

Reports. A report on the field work must not be either a narrative or an abstract of readings. It should be divided into (a) sections each of which is devoted to some main problem or subject, each of which is denoted by a center heading, and which are subdivided into (b) paragraphs each of which is started with a proper heading. Each paragraph should be devoted to some particular phase of the subject denoted by the section heading. For instance: Center heading: ILLINOIAN DRIFT. First paragraph: General statement of problem, second paragraph; facts seen in field, i.e. "Observations", including references to literature for further details, third paragraph: interpretation and discussion of explanations made by different authorities. Great care should be taken to separate facts from interpretations. Do not cite opinions as evidence but give reasons. Do not say "this drift is Illinoian because Leverett said so in 1899" but say "Alden concluded that this drift is Illinoian for the following reasons---" Be brief and to the point. Do not put in diagrams unless they are made an essential part of the discussion; isolated drawings or maps which are not mentioned in the text are a detriment. Diagrams are in general better than photographs but when the latter are used it is most desirable to indicate by marking on the picture or with aid of a key sketch just what features are shown. Remember that photographs include everything, essential and otherwise, and therefore are hard to understand. Avoid useless repetition of literature; summarize and state clearly just what you saw in the field. For instance it is enough to say: "Drumlins were seen along highways -- and -- between --- and ---. They are described in detail by --- (reference). Examples of the following types were seen -------. Facts which bear on the --- theory of the origin of drumlins were observed at -----." "The ----drift is locally covered by gumbotil as prooved by a boring made by the class at --- with the following log." Eliminate all unessentials and the report will not be very long. In fact, a short concise report is often much better than a long verbose one. The report must state where you went, what facts you saw, who has published on the area, what his main conclusions were and WHY, and your reasons for your interpretations. It is best to make a rough draft and later rewrite after this has become "cold" enough for you to see your own mistakes. An outline map showing the moraines and lake beaches is furnished. It is expected that several of these maps will be used to show route and different stages of the glacial history of the region. Lines of glacial drainage can be shown on these. They will save much writing. These maps will also be used in the examination for those who do not write reports. Proper coloring may be determined from published maps.
Add a neat legend to each map.

References. Alden, W. C., Quaternary geology of southeastern Wisconsin: U. S. Geol. Survey, Prof. Paper 106, 1918. This is the most important work on the region and should be read in some fair detail skipping the parts on bed rocks and about areas which we did not see. The index is worthless.

Leighton, M. M., The differentiation of the drift sheets of northwestern Illinois: Jour. Geology, vol. 31, pp. 265-281, 1923
Thwaites, F. T., A glacial gravel seam in limestone at Ripon, Wisconsin: Jour. Geology, vol. 29, pp. 57-65, 1921
Martin, Lawrence, Physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey, Bull. 36, pp. 110-128, 231-254, 290-295, 1916
Goldthwait, J. W., The abandoned shore lines of eastern Wisconsin: Wisconsin Geol. and Nat. Hist. Survey, Bull. 17, 1907 This describes the forest bed.
Alden, W. C., The Delavan glacial lobe: U. S. Geol. Survey, Prof. Paper 34, 1905. Gives some details on the Eagle gravel terraces not contained in Prof. Paper 106. Maps from this report in frame on stairs to third floor.
Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey, Mon. 38, pp. 131-140, 1899. Map p. 24 is not up to date but is almost only published map of northern Illinois.
Trainer, D. W., Jr., Moulding sands of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey, Bull. 69, pp. 37-42, 1928 Mentions high beaches of Lake Oshkosh
Other references may be obtained from the outline. See the form in which references are given. This is the one used by the U. S. Geol. Survey. Care in giving citations is important for it is often found very hard to find sources when this is not taken care of.

Last date for reports has been extended to 5 P. M., Saturday, June 14. 1930

"30"

GEOLOGY 143
GLACIAL GEOLOGY
Field trips, 1931

Introduction. Work connected with field trips is divided into three parts: (a) readings with both oral and written reports before the trip on subjects which will be seen, (b) field work including observations between stops, and (c) oral review of the trip during first class hour after return. Option is given of then either (a) writing a report on all the trips, or (b) taking a written examination on features studied on the trips and related subjects studied either in class or in special readings.

Maps. Topographic maps are not published for all the regions seen on trips. Copies of available maps are furnished to about half the class. Those desiring to keep a set of maps may secure them after each trip or save some of those given out. Please return any maps not needed. Mounted maps must all be returned. Cost of maps is prorated.

Notes, etc. "The poorest lead pencil is better than the best memory." So many things are seen on the field trips that is is impossible to carry all of the ideasgained in the head. Try to learn the habit of recording locations by section, township, and range. If your map does not show any of these ask the Chief. "Stop numbers" or "locality numbers" are a bad habit. Keep your eyes open all the time for questions will be asked on things which could only be seen on the run. Remember stops with several cars are impossible on most Wisconsin paved roads. LOOK at things before waiting to be TOLD about them. Use the maps especially the Alden maps. Bring these directions. Please remember that your are representatives of the University and do not do anything which might lessen the respect of anyone of that institution.

Tools. Each tool is given into the personal care of some student who is held responsible for seeing that it is loaded up after every stop even if it has not been removed from the car to his knowledge. See schedule of duties. Remember that we could not replace anything on Sunday.

Driving. Owners of cars will be paid TWICE the cost of gas and oil needed for the trip-plus cost of minor repairs due to the trip and storage. Car owners must carry liability and property damage insurance. The University assumes no liability for accidents, or for loss of personal belongings. The trips are not speed contests. Please do not overtake the leader unless absolutely necessary. Please do not change the order of cars at stops or on the road unless absolutely necessary. The leader will leave room to park in regular order. Cars will have red flags front and rear. Please return them at end of trip. This serves for identification and it is not expected that you will be able to keep in sight of the next car except on side roads. Please DO NOT STOP ON PAVEMENT or travelled part of a main road. Note that state laws require enough room to be left for TWO others cars to pass one another at full speed. Please obey the spirit and the letter of all traffic regulations except that nobody seems to obey stop signs at Illinois railroad crossings. If the directions call for following a certain highway and a detour is in force follow that unless otherwise directed by the Chief. If car trouble delays you use your best judgment as to where the rest of the party will be at a given time. If in doubt ask at service stations for cars with red flags. There is no excuse for failing to rejoin the party in a short time. A.B. C.= always be careful.

Cost. Cost of trips include expenses of the Chief. A deposit is required IN ADVANCE of each trip. Please pay in cash if you do not pay early. Better rates are secured by paying in lump sum. The same meals will be served to all. Extras are at personal expense. Room and car mates are assigned. Balance will be refunded at close of trips. Bring lunch first day.

Southern field trip, April 25-26

First day. Meet at Science Hall at 7:30 A. M. No waiting, no going for passengers or gas after hour of departure. If you doubt that this means business ask about last year! Go south on Park St., left on University Ave., right onto Bassett, left onto Wilson. Williamson, Speight Streets to pick up Wis. 30. Follow Wis. 30 east. This takes us through typical drumlin country. Watch leader for stop at an esker. Approaching Delafield stops will be made to see outwash terraces. Discussion of origin of terraces and the interlobate moraine. Continue east of Delafield on 30 to near junction with Wis. 83. Stops to see glacial stream beds eroded in moraine. Go south on 83 with stop at head of first grade to see a hanging drainage outlet. Go south on 83 to junction with C. H. E. Follow that to North Prairie. Stops to see outwash terraces. Be prepared to discuss their origin. Pick up and follow Wis. 59 to Eagle. Side trip there to see outwash terraces. Thence C. H. N. southto its junction with C. H. K. Follow K. west to junction with U. S. 12. Follow 12 northwest to Whitewater with detours to see interlobate moraine. Pick up Wis. 89 and go south to near Richmond. There visit interlobate angle. Continue on 89 to Walworth. Thence go east on C. H. B. to overhead railroad crossing. Stop in "Y." Go east to town road north to Lake Geneva. Follow leader to Fontana gravel pit. Park in pit and ascend. Here consider origin of Lake Geneva. Return to Walworth on Wis. 36. Stop at Wayside Hotel. Store cars in garage to north. Supper, room, and breakfast will be paid out of general fund. Please do not change roommates without permission. Hour for departure next morning will be announced at supper.

Second day. Go south on Wis. 89 and pick up Ill. 23 at State Line. Continue south to Harvard and thence southeast on Ill. 19 to point selected by Chief. Be careful on Illinois roads as traffic is very heavy on Sunday. Here the relation of the Darien or West Chicago moraine to the older Marengo Ridge moraine will be taken up. Route from last stop on Ill. 19 will depend on weather. If reasonably dry it will be west on town roads to Roscoe, Ill. Stops will be made to see the early Wisconsin drift with thin loess cover, the Illinoian drift with both silttil and gumbotil phases of weathering, diversions of streams , old oxidized gravels, young outwash plains. Gumbotil can only be found in a boring which last year reached the record depth of 2.. feet. Let's better this! At Roscoe pick up old paved road and go north to Beloit. There turn right on Wis. 14 to Clinton, thence north on Wis. 140 to junction with Wis. 20. This takes us through the belt of Illinoian drumlins. Be prepared to discuss evidence of age. Consider alternative hypotheses. Continue north of here on town road to junction with C. H. A. Follow A. west near Johnstown moraine to Janesville. Visit to gravel pit in outwash. Note erosion of outwash plain. Follow Wis. 13 to Madison. This route follows edge of terminal to Evansville and then crosses to inside area of middle Wisconsin glaciation.

Name	Reading	Duties	Roommates
Lora M. Baker	Janesville outwash	Log keeper	-------
G. E. Burpee	Interlobate moraine	Driver-growler	Furse-Burpee
G. W. Field	Johnstown moraine	Driller	Whiting-Field
D. F. Frasche	Eagle terraces	Sample grabber	Knight-Frasche
G. D. Furse	N.W. Ill.	Tool dresser	---
W. M. Hanley	Boulder trains	Shovel	O'Neil-Hanley
A. C. Knight	Lake Geneva	Chemist	----
P. J. O'Neil	Marengo Ridge	Historian	----
L. L. Whiting	Illinoian drift	Driver-asst.dr.	-----
L. A. Zollmer	Drumlins	Bar	Zollmer-?

Afternoon field trip, May 7

Leave from front of Science Hall, 1:00 P. M. SHARP Madison quadrangle. Follow Park St. south into Wis. 13. Follow that south across the deltaic Wingra or Third Moraine of the Second Wisconsin drift. Stop south of Nine Spring Creek at crest of hill to see kames covering crests of drumlins. Be SURE TO GET CARS CLEAR OF PAVEMENT as this is a dangerous place. Continue south to first road leading to right (west). Follow that west across ground moraine. Cross C. H. D and continue west to first left turn (south). Here we cross the Milton or Second Moraine. Turn left onto outwash plain which is here almost level with crest of the moraine. Enter Evansville quadrangle. Possible stop to see this relation. Continue south across outwash plain between islands of ground moraine. At end of road turn left (east) and cross hill. Stop on top to see view. Rejoin C. H. D and turn right (south). Follow D south through Oak Hall to corners with B. M. 955. This is ground moraine and pitted outwash. Turn right (west) and go one mile; all D turn left (south) and go one mile across Johnstown or First (Outer) moraine. Stop to see this. Turn left (east) and go one half mile. Then turn right (south). Follow town road south with stop to see Brooklyn Moraine. This moraine is locally covered by outwash from the Johnstown moraine. At B. M. 898 turn left (east) and ascend steep hill. ~~Stop at summit to see Brooklyn~~ Moraine. Continue east to first road south; turn right (south) and continue to pick up Wis. 92. Follow that south and then west across Brooklyn Moraine At last stop on that discuss its age: (a) First Wisconsin, (b) pre-Johnstown Second Wisconsin. Where else have you see evidence favoring last interpretation? Consider also the outwash plain between the Brooklyn and Johnstown Moraines as shown on Evansville quadrangle. Next stop on crest of thinly veneered rock hill in Illinoian area. Consider amount of drift oroginally present. Follow ~~92~~ west and south across similar country and outwash of Second Wisconsin into Dayton. Enter New Glarus quadrangle. Stop west of Dayton to see inside of Illinoian terminal. Continue west, leaving 92, to four corners east of Ross Crossing. There turn left (south). Stop to see old drained lake basin west of terminal. Continue south to end of road, then turn left (east) and go east until C. H. D is reached. Turn right on D (south). Continue south on D past many rock hills which show local kames. If cuts in these are fresh deep oxidation may be noted. Why does the Illinoian terminal loose its identity on the rock ridges between Dayton and Monticello? At end of C. H. D (T corner) turn right (west) onto C. H. C. Follow that west across thinly drift covered ridges to stop at old mill on Little Sugar River. Here climb bluff across railroads. From this the continuation of the Illinoian terminal may be seen crossing Little Sugar Valley. What kind of moraine is this? Explain rock ledges near the dam. (Note omission of this moraine as well as that at Dayton on Alden's map.) Can you use these phenomena to prove the great age of the Illinoian? Continue south through city of Monticello and pick up Wis. 39 at corner just south of Millpond. Turn left (east) on 39 and follow itto Pabler School. Here go up hill straight ahead instead of following highway. Continue on town road to stop at sandstone crags. Consider age. Try to find drift pebbles or boulders. Continue west on town road. Turn right (north) at first road and follow that north with jog to east to rejoin 39. Follow 39 back to Monticello. Thence retrace stops on C. H. C. and C. H. D to Dayton except follow D all the way omitting jog to see moraine made on way out. Continue on 92 to Belleville. At Belleville decision will be made as to two alternative routes. Either Wis. 69 and U. S. 18 to Madison (all paved) or C. H. D. to Madison (all gravel). No stops scheduled on return from Dayton. If Verona route is followed most of the way up to Verona is on Johnstown moraine outwash. Johnstown moraine is well shown at Verona. Pitted outwash from Milton along U. S. 18.

Northern trip, May 9-10, 1931

Introduction. Deposit before going on trip $7.00 Refund will be made of any surplus. Take warm clothing as we are going north and near to the cold lake. Maps will be supplied as before but a large part of the route is not on U. S. G. S. quadrangles. Use Alden maps in these places. Those who desire a set of clean maps please ask for them while they last. Mounted maps are tobe returned at end of trip. Bring lunch.

Route Leave front of Science Hall 7;30 A. M. SHARP, May 9. NO WAITING Go east on Langldon, down Wisconsin Ave. to Gorham, east on Gorham to end, south to Johnson, east on Johnson to pick up. U. S. 151. Follow that to Columbus. Route all paved, mostly ground moraine with some drumlins. At traffic light in Columbus turn right (east) onto Wis, 60. Folow 60 east through Hartford with stops to see drumlins and eskers. Traffic light in Hartford. East of Hartford note pitted outwash terraces and till interlobate. Watch leader for sharp right turn (south) onto a town road just over a rise. DO NOT OVERRUN this dangerous turn! Go south over interlobate to Polforts Peak (not named on map). Turn cars south of this kame and ascend to summit From here an excellent view of the outwash terraces and interlobate is obtained. Discuss origin of hill. Backtrack to 60 and go right (east). Continue until C. H. J. is picked up. Make left turn (north) and follow J through the interlobate moraine and associated pitted terraces. Stops to see these. When Wis. 68 is reached turn right (east) and follow into West Bend (traffic lights). Pick up Wis. 55 and turn left (north) onto it. Follow 55 to Barton. Stop will be made at a filling station either in West Bend or Barton. Turn right (east) into Wis. 144. Follow that until Wis. 28 is picked up. Lunch by roadside at a gate into some woods. Watch leader. Stop near Cascade to see pitted outwash. Beyond Cascade turn left (north) onto C. H. E. Follow that to Plymouth with stop to see edge of Red Drift (Third Wisconsin). At Plymouth turn left (west) onto Wis. 23 and go west through pitted outwash terraces and glacial stream channels to C. H. P. Turn right (north) onto P. Follow north with stop at big gravel pit. Thence take C. H. A north and east through pitted terraces to Elkhart Lake. Continue on A east with stops at a gravel pit west of Franklin. Here the red till overlies gray kame gravels. Continue east across red terminal and ground moraine until U. S. 141 is picked up. Turn left (north) onto that and follow north into Manitowoc. Stop at buried beach deposit near St. Wendel. Dangerous left turn into town road in bottom of ravine. At Manitowoc pick up Wis. 17 and follow that north and east to Two Rivers. Super highway follows beach of Lake Michigan. PLEASE KEEP IN RIGHT HAND LANE as center is for overtaking only.Stop at Hotel Hamilton on left (west)of main street for early supper. Park cars in side street. Return to cars and go north on 17 to Two Creeks (a cheese factory, a store, and some bootleg cries). There turn right (east) onto town road and continue east to shore of Lake Michigan going down a narrow lane near some old ruins. Park near old dock. Walk south on beach to see the Forest Bed, etc. When too dark to see return to Hotel Hamilton and put cars in garage to south.

Second day. Call at 6:30 Breakfast 7:00 Departure 8:00 Back track on super highway to Manitowoc. Thence follow leader to the clay pit. Then go south across town until Wis. 31 is picked up. Follow that to Valders. Just short of the village turn sharp right onto Wis. 148 (north). Go north up hill to first town road leading west. Follow that to quarry and turn cars around. Here the strike of the gray and red drifts will be seen. Apply criteria to find direction of movement and time relations. Return to 31 and go west to Chilton. On main street turn right and go east to Chilton Center Lunch at Krosners Restaurant on south side of street. Paid out of

general fund. East and west of Chilton the thin border of the red till will be noted. Explain the irregularity of this border. Turn cars around and go back to Wis. 31 and follow that to 820 foot corners in Sec. 16 north of Fond du Lac. Here make left turn (east) up a steep hill. Stop to see buried beach gravels. Continue following leader on town roads along route to be selected at time. Examine border of red till, gray moraines, drumlins altered by change of ice movement. Examine drift for Galena dolomite pebbles (buff coarse grained dolomite). Which lobe would have brought this rock? Which lobe must have made the drumlins which trend southwest? Account for change. Pick up Wis. 23 and go down long grade noting on run the thin edge of the red till overlying gray kames and till. At foot of hill make left turn (south) into gravel pit. This is the beach deposit of Glacial Lake Oshkosh. Which one? Find elevation of water. Find wind direction which caused this spit. Note the kind of gravel, assortment, and bedding. Also discuss the form of the Niagara escarpment. Go west on Wis. 23 to Fond du Lac. Turn left onto main street (south). Go south and turn right (west) into U. S. 151. Weather will decide on route from here on. If dry follow U. S. 151 to junction with C. H. T. Then turn right (west) onto T and follow that to Brandon. If wet stay on pavement and turn off 151 right (west) onto Wis. 103 (paved) and follow that to junction with Wis. 49. Then go north a short distance on 49 to Brandon. Continue on 49 (either route) until Wis. 44 is reached. Follow 44 to North Leeds with no scheduled stops. There turn right (west) on Wis. 60 and go through Arlington. Turn left (south) on C. H. G. Go south to ~~junction with C. H. V. Go right on V to~~ junction with C. H. E. ~~Turn left~~ Follow (south) on E. ~~and follow~~ to junction with Wis. 113. Follow 113 to Madison. Do not forget to turn in Alden maps.

Summary. The second long trip is to bring out (a) changes in ice centers which gave rise to differences in both lobation and character of till during sucessive advances of the Wisconsin ice, (b) glacial erosion of Niagara escarpment, (c) phenomena of Glacial Lakes Oshkosh, (d) phenomena of glacial lakes in the Lake Michigan basin with correlation with Winnebago basin, (e) evidence as to climate and length of time between the Second (gray) and Third (red) Wisconsin drifts, (f) eskers and crevasse fillings, (g) drumlins, (h) interlobate moraine and associated glacial drainage phenomena, (i) drumlins.

Reports and examination. Note option of either writing an examination or a report on the trips. It is urged that as many as possible write the report. Questions for examination will be taken from or be similar to those in the list of 100 review questions. Suggestions for writing reports may be obtained from mimeographed outline prepared for that purpose but outlines of subjects contained therein do not meet present needs. Remember that a report on field trips must not be either a narrative or an abstract of readings. It must be subdivided into first SECTIONS each of which is devoted to some major problem or subject, and second, each of these sections must be subdivided into PARAGRAPHS each of which is confined to the statement of a separate idea. Every paragraph should be started with an underlined heading. For instance: major heading, usually placed in center: ILLINOIAN DRIFT; First paragraph: statement of problem, second paragraph, observations in field, third paragraph, interpretation and discussion of explanations made by different authorities. Great care must be taken to separate FACTS from INTERPRETATIONS. Do not cite OPINIONS as evidence but give reasons. Do not say: " this drift is Illinoian because Leverett said so in 1899" but say: "in 1909 Alden concluded that the drift of this region is Illinoian for the following reasons---------." Be brief and to the point. Do not put in diagrams unless they are made an essential part of the discussion for isolated drawings

or maps which ARE NOT MENTIONED IN THE TEXT are a detriment. In general diagrams, if well drawn, are better than photographs. When photographs are used explanations of the important features should be explicit; an excellent idea is to draw a key sketch on same scale as photograph. For this tracing paper is good. If you can draw well a photograph can be traced so as to bring out the essentials and omit the unessentials and this tracing substituted for the original. These remarks apply mainly to photographs of exposures rather than to landscapes showing topography. Topographic features may be illustrated either by sections cut out of the topographic maps or, better, if you have time, by block diagrams either true perspective or isometric. Such features as the interlobate angle and the origin of the interlobate lend themselves very well to such methods.

References

Lobeck, A. K., Block diagrams, a few simple hints to teachers: Jour. Geogr., vol. 19, pp. 24-33, 1920
Lobeck, A. K., Block diagrams, John Wiley and Sons, New York, 1924
Mead, W. J., A simple method for making block diagrams: Wisconsin Engineer, vol. 25, No. 2, 1920
Grieves, L. G., Military sketching and map reading, 1917

Text of report. Avoid a useless repetition of what is already in the published literature. Summarize and state clearly just WHAT YOU SAW and what it means including the opinions of others with particular emphasis on WHY these conclusions were reached. It is enough to say: "Drumlins were seen along highways -- and -- between ---- and ----. They are described in detail by ----(reference, note form in which references are here given or at least be consistent in form you use). Facts which bear on the origin of drumlins were observed (state where and just what the facts consited of and their significance but do not enter upon an extended discussion of the controverted question of drumlin origin.)" "The --- drift is locally covered by gumbotil (better: the surface of the --- drift has been locally altered into gumbotil) as proved by a boring made by the class at ----(give log of hole)." If the above suggestions are followed implicitly and unessentials rigorously excluded the report will not be very long despite the great number of things seen. A short concise report is much better than a long verbose one filled with details. Note how hard Leverett's monographs are to read! Comapre them with more modern reports written since the cost of printing has been high. Much space in describing the HISTORY of glaciation may be saved by using several of the mimeographed outline maps which are furnished. Color them from published maps. Glacial drainage conditions can be outlined on these with position of ice border at different points. Standard colors formerly used by the writer were: terminal moraine, red; outwash, blue; ground moraine, brown; lake beds, yellow; drumlins, purple; eskers, green. These colors applied to the Second Wisconsin drift only. Third Wisconsin was shown in black and pre-Wisconsin in orange. Some variation of these colors will be necessary. Suggest using colors similar to those on model just south of library entrance. THESE MAPS WILL ALSO BE USED IN THE EXAMINATION for those who do not write reports. Add a neat legend or explanation to each map. This can be typed either on map or a sheet to face it. Start writing your report long enough in advance to allow it to become "cold" before you prepare the final copy.

Summary. Your report must tell as briefly as possible: (a)where you went, (b) what facts you saw, (c) who has published on the area, (d) what his main interpretations were and WHY, (e) what interpretation the party reached if this differed from that published and WHY.

References

The following references bear directly on areas seen:
Alden, W. C., Quaternary geology of southeastern Wisconsin: U. S. Geol. Survey, Prof. Paper 106, 1918 This should be read in some detail using the contents, rather than the very poor index, to skip parts about the bed rocks and regions we did not see
Alden, W. C., The Delavan glacial lobe: U. S. Geol. Survey, Prof. Paper 34, 1905. Gives some details on the gravel terraces not contained in the later report. See also the set of maps from this report in frame on stairs to third floor.
Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey, Mon. 38, pp. 131-140, 1899. This report is old and hard to read but the map opposite p. 24 is the only reasonably detailed one now published.
Leighton, M. M., The differentiation of the drift sheets of northwestern Illinois: Jour. Geology, vol. 31, pp. 265-281, 1923 Considers history of correlation of the drift west of Marengo Ridge Moraine. No map is pulised showing the West Chicago Moraine.
Martin, Lawrence, Physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey, Bull 36, pp. 110-128, 221-254, 290-295, 1916
Goldthwait, J. W., The abandoned shore lines of eastern Wisconsin: Wisconsin Geol. and Nat. Hist. Survey, Bull. 17, 1907 Important only for local details at and near the Forest Bed. A modern description of the Forest Bed is not yet published.

The following references bear less directly on the subject but are nevertheless interesting if time permits:
Trainer, D. W., Jr., Moulding sands of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey, Bull. 69, pp. 37-42, 1928 Describes some of high beaches of Glacial Lake Oshkosh
Thwaites, F. T., Manuscript reports on glacial geology in northeastern Wisconsin, 1927, 1928 On file in office. Describe Glacial Lakes Oshkosh
Leighton, M. M., and MacClintock, Paul, Weathered zones of the drift-sheets of Illinois: Jour. Geology, vol. 38, pp. 28-53, 1930; Illinois Geol. Survey, Rept. Investigations, No. 20, 1930
Leighton, M. M., The Peorian loess and the classification of the glacial drift sheets of the Mississippi valley: Jour. Geology, vol. 39, pp. 45-53, 1931
Kay, G. F., The relative ages of the Iowan and Illinoian drift sheets: Am. Jour. Science, 5th ser., vol. 16, pp. 497-518, 1928
Kay, G. F., The relative ages of the Iowan and Wisconsin drift sheets: Am. Jour. Science, 5th ser., vol. 21, pp. 158-172, 1931
Alden, W. C., Drumlins of southeastern Wisconsin: U. S. Geol. Survey, Bull.

NOTE LAST DATE FOR REPORTS AND DATE OF EXAMINATION GIVEN ON CALENDAR
No second examination will be given.

GEOLOGY 143
GLACIAL GEOLOGY

Roster for field trips, 1932

Name	Duties	Reading first trip	second trip
1. Baker, G. L.	Historian	P.P. 106, 186-189 Janesville	P. P. 106, 317-322, red till
Barton, T. F.	Driver	P.P. 106, 235-237, 269, 289, 308 Interlobate	P. P. 106, 326-331, Lake Chicago, early
2. Bent, G. C.	Shovel	P.P. 106, 209-212, 218-220, Johnstown moraine	P. P. 106331-339, Lake Chicago, late
3. Hago, G. O.	Chemist	P. P. 34, 55-62 Eagle terraces	P. P. 106, 340-345, post-glacial
4. Hunzicker, V. J.	Sample grabber	J. of G., 31, 265-281, N.W. Illinois	P. P. 106, 310-317, red till of Lake Michigan
5. Isaacson, M. R.	Driller	Wis. B.8, 75-77; P. P. 34, 50-52, Lake Geneva	P. P. 106, 324-326, Lake Oshkosh (Jean Nicolet)
6. Randall, J. R.	Geographer	Mon. 38, 131-140, 290-295, Iowan, Marengo moraine	Bull. 36, 223-239, Niagara escarpment
7. Stiles, Marg.	Log keeper	P. P. 106, 138-140, 154, old drift E. Rock River	Ms. by Thwaites on Lake Oshkosh
8. Strain, W. T.	Bar, growler	Bull. 273 U. S. G. S., drumlins	Wis. Bull. 17, 2-8, 56-61, beaches
9. Turk, L. O.	Tool dresser	P. P. 106, 138-140, 155-160, old drift W. Rock River	Wis. Bull. 17, 41-42, 61-62, Forest Bed

Roommates

Barton-Bent Strain-Randall Baker-Hago Isaacson-Turk Burpee-Hunzicker

Seating

Everyone except the drivers has a number. Cars are also numbered. Take places in cars in numerical order. At each stop the low number moves one car ahead except in the leaders car where he moves to rear car. This will alow everyone to ride in the leading car part of the time. PLEASE REMEMBER YOUR NUMBER.

CAUTIONS
Please do not stop on pavement. Avoid getting out of left sides of cars. In case of accident do not mention that you are on a field trip. Do not discuss liability. Write down names of witnesses and the time. First aid kit in leaders car. Let's not have any accidents, however! Report complaints to the growler only.

GEOLOGY 143
GLACIAL GEOLOGY
Field trips, 1931-32

Introduction. Work connected with field trips is divided into three parts: (a) readings with both oral and written reports before the trip on subjects which will be seen, (b) field work including observations between stops, and (c) oral review of the trip during first class hour after return. Option is given of then either (a) writing a report on all the trips, or (b) taking a written examination on features studied on the trips and related subjects studied either in class or in special readings.

Maps. Topographic maps are not published for all the regions seen on trips. [illegible] Mounted maps must all be returned. [illegible]

Notes, etc. "The poorest lead pencil is better than the best memory." So many things are seen on the field trips that is is impossible to carry all of the ideasgained in the head. Try to learn the habit of recording locations by section, township, and range. If your map does not show any of these ask the Chief. "Stop numbers" or "locality numbers" are a bad habit. Keep your eyes open all the time for questions will be asked on things which could only be seen on the run. Remember stops with several cars are impossible on most Wisconsin paved roads. LOOK at things before waiting to be TOLD about them. Use the maps especially the Alden maps. Bring these directions. Please remember that your are representatives of the University and do not do anything which might lessen the respect of anyone of that institution.

Tools. Each tool is given into the personal care of some student who is held responsible for seeing that it is loaded up after every stop even if it has not been removed from the car to his knowledge. See schedule of duties. Remember that we could not replace anything on Sunday.

Driving. Owners of cars will be paid TWICE the cost of gas and oil needed for the trip-plus cost of minor repairs due to the trip and storage. Car owners must carry liability and property damage insurance. The University assumes no liability for accidents, or for loss of personal belongings. The trips are not speed contests. Please do not overtake the leader unless absolutely necessary. Please do not change the order of cars at stops or on the road unless absolutely necessary. The leader will leave room to park in regular order. Cars will have red flags front and rear. Please return them at end of trip. This serves for identification and it is not expected that you will be able to keep in sight of the next car except on side roads. Please DO NOT STOP ON PAVEMENT or travelled part of a main road. Note that state laws require enough room to be left for TWO others cars to pass one another at full speed. Please obey the spirit and the letter of all traffic regulations except that nobody seems to obey stop signs at Illinois railroad crossings. If the directions call for following a certain highway and a detour is in force follow that unless otherwise directed by the Chief. If car trouble delays you use your best judgment as to where the rest of the party will be at a given time. If in doubt ask at service stations for cars with red flags. There is no excuse for failing to rejoin the party in a short time. A.B. C.= always be careful.

Cost. Cost of trips includes expenses of the Chief. A deposit of $7.00 is required IN ADVANCE of each trip. Please pay in cash if you do not pay early. Better rates are secured by paying in lump sum. The same meals will be served to all. Extras are at personal expense. Room and car mates are assigned. Balance will be refunded at close of trips. Bring lunch first day.

First day. Meet at rear door of Science Hall, 7:30 A. M. SHARP. This means you; if you doubt it ask about 1930. Go south on Park St., left (east) on University to end, right (south) onto Bassett (new traffic light at corner of Johnson), continue to Wilson, turn left (northeast) and follow Wilson to Williamson (R. R. stations), thence Williamson to Spaight, and that until uou meet Wis. 30. Follow 30 east through typical drumlin country. Watch for various forms of drumlins. First scheduled stop at an esker some miles east of Johnson Creek. Continue on 30 to Delafield. Side trip to Cushing Memorial Park. Continue through Delafield to junction with Wis. 83. Turn south (right) on 83 and watch for stop at gravel pit on left. Here examine the gravel terraces and abandoned drainage lines. Discuss relation to interlobate deposits. Continue south on 83 with stop near Statesan to see pitted terraces. Pick up C. H. E with turn to right (west). Stop to see crevasse filling. Follow E to North Prairie. Lunch at school house. Continue to North Prairie and go straight through to Jerico. There turn right (west) on Wis. 99 and go one mile. Here stop to examine the gravel terraces. Turn left (south) and go to end of road north of Eagle Lake. Turn right (west) and follow town road to Wis. 67. Follow 67 to its junction with U. S. 12. Take thence a road with runs diagonally southwest to first road leading due west. Follow that across outwash plain to road which turns north near the moraine. Turn right (north) and stop at big abandoned railroad cut in interlobate moraine. Climb the cut for view. Continue north alongside old grade. Cross it in deep cut and then turn sharply to left (south) and go to first four corners. There turn right and follow winding road through interlobate past Whitewater Lake to a four corners on outwash plain. There turn left (south) and follow town roads with several turns to C. H. A south of Lake Lorraine (Lake Nine). We are now in the famous interlobate angle. Follow A to school house near junction with Wis. 89. Stop for discussion. Take 89 south following outer edge of moraine. Watch leader for a left turn southeast on ~~old route of 89~~ across the moraine. Watch for the eroded drainage outlet of Turtle Creek. After crossing the creek note gravel pit used for paving (in field to left) and mark its location in respect to bends of the stream. Take old 89 to right (south) shortly after crossing creek. Stop at gravel pit to study relation of outwash and moraine to this outlet. Continue south into Darien and pick up 89 (BEWARE OF TRAFFIC LIGHT). Follow 89 along the moraine border noting the older ground moraine to your right. Watch leader for a left turn (east) onto a town road. Follow this 8¼ miles to four corners ~~at Yerkes Observatory~~. There turn right (south) down long hill to Fontana. Turn right into gravel pit. Park cars and ascend the hill. Discuss origin of Lake Geneva. Thence take Wis. 36 to Walworth. Wayside Hotel, garage to north. Starting hour for morning will be announced, also possible evening discussion.

Second day. Go east from traffic light on C. H. B. to overhead crossing of Milwaukee track. Park in Y and discuss relations of moraines. Retrurn west and watch leader for turn left (south) on town road. At School house 1½ miles south note change from gray soil of the Darion Moraine to red soil of the Marongo Moraine. Stop for discussion. Continue to state line and make right turn (west) to Big Foot Prairie. There pick up Ill. 23 (paved) and go south along the west side of the Marongo Moraine. Note outwash plain to your right. Note outlet valley south of Harvard. Stop at junction with Ill. 19. Follow 19 across the Marongo watching for the more gravelly Darion to your left. Stop for discussion. Near Hughes school, leave pavement and follow leader on town roads to Roscoe, Ill. Several stops. Luch probably at White Pigeon School. ~~Deep test with auger to show soil profile.~~ From Roscoe follow old Ill. 2 (paved) to Beloit. Pick up Wis. 92 and follow that to Evansville. If time permits stops will be made to show old thin drift on rock hills. From Evansville follow Wis. 13 to Madison.

Afternoon field trip, May 7

Leave from front of Science Hall, 1:00 P. M. SHARP Madison quadrangle. Follow Park St. south into Wis. 13. Follow that south across the deltaic Wingra or Third Moraine of the Second Wisconsin drift. Stop south of Nine Spring Creek at crest of hill to see kames covering crests of drumlins. Be SURE TO GET CARS CLEAR OF PAVEMENT as this is a dangerous place. Continue south to first road leading to right (west). Follow that west across ground moraine. Cross C. H. D and continue west to first left turn (south). Here we cross the Milton or Second Moraine. Turn left onto outwash plain which is here almost level with crest of the moraine. Enter Evansville quadrangle. Possible stop to see this relation. Continue south across outwash plain between islands of ground moraine. At end of road turn left (east) and cross hill. Stop on top to see view. [illegible] and then right (south). Follow D south through Oak Hall to corners with B. M. 955. on P This is ground moraine and pitted outwash. Turn right (west) and go one mile; turn left (south) and go one mile across Johnstown or First (Outer) moraine. Stop to see this. Turn left (east) and go one half mile. Then turn right (south). Follow town road south with stop to see Brooklyn Moraine. This moraine is locally covered by outwash from the Johnstown moraine. At B. M. 898 turn left (east) and ascend steep hill. [illegible]

..Continue east to first road south; turn right (south) and continue to pick up Wis. 92. Follow that south and then west across Brooklyn Moraine At last stop on that discuss its age: (a) First Wisconsin, (b) pre-Johnstown Second Wisconsin. Where else have you see evidence favoring last interpretation? Consider also the outwash plain between the Brooklyn and Johnstown Moraines as shown on Evansville quadrangle. Next stop on crest of thinly veneered rock hill in Illinoian area. Consider amount of drift oroginally present. Follow 92 west and south across similar country and outwash of Second Wisconsin into Dayton. Enter New Glarus quadrangle. Stop west of Dayton to see inside of Illinoian terminal.

. . . Continue south on 92 past many rock hills which show local kames. If cuts in these are fresh deep oxidation may be noted. Why does the Illinoian terminal loose its identity on the rock ridges between Dayton and Monticello? At end of C. H. D (T corner) turn right (west) onto C. H. C. Follow that west across thinly drift covered ridges to stop at old mill on Little Sugar River. Here climb bluff across railroads. From this the continuation of the Illinoian terminal may be seen crossing Little Sugar Valley. What kind of moraine is this? Explain rock ledges near the dam. (Note omission of this moraine as well as that at Dayton on Alden's map.) Can you use these phenomena to prove the great age of the Illinoian? Continue south through city of Monticello and pick up Wis. 39 at corner just south of Millpond. Turn left (east) on 39 and follow itto Bablor School. Here go up hill straight ahead instead of following highway. Continue on town road to stop at sandstone crags. Consider age. Try to find drift pebbles or boulders. Continue west on town road. Turn right (north) at first road and follow that north with jog to east to rejoin 39. Follow 39 back to Monticello. → to CHE (Monroe Quad.)
Thence retrace [illegible] C. H. C. [illegible]

E to Wis. 92, 92 to Wis 13, 13 to Madison

Northern trip.

Introduction. Deposit before going on trip is $8.00 The surplus will be refunded. Take warm clothing as we are going north and near to the cold lake. Bring luch for first day. Other meals paid for from public funds.

Route. Leave rear door of Science Hall 7:30 A. M. SHARP. NO WAITING. Car owners should set a good example. East on Langdon, right on Wisconsin Ave. to Gorham, northeast on Gorham to end, right one block to Johnson, left on Johnson to end there picking up U. S. 151. Follow 151 to traffic light in Columbus. Route all paved, mostly ground moraine with a few drumlins. At Columbus turn right (east) onto Wis. 60. Follow 60 east with stopsat esker and drumlin cut. Watch for traffic light in Hartford. East of there we pass from ground moraine to pitted terrace. Watch leader for a sharp right turn (south) into a town road a few miles east of Hartford. Do not overrun. Go south in the interlobate to Polforts Peak or Sugar Loaf. Turn around south of this hill and park cars for ascent. Backtrack to 60 and go right (east). Continue on 60 until C. H. J is picked up. Turn left on J and eat lunchat picnic ground. Follow J to north through interlobate with pitted terraces. Stops as decided at time. Pick up Wis. 33 and turn right on it (east). Follow into West Bend unless it is decided to make a short cut on a town road. Watch the leader. Pick up Wis. 55 and follow it north to Kewaskum. At Kewaskum turn right (east) into C. H. G. Follow it to C. H. S which turns left (north). Follow S to C. H. A. Follow A (winding in general direction E. of north) to Glenbulah. This takes us across the famous Kettle Range or Interlobate Moraine. At Glenbulah make sidetrip to pit of Moraine Sand and Gravel Co. Return to A and follow it through Elkhart Lake and thence east via Franklin to junction with U. S. 141. Stop on hill west of Franklin to see relation of gray and red drifts (Third and Fourth Wisconsin drifts). Note contrast of topography of gray and red drifts. Explain. On reaching 141 turn left (north) and follow pavement with stop at see gravel pit near St. Wendel. DANGEROUS LEFT TURN if traffic is heavy. At Manitowoc watch leader for a short cut to west bridge. On north side pick up Wis. 17 and follow it north and northeast to Two Rivers. Superhighway: PLEASE KEEP IN RIGHT HAND LANE. Turn left into side street and park for early supper at Hotel Hamilton. After supper return to cars and go north on 17 to the Forest Bed near Two Creeks. Watch leader for right turn onto town road. Exact spot for visit will be selected at time. When too dark to see return to Hotel Hamilton. Possible meeting for discussion.

Second day. Call 6:30, Breakfast 7:00, departure 8:00. Back track on superhighway to Manitowoc. Stop at city gravel pit. Follow leader to clay pit. Return to city and pick up Wis. 31. Follow 31 west to Valders. Just approaching Valders make sharp right turn (north) into Wis. 148. Follow that to top of first hill and make left turn (west) into side road. Follow to quarry. Return to 31 and follow to Chilton. On main street turn right (east) and proceed several blocks to Kiesner's Restaurant on south side of street. Lunch will be paid out of public funds. Turn cars around and return to 31. At Chilton we have the border of the Red Drift (Kewaunee soils). Account for its irregularity. Continue on 31 across the Niagara escarpment and into the Lake Winnebago region. Note and account for the return to Red Drift area. On reaching Brothertown we descend to the 810 foot beach of Later Glacial Lake Oshkosh. This is followed for some distance but is not everywhere a distinct feature. Note old gravel pits in the bars across former bays. As most of these have been abandoned no stop will be made. Continue on 31 to the 820 foot corners in Sec. 16 . There turn left into C. H. Q. Stop at crest of first steep rise to see buried beach deposit of Early Glacial Lake Oshkosh. From here follow leader on town and county roads by route to be selected through the overridden drumlin belt of the Fond du Lac Quadrangle. Pick up Wis. 23 and return to the Niagara escarpment. Note thin edge of the red till in road cuts. At foot of descent watch leader for left turn (south, caution if traffic is heavy) into a gravel pit of beach of Later Glacial Lake Oshkosh. Discuss winds.

which led to deposition of this spit. Find the water elevation; note bedding, assortment, etc. Discuss form of the Niagara escarpment. LAST SCHEDULED STOP. See that your baggage is in same car you are. Those in a hurry may take Wis. 23 to Fond du Lac, thence U. S. 151 to Madison. This route is paved but on Sunday afternoon little speed can be made. The following route is an alternative and should pass a number of interesting features. Return to corners near Catholic school at foot of bluff and turn right (south). Continue until you pick up C. H. K. Go south on K and then turn right (west)to South Byron. Continue west on town roads and C. H. Y and C. H. D. to Waupun. There pick up Wis. 68 (paved) and follow it to Wis. 73. Follow 73 to Randolph. There turn right (southwest) into C. H. A. Follow A to Wis. 60, 60 to west side of Arlington, C. H. E. (left turn (south)) to Wis. 113, thence 113 into Madison.

Summary. Please return all mounted maps at first meeting of class if they have not been turned in at last stop. This second long trip is to bring out (a) changes in ice centers which gave rise to differences in both lobation and character of till, thus marking subdivisions of the Wisconsin stage, (b) glacial erosion of the Niagara escarpment, (c) the phenomena of the two Glacial Lakes Oshkosh, (d) phenomena of glacial lakes in the Lake Michigan basin, (e) the Forest Bed including its bearing on the subinterval between the Third and Fourth Wisconsin drifts, here called the Red and Gray drifts, (f) eskers and crevasse fillings, (g) drumlins, (h) the interlobate moraine and its associated drainage deposits.

Reports and examination. Those who are not leaving school early have the option of either writing a report on all field trips combined or taking an examination. Questions for this examination will be taken from or be similar to those in the list of 100 Review Questions. It is urged that as many as possible write the report. Note last date for reports. Maps for study will be hung in Seminary room. THOSE WHO MUST LEAVE EARLY have option of either taking an incomplete to be made up the next year or, if graduates in good standing, receiving two credits for the course. Note that this arrangement is made only for sufficient reason and is not optional with everyone. Suggestions on the writing of field reports are contained in a special set of directions. Remember that a report on a field trip must NOT be either a narrative or an abstract of readings. It must be subdivided into S ECTIONS each of which is subdivided in turn into PARAGRAPHS each of which is confined to the statement of a separate idea. Sections are started with a heading written in the middle of the page. Each paragraph is started with an underlined heading eitherin center of page or as here done. Example:

ILLINOIAN DRIFT(Section heading)
Statement of problem (introduction) (Paragraph heading.)
Observations in field " "
Interpretation " "

The last paragraph must include the discussion of other explanations which have been reached by previous students of the area and your conclusions. Great care must be taken to separate FACTS from INTERPRETATIONS. Never cite anyone's OPINION as evidence. Do not say: "this drift is Illinoian because Leverettt said so in 1899" but say instead: " in 1899 Leverett concluded that the drift of this area is Illinoian for the following reasons------. In 1909 Alden differed from Leverett because of the following facts------." Be brief and to the point. Do not put in any diagrams or pictures unless they are made an ESSENTIAL PART of the discussion for isolated drawings

or maps which ARE NOT MENTIONED IN THE TEXT are a detriment. In general diagrams, if well drawn, are better than photographs. When photographs are used explanations of the important features should be explicit; an excellent idea is to draw a key sketch on same scale as photograph. For this tracing paper is good. If you can draw well a photograph can be traced so as to bring out the essentials and omit the unessentials and this tracing substituted for the original. These remarks apply mainly to photographs of exposures rather than to landscapes showing topography. Topographic features may be illustrated either by sections cut out of the topographic maps or, better, if you have time, by block diagrams either true perspective or isometric. Such features as the interlobate angle and the origin of the interlobate lend themselves very well to such methods.

References

Lobeck, A. K., Block diagrams, a few simple hints to teachers: Jour. Geogr., vol. 19, pp. 24-33, 1920
Lobeck, A. K., Block diagrams, John Wiley and Sons, New York, 1924
Mead, W. J., A simple method for making block diagrams: Wisconsin Engineer, vol. 25, No. 2, 1920
Grieves, L. G., Military sketching and map reading, 1917

Text of report. Avoid a useless repetition of what is already in the published literature. Summarize and state clearly just WHAT YOU SAW and what it means including the opinions of others with particular emphasis on WHY these conclusions were reached. It is enough to say: "Drumlins were seen along highways -- and -- between ---- and ----. They are described in detail by ----(reference, note form in which references are here given or at least be consistent in form you use). Facts which bear on the origin of drumlins were observed (state where and just what the facts consited of and their significance but do not enter upon an extended discussion of the controverted question of drumlin origin.)" "The --- drift is locally covered by gumbotil (better: the surface of the --- drift has been locally altered into gumbotil) as proved by a boring made by the class at ----(give log of hole)." If the above suggestions are followed implicitly and unessentials rigorously excluded the report will not be very long despite the great number of things seen. A short concise report is much better than a long verbose one filled with details. Note how hard Leverett's monographs are to read! Comapre them with more modern reports written since the cost of printing has been high. Much space in describing the HISTORY of glaciation may be saved by using several of the mimeographed outline maps which are furnished. Color them from published maps. Glacial drainage conditions can be outlined on these with position of ice border at different points. Standard colors formerly used by the writer were: terminal moraine, red; outwash, blue; ground moraine brown; lake beds, yellow; drumlins, purple; eskers, green. These colors applied to the Second Wisconsin drift only. Third Wisconsin was shown in black and pre-Wisconsin in orange. Some variation of these colors will be necessary. Suggest using colors similar to those on model just south of library entrance. THESE MAPS WILL ALSO BE USED IN THE EXAMINATION for those who do not write reports. Add a neat legend or explanation to each map. This can be typed either on map or a sheet to face it. Start writing your report long enough in advance to allow it to become "cold" before you prepare the final copy.

Summary. Your report must tell as briefly as possible: (a)where you went, (b) what facts you saw, (c) who has published on the area, (d) what his main interpretations were and WHY, (e) what interpretation the party reached if this differed from that published and WHY.

OK

References

The following references bear directly on areas seen:

Alden, W. C., Quaternary geology of southeastern Wisconsin: U. S. Geol. Survey, Prof. Paper 106, 1918 This should be read in some detail using the contents, rather than the very poor index, to skip parts about the bed rocks and regions we did not see

Alden, W. C., The Delavan glacial lobe: U. S. Geol. Survey, Prof. Paper 34, 1905. Gives some details on the gravel terraces not contained in the later report. See also the set of maps from this report in frame on stairs to third floor.

Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey, Mon. 38, pp. 131-140, 1899. This report is old and hard to read but the map opposite p. 24 is the only reasonably detailed one now published.

Leighton, M. M., The differentiation of the drift sheets of northwestern Illinois: Jour. Geology, vol. 31, pp. 265-281, 1923 Considers history of correlation of the drift west of Marengo Ridge Moraine. No map is published showing the West Chicago Moraine.

Martin, Lawrence, Physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey, Bull 36, pp. 110-128, 221-254, 290-295, 1916

Goldthwait, J. W., The abandoned shore lines of eastern Wisconsin: Wisconsin Geol. and Nat. Hist. Survey, Bull. 17, 1907 Important only for local details at and near the Forest Bed. A modern description of the Forest Bed is not yet published.

The following references bear less directly on the subject but are nevertheless interesting if time permits:

Trainer, D. W., Jr., Moulding sands of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey, Bull. 69, pp. 37-42, 1928 Describes some of high beaches of Glacial Lake Oshkosh

Thwaites, F. T., Manuscript reports on glacial geology in northeastern Wisconsin, 1927, 1928 On file in office. Describe Glacial Lakes Oshkosh

Leighton, M. M., and MacClintock, Paul, Weathered zones of the drift-sheets of Illinois: Jour. Geology, vol. 38, pp. 28-53, 1930; Illinois Geol. Survey, Rept. Investigations, No. 20, 1930

Leighton, M. M., The Peorian loess and the classification of the glacial drift sheets of the Mississippi valley: Jour. Geology, vol. 39, pp. 45-53, 1931

Kay, G. F., The relative ages of the Iowan and Illinoian drift sheets: Am. Jour. Science, 5th ser., vol. 16, pp. 497-518, 1928

Kay, G. F., The relative ages of the Iowan and Wisconsin drift sheets: Am. Jour. Science, 5th ser., vol. 21, pp. 158-172, 1931

Alden, W. C., Drumlins of southeastern Wisconsin: U. S. Geol. Survey, Bull.

NOTE LAST DATE FOR REPORTS AND DATE OF EXAMINATION GIVEN ON CALENDAR

No second examination will be given.

STOPS ON 1933 FIELD TRIPS IN GLACIAL GEOLOGY

F. T. Thwaites, Chief

Log by J. M. Trefethen

WALWORTH TRIP

No.	Miles from Madison	Features seen	Location, T, R. Sec. coordinates
1	42.1	Esker between drumlins	0716.17e7
2	52.1	Kettle in pitted outwash	0717.15a2
3	54.1	Cushing Memorial Park, outwash terraces	0718.18a5
4	56.5	Nagawicka Lake, outwash terraces in kettle	0718.20f1
5	57.3	Gravel pit; glacial drainage channels	0718.21a5
6	59.5	Statesan; view of outwash terraces and drainage outlet	0718.33g7
7	61.8	Crevasse filling between kettles	0618.17h2
8	64.2	Pitted outwash terraces at School House	0618.30g1
9	66.4	Prairie View School on recessional moraine, drainage channel and interlobate to north	0518.06g1
10	71.5	Second of Eagle terraces(country photographer)	0517.26h1
11	80.0	Terminal moraine rising through outwash	0416.14d1
12	81.3	Recessional of Delavan lobe, view of outwash with lakes in Kettles	0416.23f2
13	87.2	Inside edge of Elkhorn Moraine, old R. R. cut	0415.25h2
14	88.0	Old R. R. cut through till interlobate	0415.24e6
15	93.3	Outwash terrace between Johnstown and Milton moraines	0415.34b4
16	95.3	Outwash plain between Johnstown and Milton moraines, good view of both (cheese factory)	0415.32a4
17	98.1	Near church: junction Johnstown and Darien moraines at Richmond	0315.17a4
18	106.1	Gravel pit showing till of Darien moraine overlying outwash	0215.15c4
19	116.3	Fontana gravel pit, till on top of gravel, view of Lake Geneva	0116.15h1
20	118.4	Overhead crossing, view of continuation of Darien moraine	0116.22e1
21	121.2	Marengo Ridge moraine, Darien to east	0116.34d2
22	123.3	State Line Road at border of Darien moraine	0116.35a1

Total of trip was 199 miles

TWO RIVERS TRIP-FIRST DAY

1	46.8	Clyman Junction esker	1015.16g7
2	47.1	Cut in drumlin showing silt layers	1015.15h6
3	51.4	Drowned drumlins in Hustisford millpond	1016.09c6
4	56.7	Neosho esker	1017.19h1
5	67.6	On outwash plain to view interlobate	1018.26a8
6	70.2	View of Sugarloaf knob, moulin kame	1018.25h4
7	70.5	Sugarloaf knob, view of moraine to east	1018.24b4
875.2		Below Cedar Lake, glacial stream bed	1019.05f8
9	76.0	View of island -crevasse fillings	1119.30e2
10	80.0	Glacial drainage channel between moraines	1119.17h8
11	84.6	Northern Gravel Co. pit in delta kame of interlobate	1119.03c4
12	96.9	Road cut in moulin kame showing foreset bedding	1319.34d1
13	117.6	✓ Summit of interlobate; large kettle on left and right; conical hill on left=moulin deposit buried by later pitted outwash	1520.23e8
14	119.4	North slope of interlobate shwoing ice contact face	1520.14e8
15	122.8	✓ Pit of Moraine Sand and Gravel Co.,;gap in interlobate	1521.06e6
16	124.1	View of Crystal Lake in kettle of pitted outwash	1621.31a3
17	132.0	✓ Gravel pit at Franklin; red till over gray till and gray gravel	1622.30h6
18	147.0	✓ Supposed buried Glenwood beach under red till	1723.17a1

To Two Rivers 169.8 miles

SECOND DAY

1	170.1	✓ Ball park. Nipissing beach. Cut exposes lake deposit buried by red till	2025.31a7
2	183.7	✓ Forest Bed between Red and Gray drifts	2124.11a1
3	201.2	Manitowoc city gravel pit. Gray deltaic gravel overlain by red silt disturbed by red ice	2024.17c7
4	204.0	Clay pit of Medusa Portland Cement Co. red till, varved clay, gray till	1923.24d2
5	218.3	✓ Limestone quarry at Valders, crossing striae	1922.32e4
6	223.8	Interlobate moraine possibly overridden by red ice; note change from Alden mapping	1821.09a2
7	257.9	✓ Overridden Second Wisconsin Lake Michigan drumlins reshaped by Third Wisconsin Green Bay lobe	1518.12f1
8	263.5	Drumlin with new tail	1618.36f1
9	268.8	✓ View from Niagara escarpment over Lake Winnebago	1618.16d6
10	269.2	Road cut showing buried 850 ft. beach of Early Lake Oshkosh under red till	1618.16e8
11	275.8	✓ 805 ft. bar of Later Lake Oshkosh	1518.07d4
12	276.6	Gray gravel under red clay and till	1518.07a3

Total trip 353.3 miles

MONTICELLO TRIP

1	4.3	Wingra moraine overlying drumlins	0609.10b5
2	8.7	View of inside of Milton moraine	0609.09a3
3	9.3	Stoners Prairie- called outwash but really mainly lake sediments between moraine and rock hills to west	0609.17h1
4	11.3	Hill 1160; view over Milton and Johnstown moraines from bed rock hill capped with Black River dolomite	0609.21d5
5	17.3	Gravel pit in alluvial fan from Johnstown moraine	0509.21 .17g5
6	17.9	Cut through kame; evidence of shove	0509.21 17h3
7	19.3	View of outside of Johnstown moraine from Brooklynmoraine	0609.21h8
8	20.9	Cut in Illinoian silttil overlying sand	0509.28d8
9	22.3	Gorge through rock ridge cut by waters from Brooklyn moraine	0509.28a1
10	25.8	Liberty Pole Hill; Brooklyn moraine and another gorge cut by glacial waters from it	0409.10e2
11	31.9	West of Dayton; view of Illinoian terminal	0408.11a5
12	40.5	Monticello millpond; Illinoian stream diversion and terminal moraine	0308.08h6
13	46.5	Crags in St. Peter sandstone due to post Illinoian weathering	0308.28b7

Total of trip84 miles.

Grand total of all trips in 1933 636.3 miles at cost to each student of $5.40 or 0.85 cents per mile

GEOLOGY 143

GLACIAL GEOLOGY

Route log for 1937 trips. Preliminary deposit with treasurer is $5.00.

Mac Farland. South on U. S. 12 to U. S. 51. 51 road to Macfarland. Turn left (E) and follow leader.

Two Rivers (Saturday). NE on Langlon - Wisconsin Ave. to Gorham. Left (NE) to end of Gorham. Right one block to Johnson. Left (NE) on Johnson to junction with U. S. 151. 151 to Fond du Lac. At court house left (N) ~~then immediately right (E) on F. East on F to Park Ave. Left (N) on Park Ave to 23. Right (E) on 23 to gravel pit near St. Marys Springs Academy. Leave gravel pit and go north in front of academy. Continue to Taychestah. Pick up 55 and go north and east. Turn right on town road. Pick up U and go east through Calvary, then north on G. Lunch probably by roadside in side road. Continue north on G to Q. Right (E) on Q and H to Kiel. Stop at filling station at bridgehead. Pick up 149 and go east to A. Left (N) on A through St. Magnus. Right (NE) onto 151 to Valders. Left (N) on 146 to first road left. Left (W) to quarry. Turn around. Back to 146 and then left (N) on 146 to Cato. Cross 10 and go North ½ m. on A. Right (E) on town road for 4 miles. Left (N) on town road for 1¾ m. Right (E) to corner. Left (N) following corner to 4 corners. Right (E) on town road to 141. Right (S) on 141 to Rockwood quarry ½ mile. Left (N) on town road with stop at quarry. Ahead with curves to Manitowoc. Right (NW) on A. Follow A to D. Left (E) on D to Two Rivers. Brief stop at Hotel Hamilton. Continue north and east on 42 to Two Creeks. Right (E) on town road to end on shore of Lake. Forest bed to south on beach. Return to Hotel Hamilton with possible detour to ball park. Storage on car paid by treasurer at Buick garage about one block south on same side of street.~~

Sunday - southwest on 42 to north edge of Manitowoc. Right (W) on old pavement to junction with B. Stop at gravel pits. South on B to junction with 10. Right (W) on 10 to 119. Left (S) on 119 to 151. Left, then right to 141. Right (S) on 141 and follow to 5th right angle turn at church, school and cheese factory. Keep

Breakfast.

Leave town (E) on 23. Assemble at

Follow convoy E on 23

Left (N) on town road. Follow convoy to 55 at a school house

ahead (S) on town road 4½ m. to Cleveland. Left (E) to visit beach cliff at Centerville. Return west to 141. Cross 141 go west ½ mile. Then N to Fisher Creek. Stop. Right onto 141 (S). Then S[out]H to 149. Right (W) on 149. West to 42. Left (S) on 42 to A at Howard. Right (W) on A. Stop at gravel pit west of Franklin. Drive in if possible, continue on A through Elkhart Lake to Glenbeulah. Left (SE) on P to 23. Cross 23 and continue S to 2. Right (W) on 2 to A. Right (N) on A to Green Bush. Stop at filling station. Left (SW) on T to first fork. Keep left (S) on town road. Lunch stop in woods on morraine. Keep ahead to 67. Right W on 67 to V. Left (S) on V to visit knees. Follow leader to ~~Sawmill~~ Kewaskum. ~~Pick up A and go S on A to P. Follow P to Dundee. There take 67 to Campbellsport (left, SW).~~ Thence W to 25. 25 to Minnesota Junction. Optional route home.

Monticello: South on Park St. Stop at top of hill south of city. Continue to Swan Creek. Turn right (W) on town road. Cross D and turn left (S) at next road. Continue south to end of road. Thence east over top of hill to join D. Continue South on D to moraine. Follow leader to junction with 92 west of Brooklyn. Follow 92 to Dayton. Detour to see moraine. Pick up D and follow (S) to C. Take C to Monticello. SE on 39 to Bubler School. Thence follow leader back to Monticello. Home on 69 with supper stop at New Glarus Woods Park.

Belmorth: Same route as before to Yahara River. Right (SE) on river drive to pick up 30. Left (NE) on 30. Follow 30 to Cushing Memorial State Park near Delafield. Stop in Park. Continue on 30 to junction with 83. Right (S) on 83. Stop at gravel pit on hill. Drive in. Follow 83 south across 18 to junction with E. Follow E to 99. Right (S) on 99 to Eagle. Pick up 67 and follow S and SW to junction with 12. Take 12 south about ½ mile to town road on right. Follow town road. Lunch stop either at school or woods. Follow leader to junction with 59. At Richmond keep left (NE) on A to junction with P. Right (S) on P through Delavan to C. Follow leader to gravel pit at Fontana. Take 36 to junction with B. Left (E) on B to overhead crossing. Turn around and follow leader down to Illinois line. Join 14 at Big Foot Prairie. Follow 14 home.

GEOLOGY 143

GLACIAL GEOLOGY

Field trip references - if not called on in class, please hand in written summary, (not over one page).

1. Forest Bed - Wilson, L. R., The Two Creeks forest bed, Manitowoc County, Wisconsin. Wisconsin Acad. Sci., Trans., vol. 27, pp. 31-46, 1932.
2. Forest Bed - Wilson, L. R., Further fossil studies of the Two Creeks Forest Bed, Manitowoc County, Wisconsin. Torr.Bot. Club., vol. 66, pp. 317-525, 1936.
3. Forest Bed - Goldthwait, J. W., Abandoned shorelines of eastern Wisconsin: Wisconsin Geol. and Nat. Hist. Survey. Bull. 17, pp. 61-62, 1907.
4. Red Drift - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey. Prof.Paper 106, pp. 310-324, 1918.
5. Beaches - Goldthwait, J. W., Abandoned shorelines of eastern Wisconsin: Wisconsin Geol. and Nat. Hist Survey. Bull, 17, pp. 57-61, 1907.
6. Beaches - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey, Prof Paper 106, pp. 326-339, 1918.
7. Lake Oshkosh - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey, Prof Paper 106, pp. 324-325, 1918.
8. Interlobate moraine and lake border moraines - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey, Prof. Paper 106, pp. 301-309, 1918.
9. Glacial erosion - Martin, Lawrence. Physical geography of Wisconsin: Wis. Geol. and Nat.Hist.Survey, Bull. 36, pp. 237-253, 1932.
10. Drumlins - Alden, W. C., Drumlins of southeastern Wisconsin: U. S. Geol. Survey Bull. 273, 1905.
11. Drumlins Alden, W. C., Quaternary geology of southeastern Wisconsin: U. S. Geol. Survey Prof Paper 106, pp. 253-256, 1918.
12. Soil Profiles - Kellogg, C. E., Preliminary study of the profiles of the principal soil types of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 77A, 1930.
13. Striae - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, pp. 203-208, 1918.
14. Origin of Lake Michigan - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, pp. 126-130, 1918.
15. Origin of Lake Michigan - Chamberlin, T. C., Geology of Wisconsin, vol I, pp. 253-259, 1883.
16. Interlobate Moraine - Chamberlin, T. C., Geology of eastern Wisconsin: Geology of Wisconsin, vol. II, pp. 205-219, 1877.
17. Bed Rocks - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, pp. 49-103, 1908.
18. Bed Drift - Chamberlin, T. C., Geology of eastern Wisconsin: vol. II, pp. 219-230, 1877.
19. Origin of Lake Michigan - Shepard, F. P., Origin of Great Lakes Basins: Jour. Geology, vol. 45, pp. 76-88, 1937.
20. Bed Rocks - Thwaites, F. T., The Paleozoic rocks found in deep wells: Jour. Geol., vol. 31, pp. 529-555, 1923.
21. Eagle Terraces - Alden, W. C., The Delavan glacial lobe: U. S. Geol. Survey. Prof. Paper 34, pp. 44-49; 57-62, 1904.
22. Lake Geneva and Oconomowoc district - Fenneman, N. M., Lakes of southeastern Wisconsin: Wis. Geol. and Nat. Hist. Survey. Bull. 8, pp. 63-65, 93-97, 1902.
23. Kettle Moraine - Alden, W. C., The Delavan glacial lobe: U. S. Geol. Survey Prof Paper 34, pp. 53-56, 1904.
24. Kettle Moraine - Alden, W. C., Quaternary geology of southeastern Wisconsin: U. S. Geol. Survey Prof.Paper 106, pp. 13-15, 235-237, 269, 283, 289, 1918.

25. Pre-Wisconsin drift eastern - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof Paper 106. pp. 137-143, 1918.
26. Pre-Wisconsin drift western - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof Paper 106, pp. 144-151, 1918.
27. Johnstown moraine - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, pp. 209-220, 1918.
28. Darien Moraine - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, pp. 232-235, 1918.
29. Darien Moraine - Alden, W. C., Delavan glacial lobe: U. S. Geol. Survey. Prof Paper 34, pp. 33-34, 1904.
30. Delavan lobe - Alden, W. C., Delavan glacial lobe: U. S. Geol. Survey Prof. Paper 34, pp. 25-33, 1904.
31. Delavan lobe - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, pp. 257-262, 1918.
32. Marginal Wisconsin drift - Leighton, M. M., Differentiation of drift sheets of northwestern Illinois: Jour. Geol. vol. 31, pp. 265-281, 1923.
33. Drift in Illinois - Leverett, Frank. Illinois glacial lobe: U. S. Geol. Survey, Mon. 38, pp. 131-140, 1899.
34. Marengo Ridge and Brooklyn moraine - Alden, W. C., Delavan glacial lobe: U. S. Geol. Survey Prof Paper 34, pp. 22-24, 1904.
35. Marengo Ridge and Brooklyn moraine - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, 180-185, 1918.
36. Outwash near Janesville, etc. - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof Paper 106, pp. 186-189, 238-240, 1918.
37. Genoa Moraine - Alden, W. C. Quaternary geology of southeastern Wisconsin: U. S. Geol. Survey prof Paper 106, pp. 230-232, 1918.
38. Lake Mills Moraine, etc. - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof Paper 106, pp. 275-284, 1918.
39. Eskers - Alden, W. C. Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof Paper 106, pp. 284-288, 1918.
40. General 16th. International Geological Congress: Guidebook 26, pp. 1-12, 35-51, 1932.

1921

MIDSEMESTER EXAMINATION, GEOLOGY 143

Write on any four. Do not change the numbers.

1. a. Give four evidences observed in the field which demonstrate that the drift around Madison was deposited by a glacier. b. Give two evidences that this event took place in relatively recent geologic time.

2. Map the different types of glacial deposits shown on the section of topographic map given you. Be sure to show the boundaries by solid lines. Use the usual field symbols, and give a legend explaining them.

3. a. How do you distinguish between terminal moraine and ground moraine. b. Between pitted outwash and terminal moraine. c. Between esker and drumlin, d. Between terminal moraine and sand dunes.

4. What types of glacial deposits would you search for to locate gravel. Discuss the origin and nature of one of them.

5. a. Contrast the structure and composition of loess and lake clays. b. Discuss the evidences bearing on the origin of loess.

GEOLOGY 143, FINAL EXAMINATION

June 11, 1921

Write on 7 including the first. Do not change the numbers. Please number in column on cover and mark with dash the questions omitted.

1. At northeast corner of a section, surface elevation 900, depth to rock 20 feet; at east 1/4 post surface 925, depth to rock 75 feet; at NW corner surface 850, depth to rock 150; at SW corner surface 900, depth to rock 250 feet; required probable depth to rock at point 1/4 mile westof center of section with surface elevation 850 feet. The northeast and southwest corners of the section are terminal moraine. the central portion outwash. Forecast probable material in new hole.

2. State definitely criteria used in a. mapping outer border of a terminal moraine, b. inner border of same, c. border of a drumlin, d. distinguishing an esker from a kame, e. distinguishing pitted outwash from drift of similar topographic form but different origin.

3. State five criteria by which the direction of glacial movement may be determined and state exactly where you saw each of them in the field.

4. Discuss the origin of eskers noting evidence you have seen in the field which bears on the question.

5. a. State the topographic evidence which aids in the discovery of gravel deposits. b. Distinguish between 1. delta moraine and esker, 2. till and gravel, 3. loess and lake clay, 4. outwash and stream terrace, 5. kame and moraine.

6. How do you tell soil due to weathering of drift from that composed of loess, of lake clay. Where did you see examples of any of these types?

7. Discuss briefly the two general classes of hypotheses of the origin of the glacial period and describe specifically one hypothesis with th the reasons for and against its general acceptance.

8. A certain region of low relief and gentle slopes is covered by deeply weathered drift except where knolls of fresh gravel rise above the general surface. In an adjacent district the slopes are steep and the relief great. If the drift were of the same age in both areas, what differences in erosion and weathering of the drift would you expect to find between the two?

9. State in a single sentence a. how you would distinguish a glacier from a snow field, b. methods by which a glacier gathers debris, c. names of four recognized glacial epochs, d. difference between moraines deposited where glacier is descending and ascending a slope.

1922

MIDSEMESTER EXAMINATION, GEOLOGY 145

1922

Write on any four. Do not change the numbers

1. Map the different types of glacial deposits shown on the section of topographic map given you. Be sure to show the boundaries by solid lines. Use the usual field symbols, and give a legend explaining them.

2. Contrast the structure and composition of (a) loess and residual clays, (b) of till and gravel.

3. Outline evidence by which origin of deposit at Pich gravel pit is known.

4. In a certain area fresh drift is exposed in the hill sides, and deeply weathered drift on the uplands along with knolls of fresh gravel. Discuss the significance of these facts with reference to the age of the drift or drifts.

5. Name three types of topography due to water associated with ice. Discuss the origin of one and the occurrence in it of deposits of economic value.

FINAL EXAMINATION, June 6, 1922.

Geology 143.

Write on 8. Keep numbers same as here given.

(1) You are asked to forecast the depth of drift at a certain place where no previous survey has been made. What field and office work is needed?

(2) East-west striae are reported in west central Illinois; state what field observations are needed to fix direction of ice movement.

(3) Outline the principle of Crolls astronomic hypothesis and state briefly some of the objections to it.

(4) Outline principle of two distinct methods of measuring post-glacial time.

(5) What significance to the interglacial theory has the occurence of vegetal remains between layers of till?

(6) Name four factors which govern the speed of weathering of drift.

(7) With regard to gumbotil state: what it is, where found, two theories of its origin, and compare the two explanations.

(8) State the Pleistocene sucession in the Mississippi valley as defined by Chamberlin.

(9) State three distinct evidences which indicate the wind origin of loess and one which indicates that it was not deposited during a glacial stage.

(10) State two distinct lines of evidence which indicate the existance of a marginal lake and the field observations to be made in such an area.

Geology 143 Midsemester Examination April 2, 1923

Write on five.

1. You are passing from an area of pitted outwash to a terminal moraine; what will you note so as to be able to draw the boundary on the map?

2. Discuss briefly the two principal theories of the origin of drumlins.

3. What conditions of ice and topography are necessary to have formed (a) till moraine with kettles, (b) delta moraine, (c) kame moraine, (d) pitted outwash plain, (e) ordinary outwash plain.

4. A well in the eastern part of this city shown from top down (a) peat (b) marl with shells, (c) dolomite laminated clay, (d) till, (e) gravel, (f) sand, (g) dolomite laminated clay, (h) gravel with local pebbles, (i) bed rock. What succession of events does this record?

5. In a certain section the following elevation of bed rock surface were obtained. SW corner 480, W¼ post 523, ¼m east of last 518, N¼ post 540, ¼ mile E of last 521, ¼mS of NE corner 540, S½ post 550, SE corner 600 . Estimate the depts to rock at the center of the section where the surface elevation is 590.

6. Outline Degeer's method of measuring duration of glacial lakes.

Geology 143

write on 8 including 1

Special final examination, May 24, 1923.

(1) You are to examine for gravel deposits along S.T.H. 20 west of Monroe. State (a) what topographic positions you would look, (b) Type of gravel topography as different from surroundings, (c) reason for this, (d) mark suggested localities on map, (e) probable suitability for concrete in diffent places.

(2) Map in glacial features on map given and give legend.

(3) Name and disscuss four factors which regulate speed of erosion.

(4) With regard to the Iowan drift state (a) where it is mapped, (b) its relation to other deposits of Pleistocene, (c) its characteristic topography, (d) at least one factor which confuses the question of age, (d) why there is a question as to the existence of the Iowan drift.

(5) What topographic features affected the deposition of loess; what evidence tells whether glacial or interglacial in age?

(6) What observations should be recored in the field and made later on an exposure of a forest bed?

(7) East-west striae are reported from a locality between Fond du Lac and Sheboygan. How could you tell which lobe made them?

(8) Into what main groups may the theories of the origin of the ice age be divided? Discuss one particular theory.

(9) Using the maps given you discuss the relative age of the drift at Monroe and Clinton Jct.

(10) Same as (9) for Monroe and Cross Plains.

Geology 143

Final examination June 4, 1923.

rite on first three (count 20 each) and on four others (count 1. each)
Number of question in upper left hand corner of maps etc.

(1) Show the glacial features on the map being particular to define boundaries with solid limes and give legend.

(2) 5 pictures. Please do not mark.
For each tell:
(a) field observations needed
(b) What is feature shown
(c) Its origin.
(d) Probable nature of material in glacial deposits with espacial attention to presence of commercial gravels.

(3) (a) Mark on the map in pencil the probable preglacial course of Jordan creek.
(b) What happened to the creek?
(c) What conclusions do you draw as to age of glaciation?
(d) State definitly just where you saw an example of this in the filed.

(4) How do you distinguish:
(a) Pitted outwash from terminal moraine.
(b) Delta from stream outwash deposit.
(c) Weathered till from loess.
(d) Till from lake clay.
(e) Kame from esker.

(5) Discuss the question, of the relative age of the Darien and Marengo moraines.

(6) A well shows sand with logs of wood between two layers of till. Discuss possible interpretations.

(7) What relation has the loess to the surface of the pre-Wisconsin till and hat doess this tell about the postglacial history of the area?

(8) Why do the Illinoian deposits seen in the field exhibit such a wide variation degree of weathering?

(9) With regard to the Aftonian state;
(a) what it is.
(b) Where found.
(c(What unsolved problems as to interpretaion.

(10) Same as above for Iowan.

MIDSEMESTER EXAMINATION GEOLOGY 143.
April 7. 1924.

Write on 5.

1. How do you distinguish between
   a. marine glacial clay and fresh water glacial clay.
   b. glacial lake clay and residual clay
   c. gravel boulder and kame.
   d. drumlins and rock moutonee.

2. Discuss the theory of isostacy as an explanation of the deformed Pleistocene shore lines.

3. a. With what other features might striae be confused?
   b. how differentiated?

4. Discuss the relative advantages and disadvantages of locating a large commercial gravel pit in (a) an esker (b) an outwash deposits.

5. A well is to be put down to find water in the drift. Discuss probable conditions to be met with above bed rock in (a) pitted outwash area, (b) outer edge of a large delta formed during ice recession.

6. Discuss evidence leading to conclusion of two high water stages in the western Quaternary Lakes.

Assignment for April 16: Loess: Chimek, Jour. Geol. 7, 122-140, or Am. Geologist 32, 353-369; Udden, Bull. G. S. A. 9 or W. B. Wright 197-220.

6-9

Geology 143

Final examination June 6, 1924

Write on first two which count 20 each and on six (6) others, eight in all except that there is one double question among the optional ones which count 10 each.

Required questions.

(1) Pictures with question number in upper left hand corners. For each tell: (a) Name of feature shown, (b) field observations if any needed to check this, (c) origin of feature, (d) nature of material with especial reference to commercial gravel if present. Please do not mark the pictures. The feature meant is the principal subject of the view.

(2) Hartford Quadrangle, Wisconsin. Please do not mark with ink.
(a) What was the direction (both compass direction and direction along that line) of ice movement in this area?
(b) How do you know this?
(c) List the several forms of glacial topographic features seen on this map and locate EXACTLY an example of each.
~~(d)~~

Optional questions-write on six

(3 and 4) Double question, counts 20
Place your name on the map. Draw 100 foot contours on preglacial surface down to the railroad.

(5) Refering to map of above question state:
(a) What conclusion you draw as to the age of the drift of that area.
(b) Mark on map suggested location for a boring to determine maximum depth of weathered material and explain why this spot was chosen.

(6) With regard to the TORONTO state: (a) what it is, (b) where found, (c) discuss interpretaion and significance.

(7) Same as (6) for the NEBRASKAN.

(8) With regard to loess state: (a) nature of material, (b) relation to topography and vegetation, (c) areal relation to drifts, (d) time relations to drifts, (e) origin.

(9) Discuss the explanation of the differences in topography of the terminal moraines of Wisconsin and of central Illinois.

(10) Define: (a) gumbotil, (b) drumlin, (c) esker, (d) kame, (e) glacial stage.

(11) Discuss Niagara Falls as a time measure.

Place list of numbers of questions in column on outside of your book and mark those omitted.

Geology 143

Midsemester examination, April 6, 1925

Please do not place your name on the bluebook but put it opposite corresponding number on paper which is passed around.

Write on five questions.

(1)
Define concisely (a) in terms of fact and (b) in terms of origin:

(a) varve
(b) till
(c) esker
(d) isobase
(e) silt
(f) drift
(g) hingline
(h) gravel
(i) paha
(j) gravel bowlder

(2)
Name five (5) forms of topography which might be confused with kames and tell how you could distinguish them from kames. (This does not necessarily mean to discuss origin)

(3)
How do you distinguish between (this does not say tell the origin):

(a) esker and bar
(b) outwash in front of outermost terminal moraine and outwash in front of a recessional moraine
(c) clay terminal moraine and stony terminal moraine
(d) outwash terrace and beach
(e) striae and slickensides

(4)
Compare the two theories of the derivation of the material of loess (not the theories of mode of deposition)

(5)
Discuss the origin of the basins of the Great Lakes

(6)
(a) State the principal causes of the terracing of outwash deposits.
(b) What facts regarding glacial erosion may be obtained from the study of the composition of till?

Final Examination June 5, 1925

GLACIAL GEOLOGY

1. Name two distinct ways of telling how many years have elapsed since glaciation and describe one of them in detail.
2. a. Why are there most gravel roads in the area of Wisconsin drift?

   b. What are the principal causes of formation of outwash terraces?
3. Discuss the nature and significance of the Toronto deposits.
4. Discuss the origin, occurrence, and significance of gumbotil in Pleistocene geology.
5. If you were asked to locate a site for a large commercial gravel pit, (a) what kinds of drift would you search for? (b) what three other features should also be regarded?

Special midsemester examination

Write on ~~five~~ 4

(1) Define in (a) terms of fact and (b) terms of origin:

(a) striae
(b) loess
(c) chatter marks
(d) rocdrumlin
(e) slickensides

(2) The State Survey paties have had difficulty in finding the upper limit of lake action in northern Wisconsin.

(a) with what might beaches be confused?
(b) what criteria would you suggest to settle the question?

(3) Discuss the origin of eskers.

(4) State the evidence for and against the importance of glacial erosion in the vicinity of Madison.

(5) Discuss the origin and significance of pitted outwash.

(6) Discuss the cause and results of postglacial earth movement in the region of the Great Lakes.

MIDSEMESTER EXAMINATION, GEOLOGY 143,
April 5, 1926

DO NOT PLACE YOUR NAME ON THE BLUE BOOK; write it opposite the corresponding number on the card which is passed around. In this way fair grading is assured.

Write on five questions. Please do not give information not called for.

(1) Give the diagnostic features which enable you to distinguish between:
(a) lake cliff and terrace edge
(b) beach gravel and outwash gravel
(c) glacial lake clay and marine glacial clay
(d) bar and esker
Note: this does not mean to discuss the origin.

(2) Discuss the several causes of the terracing of glacial outwash.

(3) With what might the following be confused? State briefly the way in which you could distinguish each from the somewhat similar phenomenon.
(a) Till
(b) Pitted outwash
(c) Terminal moraine
(d) Delta
Note: this does not mean to discuss the origin.

(4) Discuss the evidences for and against the glacial erosion of fresh bed rock on a large scale.

(5) State in one clear sentence what conclusion you draw from:
(a) varves of varying thickness
(b) the fact that the stoss or upstream end of a drumlin is steeper than the other end.
(c) an area of kettle and knob topography which is all fairly well assorted gravel.
(d) presence of a stream valley in a glaciated region which is much too large for the present drainage that it carries.
(e) the fact that most of the stones in the drift are of nearby origin.

(6) State concisely how you would prove definitely:
(a) the former presence of a glacial lake
(b) if a kame contained coarse gravel without digging or from a distance.
(c) the direction along striae that the ice came from
(d) course of preglacial or interglacial valleys beneath outwash in front of a recessional moraine.

Grades cannot be obtained before April 15.

SPECIAL EXAMINATION, Geology 143, June 3, 1926

Write on all questions

(1) A drill hole on an upland in southern Iowa shows the following log:

0-5 Clay, yellow, non-calcareous
5-8 Clay, gray, clacareous
8-12 Clay, gritty, black, non-calcareous
12-16 Till, red, non-calcareous
16-18 Till, yellow, calcareous

Another hole on a steep hillside at ~~the~~ lower elevation than the foregoing shows:

0-3 Clay, gray, calcareous
3-10 Till, blue, calcareous
10-15 Clay, gritty, dark, gray, non-calcareous
15-18 Till, ~~xxxx~~ yellow, non-calcareous

State the important conclusions you draw from this information.

(2) Two nearby areas show gravel in shallow cuts. One is a flat-topped bench along the bank of a river; the other is a steep-sided knoll surrounded by till. Write a short report on the comparative desirability of these deposits for a shipping gravel pit and include recomendations for exploration before purchase.

(3) Criticise the statement used as evidence of equivalent age:

"the extreme weathering and the advanced erosion of the drift at Marshfield (in the granitic region of northern Wisconsin) is at least equal to that of the oldest drift sheet in Iowa and Kansas."

(4) Define in terms of (a) description and (b) origin
(a) gumbotil
(b) loess
Give the significance of
(a) Aftonian
(b) Toronto
(c) Kansan
(d) Forest Bed

GEOLOGY 143

MIDSEMESTER EXAMINATION, APRIL 4, 1927

CAUTION: PLEASE DO NOT WRITE YOUR NAME ON YOUR BLUEBOOK. Write it opposite corresponding number on the card which will be passed around. The last student will seal this card in an envelope which will not be opened until the books are returned. In this way impartial grading is assured. Grades cannot be obtained until April 15.

WRITE ON THE FIRST TWO QUESTIONS AND ANY THREE OTHERS OR FIVE IN ALL

(1) and (2) Please do not mark the pictures but return them in your book.
- (a) Name the principal glacial feature or deposit represented in each.
- (b) Give the definition including definition in terms of origin.
- (c) Tell briefly how you decided that this feature or deposit is shown.
- (d) Discuss the possibility of finding gravel in the deposit.

(3) Give the best SINGLE diagnostic feature which enables you to differentiate between:
- (a) lake beach and terrace scarp.
- (b) outwash gravel and kame gravel
- (c) outwash and delta
- (d) lake clay and clay till
- (e) terminal moraine and ground moraine

Caution: do not discuss origin!

(4) State in a single sentence the most important single conclusion you would draw from the occurrence of: (Do not discuss origin)
- (a) varved clay
- (b) an area of knob and sag (kettle) topography underlain by sand and well-sorted gravel.
- (c) a valley without a stream which cuts entirely through a terminal moraine
- (d) two summit levels in an area of pitted outwash (two terraces).
- (e) scattered bowlders in well-sorted, horizontally bedded gravel.

(5) State concisely a SINGLE evidence which definitely proves: (one for each)
- (a) probable quality of gravel in an esker before digging.
- (b) direction in which ice moved along striae
- (c) former presence of glaciers in high mountains
- (d) former presence of a continental glacier.
- (e) marks are slickensides and not glacial striae.

(6) Discuss arguments for and against the excavation of a large part of fiords by glacial erosion, that is the idea that glacial erosion was the predominant factor in formation of fiords.

Note; only one book will be supplied; write on both sides of pages.

GLACIAL GEOLOGY - GEOLOGY 143

Final examination, June 13, 1927

Write on ten (10) questions

(1) Outline the glacial history demonstrated by the striae at Valders.

(2) Account for the terraces in the Interlobate moraine near Oconomowoc.

(3) Account for the difference in composition of the Darien and Marengo moraines. What evidence was seen which bears of their relative ages?

(4) It was once thought that the red drift of northeastern Wisconsin was very old and owed its color to long oxidation. Give modern interpretation.

(5) Account for the origin of Lake Winnebago.

(6) Outline (a), (b), etc. the events of the Wisconsin stage of glaciation and postglacial time in the vicinity of the Forest Bed.

(7) What significance has the kettle hole at the farm of the late Ex-Gov. Phillip ?

(8) You are sent to look for gravel in the area of old drift near Belleville. What sort of topographic features will you look for and why?

(9) State one or more definite local localities where we saw:
(a) overridden outwash, (b) drumlins of old drift, (c) crossing striae, (d) deltaic outwash plain, (e) varved clay.

(10) What proof did you see that the "Old drift" is really very much older than the drift at Madison?

(11) Account for the different appearance of the old drift area near Belleville and east of Roscoe.

(12) Discuss the existence of a Delavan lobe.

Geology 143
Mid semester examination. April 2, 1928

Caution: Do not put name on bluebook but write it opposite corresponding number on card which will be passed around. Only one book allowed. Grades may not be ready before April 13.

Write on first two and any three(3) others, five (5) in all.

(1&2) Pictures (please do not mark) Answer to each picture together. Pictures numbered in red- pay no attention to others.

(a) Name principle glacial feature or deposit.
(b) Define this feature in terms of fact.
(c) " " " " " " origin.
(d) Discuss possibility of finding gravel in each deposit.

(2) Give the best single diagnostic feature which enables you to differentiate between (Do not discuss origin!)

(a) lake gravel and outwash gravel
(b) drumlin and roche montonnee
(c) lake cliff and edge of outwash terrace
(d) bar and esker
(e) striae and slickensides

(3) State in a single sentence the most important single conclusion which you would draw from the occurrence of (do not discuss origin)

(a) Sucessive pairs of layers of silt and clay.
(b) fact that stoss end of a drumlin is steeper than lee
(c) Very abundant granite bowlders over considerable of drift.
(d) long gravel ridge with steep sides
(e) Stoneless unstratified silt above glacial drift.

(4) Define (a) in terms of facts and (b) in terms of origin. (Each together not separate lists)
(1) chatter mark
(2) loess
(3) till
(4) esker
(5) kame

(5) Discuss (a) the evidence of late glacial or postglacial earth movement around the Great Lakes. (b) Theories of its cause.

(6) Three areas are offered as possible sites for a commercial gravel pit.

(a) Level-topped terrace along side of a river
(b) Area of more or less scattered knolls where summits are nowhere flat or of the same elevation.
(c) Area of knobs and kettles with the highest hills flat-topped.

Discuss the probable merits of each and what should be done to test out the area before purchase.

Geology 143

Make-up examination, June 1, 1928

Write on four questions

1. How do you distinguish between
(state at least one decisive evidence and do not discuss origin):

(a) gravel bowlder and kame
(b) glacial lake clay (in Wisconsin) and postglacial lake clay
(c) loess and residual soil from limestone
(d) varve and lamination
(e) terminal moraine and pitted outwash

2. Outline the fundamental idea of the theory of the study of varves

3. State the single most important conclusion as to glacial history drawn from:

(a) Flat-topped sandy beach in river valley beyond limit of drift.
(b) Extensive sand plain with scattered enclosed depression in it;
(c) Level-topped ridge of gravel much of which is extraordinarily sorted.
(d) Steep-sided knoll of poorly sorted gravel in inclined layer
(e) Very long belt of irregular knolls of till

4. Define in two parallel columns (a) fact, (b) origin (be brief).

(a) drumlin
(b) gravel
(c) outwash
(d) hanging valley
(e) varve

5. (a) At a certain point there are E-W striae.
How could you tell if ice came from E or W?
(Give at least one decisive evidence)

(b) Explain origin of chatter marks.

Glacial Geology - Geology 143.

Examination on Field Trips - June 2, 1928

Write on ten (10) questions. Do not place name on blue book, but write it opposite some number on card.

.....

1. Account for the origin of Lake Geneva
2. (a) Account for the coloration of the Red Drift, (b) where was evidence of such seen. (State at least one specific locality.)
3. Account for the contrast in original topography of (a) Red Drift area and (b) region around McFarland.
4. (a) Account for the lake basins near East Troy. (b) Where were other lakes of same origin seen? (be specific.)
5. (a) Discuss the significance of the Brooklyn Moraine. (b) What other moraine visited may be of same age? Why?
6. State precisely where the following were seen: (a) esker (b) Illinoian drumlins, (b) Illinoian stream diversion (d) chatter marks, (e) red till on grey till (f) outwash terrace (unpitted), (g) rock hill resembling drumlin (h) clay till terminal (i) deltaic terminal, (j) ground moraine.
7. Outline with diagram the glacial history of vicinity of Walworth, Wisconsin and Harvard, Illinois.
8. Outline with diagram of ideal section of glacial deposits the history of the Wisconsin stage of glaciation in Lake Winnebago region.
9. Discuss significance of the Forest Bed.
10. Account for pitted outwash terraces near East Troy and Eagle.
11. Discuss conditions for discovery of concrete gravel near Dayton and Belleville.
12. List types of glacial deposits in which shipping gravel pits were seen.

GEOLOGY 143, GLACIAL GEOLOGY

Special make-up examination, May 17, 1927

Write on the first and any four other questions or five(5) in all.

(1) Pictures.

Please do not mark or injure the photographs.

For each tell (a) What it represents and how you decided.

(b) The definition of the subject

(c) Possibility of finding gravel in this deposit.

(2) Define in separate columns of (a) description and (b) origin the following

(a) striae, (b) chatter-mark, (c) esker, (d) hihgeline, (e) till

(3) State the single best diagnostic feature which will distinguish between

(a) bar and esker
(b) delta and kame
(c) pitted outwash and terminal moraine
(d) slickensides and striae
(e) fiord and unglaciated drowned valley

(4) Discuss the cause and effects of Pleistocene and Recent earth movement in the region of the Great Lakes.

(5) Three areas are offered as possible sites for a commercial gravel pit. One is a level-topped terrace along the sideof a large river; the second is a knoll in knob and sag topography, and the third is a winding "hog-back" in a plain. Write a brief discussion of the probable merits of each and the amount of testing required before development.

(6) State a single evidence which definitely proves:

(a) former presence of a glacial lake

(b) course of former valleys in a region now covered by pitted outwash.

(c) whether a moraine is the terminal moraine of a glacial stage or a recessional moraine outside of which the ice lay not long before the formation of the moraine.

(d) origin of a lake basin by glacial erosion

(e) that earth movement has occured in the Great Lakes region in postglacial time.

GEOLOGY 143, GLACIAL GEOLOGY

SPECIAL FINAL EXAMINATION, JUNE 6, 1927.

Write on ten (10) questions. If you choose no. 7 it counts for two. Be brief but accurate.

(1) Outline in order (a), (b), (c), etc. the events of the geologic history of the vicinity of Oshkosh since the beginning of the Wisconsin stage of glaciation. Be brief.

(2) State one or more definite localities where we saw:
(a) eskers, (b) drumlins trending NE-SW NW-SE, (c) chatter marks,
(d) interlobate moraine, (e) loess

(3) What important geologic fact was demonstrated by the drill hole north of Irene and south of Argyle?

(4) Account for the quite general presence of a silt clay covering on outwash plains.

(5) In the area of old drift what topographic forms seem to be associated with gravel deposits of the same age as the old drift?

(6) Account for the relation of outwash and terminal moraine near Prairie du Sac.

(7) Double question. If you write on this take only eight (8) others. It is desired to find a water-bearing gravel bed of considerable horizontal extent at Manitowoc. Reasoning from the glacial history of this region discuss the possibility of finding such.

(8) Discuss briefly the origin of the outwash terraces near Prairie duc Sac.

(9) In what types of deposits did you note commercial gravel pits either now or recently in operation? Account for predominance of one type.

(10) Discuss the origin of the basin of Lake Geneva.

(11) In what type of deposit do most relatively small lakes seem to occur?

(12) Discuss briefly the significance of the Brooklyn moraine.

GLACIAL GEOLOGY, Geology 143

Special examination, June 11, 1927

Write on five (5)

(1) With regard to loess state briefly (a) two hypotheses of its mode of deposition, (b) two views as to its source of material, and (c) its general distribution in America

(2) Define in single sentence or state significance of:
- (a) interglacial interval
- (b) fact that loess is thickest on east side of a ridge
- (c) gumbotil
- (d) Aftonian
- (e) Illinoian

(3) What decisive evidence is there which tends to show at least one time of complete disappearence of the Pleistocene ice caps of Canada?

(4) What evidences tend to show that the southermost drift of the U. S. is very much older than the drift near Madison?

(5) Logs of wood were found in digging a well through the drift; what possible interpretations could be given this fact?

(6) Criticise the following statement which was used as proof of the same age of drift "the extreme weathering and the advanced erosion of the drift at Marshfield (in the granite region of northern Wisconsin) is at least equal to that of the oldest drift sheet in Iowa and Kansas (where the bed rock is mainly shale)."

GLACIAL GEOLOGY - GEOLOGY 143

Final examination, June 13, 1927

Write on ten (10) questions

(1) Outline the glacial history demonstrated by the striae at Valders.

(2) Account for the terraces in the Interlobate moraine near Oconomowoc.

(3) Account for the difference in composition of the Darien and Marengo moraines. What evidence was seen which bears of their relative ages?

(4) It was once thought that the red drift of northeastern Wisconsin was very old and owed its color to long oxidation. Give modern interpretation.

(5) Account for the origin of Lake Winnebago.

(6) Outline (a), (b), etc. the events of the Wisconsin stage of glaciation and postglacial time in the vicinity of the Forest Bed.

(7) What significance has the kettle hole at the farm of the late Ex-Gov. Phillip ?

(8) You are sent to look for gravel in the area of old drift near Belleville. What sort of topographic features will you look for and why?

(9) State one or more definite local localities where we saw:
(a) overridden outwash, (b) drumlins of old drift, (c) crossing striae, (d) deltaic outwash plain, (e) varved clay.

(10) What proof did you see that the "Old drift" is really very much older than the drift at Madison?

(11) Account for the different appearance of the old drift area near Belleville and east of Roscoe.

(12) Discuss the existence of a Delavan lobe.

Geology 143
Mid semester examination. April 2, 1928

Caution: Do not put name on bluebook but write it opposite corresponding number on card which will be passed around. Only one book allowed. Grades may not be ready before April 13.

Write on first two and any three(3) others, five (5) in all.

(1&2) Pictures (please do not mark) Answer to each picture together. Pictures numbered in red- pay no attention to others.

(a) Name principle glacial feature or deposit.
(b) Define this feature in terms of fact.
(c) " " " " " " origin.
(d) Discuss possibility of finding gravel in each deposit.

(3) Give the best single diagnostic feature which enables you to differentiate between (Do not discuss origin!)

(a) lake gravel and outwash gravel
(b) drumlin and roche montonnee
(c) lake cliff and edge of outwash terrace
(d) bar and esker
(e) striae and slickensides

(4) State in a single sentence the most important single conclusion which you would draw from the occurrence of (do not discuss origin)

(a) Sucessive pairs of layers of silt and clay.
(b) fact that stoss end of a drumlin is steeper than lee
(c) Very abundant granite bowlder over considerable area of drift.
(d) long gravel ridge with steep sides
(e) Stoneless unstratified silt above glacial drift.

(5) Define (a) in terms of facts and (b) in terms of origin.(Each together not separate lists)

(1) chatter mark
(2) loess
(3) till
(4) esker
(5) kame

(6) Discuss (a) the evidence of late glacial or postglacial earth movement around the Great Lakes. (b) Theories of its cause.

(7) Three areas are offered as possible sites for a commercial gravel pit.

(a) Level-topped terrace along side of a river
(b) Area of more or less scattered knolls where summits are nowhere flat or of the same elevation.
(c) Area of knobs and kettles with the highest hills flat-topped.

Discuss the probable merits of each and what should be done to test out the area before purchase.

Geology 143

Condition examination - January 12, 1929

1. Account for the origin of Lake Geneva.
2. Discuss significance of the Forest Bed.
3. Discuss the existence of a Delavan Lobe.
4. What glacial history is demonstrated at Valders?
5. State in a single sentence the most important single conclusion which you draw from the occurrence of - (do not discuss origin)

   (a) Successive pairs of layers of silt and clay,
   (b) Plain of sand and gravel, containing enclosed depressions
   (c) Several plains of sand and gravel at different levels along the sides of a stream valley.
   (d) Valley without stream which cuts through a terminal moraine
   (e) Extremely well sorted gravel in horizontal beds

6. State concisely in a single sentence evidence which definitely proves (one for each):

   (a) direction in which ice moved along striae
   (b) fresh water deposition of clay and silt
   (c) marks are slickensides and not striae.
   (d) postglacial earth movement in Great Lakes region.
   (e) esker and not kame

7. Define in two parallel columns (a) fact and (b) origin (Be brief - do not discuss fully)

   (a) Drumlin
   (b) outwash
   (c) varve
   (d) gumbotil
   (e) loess

8. Criticise the statement used as evidence of equivalent age:
   "The extreme weathering and the advanced erosion of the drift at Marshfield (in the granite region of northern Wisconsin) is at least equal to that of the oldest drift sheet in Iowa and Kansas".

9. Two areas are considered as sites for a commercial gravel pit. Both show gravel in shallow cuts. No. 1 is a flat topped bench on side of a river valley. No. 2 is a nearly circular steep sided hill in a region otherwise composed of till. Write a short and concise statement of the relative values of these sites.

10. Distinguish between (do not discuss origin) (a) till and gravel
    (b) bar and esker (c) delta and outwash (d) stream terrace and lake cliff
    (e) pitted outwash and terminal moraine.

GEOLOGY 143

Midsemester examination, April 8, 1929.

CAUTION: Please do not write your name on the bluebook; write it after same number on card which will be passed around. This card will not be consulted until all books have been graded thus insuring fairness to all.

Write on five (5) questions.

(1) (a) In what types of glacial deposits would you search to locate gravel? (b) Discuss the origin and nature of the one in which you are most likely to find the largest deposits of well-sorted gravel.

(2) Define (not discuss in detail) the following using two parallel columns, (a) in terms of fact or observation and (b) in terms of interpretation or origin:
(a) varve, (b) till, (c) esker, (d) hanging valley, (e) kame, (f) gravel, (g) hingeline, (h) loess, (i) silt, (j) drumlin.

(3) State concisely a single definite evidence which would prove conclusively: (a) the former presence of a glacial lake
(b) the presence of coarse stony gravel in an esker without digging or from a distance.
(c) that certain sediments had been deposited in a delta.
(d) the course of a preglacial (or interglacial) valley beneath the outwash plain in front of a recessional moraine (other than well records).
Note; One evidence for each of above sets of conditions.

(4) Two areas show gravel in shallow cuts and are offered for sites for a shipping gravel pit. One is a flat-topped district with some kettles, the other a steep-sided knoll which is surrounded by till. Write a short report on the comparative desirability of these deposits including recomendations for necessary exploration before purchase.

(5) (a) Explain the origin of chatter marks. (b) You see a striated rock outcrop. Explain ONE defintie line of evidence which if found would show the direction in which the ice moved along the striae.

(6) Compare the two theories of the time of deposition of loess in North America (not of its mode of origin).

(7) State four important causes of terracing of glacial outwash.

GEOLOGY 143 Final examination, June 8, 1929

Write on ten (10) questions.

(1) It has been argued that since very old drifts are deeply oxidized the "Red Drift" of northeastern Wisconsin is really a very old sheet of till. Discuss this hypothesis citing evidences seen by you in the field.

(2) On an outline map color or mark with pencil the area occupied by ice at maximum of the Late Wisconsin glaciation and the areas submerged by marginal lakes with names of lakes.

(3) On an outline map show (a) approximate route of the field trips (all), (b) a region or regions where you saw well developed drumlins, (c) nunatack, (d) interlobate moraine, (e) kames, (f) meander scars, (g) outwash terraces, (h) pitted outwash, (i) varved clays, (j) gumbotil.

(4) Discuss the problem of the different ages of drift in northern Illinois using an outline map to show where each is.

(5) You have charge of drilling a well for water in the drift. The region contains clay till. Gravel is struck in this till but a test shows that the water is exhausted in a few minutes. Tell how you would explain this, citing where similar geological conditions were seen in the field.

(6) Discuss the various commercial gravel pits seen on the trips including pits used for concrete paving but since abandoned, giving (a) location, (b) origin, (c) suitability for use to supply a large concrete job.

(7) Explain the conditions which led to the formation of the interlobate moraine including description of where it was seen.

(8) Outline the history of the Pleistocene lakes in the Lake Michigan basin including places where evidences of this history were seen.

(9) Same as above question for lakes of the Fox-Winnebago basin.

(10) You are sent to explore for outwash gravel along the front of a terminal moraine. Tell fully how to set about this and where and why chances are best.

(11) Outline the history of the outwash terraces of the district near Eagle and Troy using outline map.

GEOLOGY 143
GLACIAL GEOLOGY
Examination, March 7, 1930

Write on all questions. Dont bother filling out all blanks; your name is all that is needed on the bluebook

(1) Give ONE outstanding difference which enables you to distinguish between:
(a) Continental and mountain glaciation
(b) striae and artificial scratches
(c) till and coarse, unbedded gravel
(d) fiord and drowned valley
Caution: Dont waste time telling all you know but stick to designated subject

(2) Define briefly: (this does not mean discuss in detail!)
(a) bergshrund
(b) chatter mark
(c) kettle hole
(d) scabland
(e) diluvium

(3) Explain and contrast the methods of nourishment of mountain and of continental glaciers

(4) Explain fully two (2) distinct and positive methods by which you could tell the direction along striae that the glacier came from.

(5) Account for the observed fact that most glacial material was derived from a comparatively short distance from where it is now found.

GEOLOGY 143
GLACIAL GEOLOGY
Midsemester examination, April 7, 1930

Write on questions 1 and 2 and on any 3 others of five (5) in all.

(1 and 2) 10 pictures
Please do not mark the pictures. They are numbered in red pencil. Put all of answer to each picture in one place. Note that last picture is on back side so do not forget to turn over.

For each picture
(a) name the principal glacial topographic feature or glacial or glacial-fluvial deposit shown
(b) define this feature or deposit IN TERMS OF FACT OR OBSERVATION
(c) define it in TERMS OF ORIGIN OR INTERPRETATION
(d) State the chance of finding gravel

Write on any three (3) of the following
(3) State the best SINGLE diagnostic feature which will tell the difference between (do not discuss origin):
(a) beach gravel and esker gravel
(b) lake cliff and outwash terrace edge.
(c) esker and ridge between two kettles in pitted outwash
(d) marine and fresh water glacial clay
(e) delta and outwash

(4) Name five (5) different important causes of the formation of terraces in outwash

(5) State in a single sentence the MOST IMPORTANT SINGLE CONCLUSION drawn from (do not discuss origin in detail):
(a) occurence of scattered glacial boulders in interlaminated clay and silt
(b) plain of sand and gravel having kettle holes and located next to a ridge of knobs of till
(c) greater depth of water inside of fiord than just outside of its mouth
(d) very abundant granite boulders in the drift of a certain area
(e) till overlying horizontally stratified sand and gravel

(6) Discuss the field evidence which bears on the two theories of the source and time of deposition of loess in relation to glaciation (not its mode of deposition).

GEOLOGY 143

Glacial Geology

Examination, April 30, 1930

Write on four (4) questions

1. Remains of temperate climate animals are found in a gravel bed buried under till. Discuss their significance and tell how the origin of the gravel might be determined.

2. How may the degree of postglacial erosion be used as a time measure? Discuss fully.

3. Give diagram showing different zones of ateration in an old till weathered under (a) swampy conditions and (b) upland conditions. Explain differences.

4. Under what conditions may glacial tills of different ages have distinct lithologic character?

5. (a) Give the column of glacial stages and interglacial intervales.
   (b) Discuss the distribution, character, and interpretation of one of the above.

GEOLOGY 143
GLACIAL GEOLOGY
Examination, March 6, 1931

Write on all questions

(1) Striae are observed on a limestone ledge. State fully two (2) distinct and positive ways by which you could tell which way the ice moved along these striae.

(2) The till in area A has a few crystalline pebbles and boulders scattered through unstratified clay; in area B the till consists of sand, some clay, and many crystalline pebbles and boulders.
Discuss the conclusions which can be drawn from these facts alone as to character of the local bed rock and the probable nature of the local topography explaining just why you reached these conclusions

(3) Explain fully with diagrams the origin of chatter marks and tell on what kinds of rock they may be found and why.

(4) Give One (1) outstanding difference which enables you to positively distinguish between but do not waste time discussing the origin of:

(a) fiord and drowned valley(unglaciated or glaciated)
(b) striae and slickensides
(c) till and weathered gravel
(d) kettle hole and pothole
(e) cirque and unglaciated ravine on mountainside

(5) Define using two columns, first for <u>facts</u> and second for <u>origin</u>:

(a) end moraine
(b) rock basin
(c) interlobate moraine
(d) bergschrund
(e) medial moraine
(f) glacial anticyclone
(g) diluvium
(h) plucking
(i) roche mountonnee
(j) sapping

GEOLOGY 143
GLACIAL GEOLOGY
Midsemester examination, April 3, 1931

Write on five (5) questions

(1) State what seems to you the best single diagnostic feature which would enable you to distinguish between (do not discuss origin):
(a) terminal moraine and pitted outwash
(b) esker and crevasse filling
(c) glacial lake clay and postglacial lake clay (in Wisconsin)
(d) beach gravel and outwash gravel
(e) drumlin and esker

(2) State briefly with a simple explanation of not more than one sentence what conclusion you would draw from the following phenomena:
(a) unstratified yellowish-brown pebbly clay beneath a plain grades down into stratified gravel
(b) gently rolling till lies with very irregular contact on horizontally bedded sand and gravel
(c) a body of gravel with highly tilted and faulted bedding is entirely enclosed by till
(d) an area underlain by sand and gravel has a very irregular surface with many kettle holes but a few of the higher hills have flat tops and rise to a common elevation
(e) a conical hill of poorly sorted stony gravel has inclined bedding all dipping in various directions and considerably faulted

(3) Give ONE single definite evidence which ALONE would prove that:
(a) continental glaciers remove a considerable amount of slightly weathered bed rock
(b) mountain glaciers erode deeply into the bed rock
(c) a given moraine within the glaciated area is the product of a readvance after a long retreat of the ice front
(d) presence of standing fresh water in front of a given moraine
(e) the level of surface of a glacial lake where no beaches are preserved or were made

(4) You are sent into unsettled glaciated country to locate gravel.
(a) What kinds of deposits would you expect to be productive?
(b) State briefly the criteria which in absence of cuts you would use to locate each kind of deposit.

(5) Discuss the forms and origin of eskers

(6) Discuss the forms and origin of drumlins

GEOLOGY 143
GLACIAL GEOLOGY
Examination, May 6, 1931

Write on four (4) questions. Anyone writing on more will be graded on first four written ONLY-order in book to determine, not number of questions

(1) Discuss two (2) theories of the derivation of loess (not its mode of deposition).

(2) Discuss the factors which influence the use of weathering phenomena as a means of comparison of age of drifts in different localities.

(3) Explain the nature and origin of the soil profile which is developed in till where drainage conditions are poor, and tell how this profile is altered when drainage becomes good.

(4) Explain possible causes for the reported scarcity of gravel in the early Pleistocene drifts.

(5) Define briefly:
(a) silttil
(b) forest bed (general term)
(c) interglacial interval (general term)
(d) Nebraskan
(e) Sangamon

Readingsfor Friday

Baker	U. S. G. S. Prof. Paper 106,	pp. 317-322
Burpee	"	326-331
Field	"	331-339
Frascho	"	340-345
Furse	"	310-317
Hanley	"	324-326
Knight	Wis. Geol. and N. H. S., Bull. 36,	pp 223-239
O'Neil	Ms. reports, F. T. T. on Lake Oshkosh	
Whiting	Outline of Glacial Geol. p. 85, No. 50 on beaches near Manitowoc and Two Rivers	
Zollmer	Outline of Glacial Geology, p. 135, No. 15, on Forest Bed only.	

Please hand in written reports.

GEOLOGY 143
GLACIAL GEOLOGY
Examination, March 4, 1932

Write on all questions. Please be brief and to the point. Information not asked for counts against grade on that needed to answer the question.

(1) Discuss briefly five (5) distinct lines of evidence which demonstrate that existing glaciers move.

(2) State briefly
(a) Three (3) distinct lines of evidence which prove that continental glaciers eroded considerable fresh bed rock in some places.
(b) Two (2) distinct lines of evidence which demonstate that continental glaciers did not disturb the underlying material in some places.

(3) Define very briefly or state the significance of the following. (Please avoid long discussions.)
(a) roche moutonee
(b) till
(c) moulin
(d) endmoraine
(e) rock basin
(f) cirque
(g) cycle of mountain glaciation
(h) anticyclone
(i) diluvium
(j) Patrician

(4) Discuss two (2) important ways in which continental glaciers differ from mountain glaciers

GEOLOGY 143
GLACIAL GEOLOGY
Midsemester examination, April 1, 1932

Write on FIRST TWO and any three others or five (5) in all. Anyone writing on more will be graded on first three of optional questions written in book regardless of their numbers. PLEASE MARK ON COVER THE QUESTION YOU OMITTED.

(1) and (2) le pictures Please do not mark on the pictures. Hand in with book.
(a) State your first choice of interpretation giving name of feature due to glaciation only.
(b) State alternative explanation or interpretations.
(c) Returning to your favored interpretation define the feature in terms of FACT
(d) Give definition of above in terms of INTERPRETATION
(e) State clearly the history of the deposit or feature which you deduce from your favored interpretation, that is the events which led to this result.

Please place all answers to same picture together. Note reverse sides where indicated. Numbers given in red.

OPTIONAL QUESTIONS Write on any three of following. Questions above required of all.

(3) State what seems to you the BEST SINGLE DIAGNOSTIC FEATURE which would enable you to distinguish between the following superficially similar topographic forms. DO NOT DISCUSS ORIGIN IN DETAIL
(a) sand dune and endmoraine
(b) esker and crevasse filling
(c) outwash and subglacial wash
(d) beach gravel and outwash gravel

(4) How did continental glaciation cause falls and rapids in the unglaciated area?

(5) What is meant by the term "annual rings of the earth". Discuss how these originated and their value to Pleistocene geology.

(6) Describe the conditions which led to the formation of outwash including its manner of bedding.

(7) State in a single sentence the MOST IMPORTANT SINGLE CONCLUSION which can be drawn from the following observations.
(a) a certain district has almost flat ground moraine plains
(b) a small cut in ground moraine area discloses much faulted and folded gravel.
(c) a conical hill of coarse gravel in midst of ground moraine
(d) a glaciated mountain valley has a rock step in it.

GEOLOGY 143
GLACIAL GEOLOGY
Examination, March 3, 1933

Write on any five (5) questions; anyone writing on more will be graded on first five written regardless of numbers. PLEASE mark question left out.

(1) State for each in a SINGLE SENTENCE one line of evidence which ALONE enables you to distinguish between:
   (a) glacial striae and slickensides
   (b) glacial striae and artificial scratches
   (c) cirque and normal stream valley
   (d) mountain glaciation and continental glaciation
   (e) glacier and snowbank

(2) Explain the origin of chatter marks.

(3) Discuss two distinct lines of evidence in regard to the thickness of former continental glaciers.

(4) Discuss the cause, nature, and distribution of movement in a continental glacier.

(5) In single sentences state the significance or definition of:
   (a) fiord
   (b) bergschrund
   (c) diluvium
   (d) erratics
   (e) Finger Lakes
   (f) anticyclone (glacial)
   (g) moulin
   (h) roche moutonnee
   (i) blizzard (glacial)

(6) List and discuss briefly three (3) distinct lines of evidence which indicate erosion of sound bed rock by continental glaciers and two (2) which indicate lack of such erosion at the place of observation.

GEOLOGY 143
GLACIAL GEOLOGY
Midsemester examination, April 3, 1933

Write on four questions. Please mark one omitted. No grades until after vacation

1. State what seems to you the best single diagnostic feature which enables you to distinguish between: (This does not mean to discuss origin.)
   (a) drumlin and kame
   (b) terminal or recessional moraine and pitted outwash
   (c) stream terrace and beach terrace
   (d) fresh water marginal lake clay and marine glacial clay
   (e) esker and crevasse filling

2. State in a single sentence the most important single conclusion which should be drawn from each of the following sets of phenomena:
   (a) Knob and kettle topography occurs in a basin below level till ground moraine and is composed of till irregularly mixed with sand and gravel.
   (b) Typical drumlins occur in a depression within a plain of sand and gravel.
   (c) Digging in a till plain discloses a considerable thickness of faulted and tilted sand and gravel.
   (d) The margin of a sand and gravel plain adjacent to a moraine is lobate and is everywhere at same elevation.

3. You are going into unsettled glaciated country to locate gravel. State:
   (a) What kinds of deposits you would expect to be productive.
   (b) How under above conditions you would recognize each

4. Explain the details of deposition of an outwash plain including the practical importance of these factors.

5. With what other kinds of topography might a terminal moraine be confused. Tell briefly how each may be differentiated.

GEOLOGY 143
GLACIAL GEOLOGY
Midsemester examination, March 30, 1934

Write on any four questions and mark the one you left out.

(1) Complete the following sentences stating in each a single line of evidence which seems to you to alone prove the statement:
(a) Pitted outwash plains are associated with recessional moraines because------
(b) Drumlins were made by moving ice because------
(c) Cirques are the result of glacial erosion because------
(d) glacio-marine clays are massive because-----
(e) Eskers were deposited in situ because-------

(2) Differentiate between the kinds of ice marginal deposits formed by (a) moving ice and (b) stagnant ice.

(3) How could you differentiate by topography alone between:
(a) large delta and outwash plain
(b) Esker and crevasse filling
(c) Terminal moraine and much pitted outwash
(d) Erosional stream terrace and ice contact outwash terrace
(e) Drumlin and moulin kame

(4) Discuss the details (bedding and assortment as well as topography) of beach deposits.

(5) State the conclusion you would draw from each of the following observations:
(a) Unstratified stony clay on a level plain grades down into stratified sand and gravel
(b) An area of knob and kettle topography lies in a hollow below a plain of till which surrounds it completely
(c) Fiords in a certain area occur only along the known system of faults and joints
(d) In a certain area granite boulders are very abundant but wells show that the bed rock is sandstone
(e) A test pit in an outwash plain encounters lake clay at a depth of a few inches

GEOLOGY 143
GLACIAL GEOLOGY
Midsemester examination, April 3, 1935

Wite on first question and any three others or four in all.

(1) Required Pictures. Please put no marks on them.
(a) Define and name the principal feature shown in each which is due to continental glaciation.
(b) List the steps in the history of the formation of aforesaid deposit.

(2) State briefly without extended discussion of origin the best SINGLE diagnostic feature which would enable you to distinguish between
(a) drumlin and moulin kame
(b) esker and crevasse filling
(c) erosional stream terrace in outwash and ice-contact outwash terrace
(d) till and poorly sorted unstratified gravel
(e) till and weathered gravel

(3) Complete the following sentences:
(a) Unpitted outwash plains lie outside of endmoraines because---
(b) Eskers and crevasse fillings where made within stagnant ice because---
(c) Fiords correspond in pattern with the directions of faults in the bed rock (tectonic features) because:--------
(d) Fresh-water glacial clays occur in alternate coarse and fine layers because------
(e) Eskers were deposited on the ground because-----

(4) State the conclusion you draw from following sets of observations:
(a) Unstratifed stony and girtty clay rests upon horizontally stratifed sand and gravel with an irregular contact.
(b) An area of knob and kettle toppgraphy is below and completely surrounded by a level plain of till overlying sand and gravel.
(c) Typical till terminal moraine occurs within a large kettle in a plain of sand and gravel.
(d) Granite boulders are very abundant in a certain area where wells show that the bed rock is sandstone.
(e) A test pit in what appears elsewhere to be an outwash plain discloses lake clay at a depth of a few inches.

(5) Discuss the principles which underlie correlation of varves.

GEOLOGY 143

Glacial Geology

Mid-semester examination April 1, 1936

Write on any four questions including the first.
Please mark on outside of bluebook which you left out.

Required questions.

1. Pictures. Please do not mark but answer in bluebook.

   (a) Name the principal feature of glacial origin.
   (b) Define and tell its origin.

Optional questions: write on any three.

2. Complete the following sentences:

   (a) The presence of several feet of alternating silt and clay in thin regular layers proves that this plain was

   (b) The great abundance of granite boulders in the till at X proves that

   (c) The fact that the sandy clay subsoil of this plain grades downward into horizontally stratified sand and gravel proves that

   (d) The presence of very long inclined layers of sand and gravel parallel to the surface of one side proves that the flat-topped hill was deposited

   (e) The levelness of the till plain shows that

3. Tell the best single diagnostic feature which enables one to distinguish between (do not discuss origin)

   (a) till and unstratified water-deposited drift

   (b) sand dune and endmoraine

   (c) esker and bar

   (d) beach gravel and outwash gravel

   (e) striae and slickensides

4. Explain two theories of the origin of fiords and how they may be reconciled.

5. Discuss the argument for and against glacial excavation of the basins of the Great Lakes.

GEOLOGY 143

GLACIAL GEOLOGY

Examination May 20, 1936

Write on four questions.

(1) On the outline map show location where you saw:

(a) forest bed

(b) Brooklyn moraine

(c) margin of Mankato drift

(d) beach of Lake Oshkosh

(e) Marengo moraine

(f) Nipissing beach

(g) cut through interlobate

(h) basin of Lake Geneva

(i) abundant drumlins

(j) Illinoian drift

(2) What proofs were observed in the field which demonstrate that the drift around Monticello is actually much older than that around Madison. Tell where facts were observed.

(3) Account for the color contrast of the two drifts observed in northeastern Wisconsin. Tell where contact was observed.

(4) It is desired to find at or near Manitowoc a water-bearing gravel bed of considerable horizontal extent. Discuss the glacial history which affected the formation of such deposits there.

(5) Discuss the significance of the Brooklyn moraine citing confirmatory evidence seen elsewhere on trips.

GEOLOGY 143

GLACIAL GEOLOGY

Final Examination June 12, 1936

Write on ten (10) questions and please mark on cover of book which one you left out..

(1) What is the significance in glacial history of the outline of the Niagara Escarpment east of Lake Winnebago?

(2) Cite proofs seen in the field which demonstrate that during the Wisconsin glaciation of eastern Wisconsin there were several distinct readvances.

(3) Cite evidences seen in the field which demonstrate that during the Wisconsin glaciation of eastern Wisconsin there was progressive westward migration of the center of ice accumulation.

(4) Cite evidences seen in the field which demonstrate that the Cary ice formed two nearly coincident endmoraines.in eastern Wisconsin.

(5) Discuss the relations of the Iowan and (original) Wisconsin glaciations.

(6) Outline with evidences seen in field the history of the glacial lakes of the Fox-Wolf, Winnebago basin.

(7) Discusss with evidences seen in field the origin and nature of the Interlobate Moraine of eastern Wisconsin.

(8) Discuss with aid of sketches or outline map the history of Cary retreat between Richmond and Delafield, Wisconsin.

(9) Show on outline map where you saw on field trips:

(a) lake in pitted outwash
(b) moulin kame
(c) crevasse filling
(d) beheaded valley
(e) overridden drumlins
(f) delta formed at ice margin
(g) postglacial crags
(h) non-pitted outwash
(j) esker
(i) gravel conglomerate

(10) Explain the glacial history demonstrated by the striae at Valders, Wis.

(11) List and tell where seen on trips the glacial and glacio-fluvial deposits which could only have originated when the adjacent glacier was stagnant.

GEOLOGY 143

GLACIAL GEOLOGY

Midsemester examination April 2, 1937

Write on any four questions. Please mark on cover of bluebook which one you left out.

1. Complete the following sentences:

   (a) The thin bedding and excellent assortment of some layers tell us that this grand deposit is

   (b) The conical form of the gravel hill shows

   (c) The level summits of this area of knob and kettle topography show that the till is probably underlain by

   (d) The succession descending of till; lake clay; horizontally bedded sand and gravel; till; bed rock shows the following history

   (f) The vertical layers of gravel found through a thickness of eight feet in this test pit suggest that the deposit is

2. State the best single criterion which will alone distinguish between

   (a) drumlin and knob of terminal moraine

   (b) terminal moraine and pitted outwash

   (c) varve and lamination

   (d) lake cliff and terrace edge.

   (e) delta and outwash

3. Discuss not less than two theories of the origin of eskers.

4. (a) Define briefly origin of chatter marks

   (b) Explain relation between rock jointing and glacial erosion.

   (c) What topographic shore feature is located by jointing of bedrock in a glaciated region

   (d) Define "open-work gravel" (no discussion of origin).

   (e) Define "rocdrumlin".

5. Explain cause of five different types of outwash terraces.

GEOLOGY 143

GLACIAL GEOLOGY

Examination May 19, 1937

Write on four and please mark on cover of book which one you left out.

1. Discuss significance of the striae at Valders and Rockwood giving criteria used to fix ice direction.

2. Complete the following sentences (no more counted):

   (a) This ridge is now classed as a crevasse filling instead of an esker because

   (b) Garrity Hill must have been deposited in a moulin because

   (c) The source of ice shifted westward between the Tazewell and Cary substages because

   (d) The Forest Bed subinterval was shorter than the Sangamon interval because

   (e) The Brooklyn moraine is not much older than the Johnstown moraine because

3. Discuss the Delavan glacial lobe in light of present knowledge and your field observations.

4. Outline the field evidence that the drift near Monticello is much older than the drift near Madison.

5. Explain the succession of Pleistocene deposits near Manitowoc and its bearing upon exploration for underground water in the drift.

GEOLOGY 143
GLACIAL GEOLOGY
100 Review Questions, revised, 1937

1. Where and what evidences have you seen in the field which bear on the origin of drumlins?
2. How is the Darien Moraine separated from the Marengo Moraine and how are their relative ages determined?
3. Outline the proofs that the Illinoian drift of northern Illinois and southern Wisconsin is really much older than the adjacent Wisconsin drift and state where examples of each kind of evidence were seen in the field.
4. Explain the origin and significance of the postglacial rock gorges of the Old Drift region.
5. Discuss the nature and origin of gumbotil and state why not seen in Wisconsin.
6. Outline the evidences which demonstrate the subdivision of the Wisconsin stage of glaciation into several substages and tell where examples of evidence were seen in the field.
7. Discuss origin of moulin kames stating where seen in field.
8. Define (a) interglacial interval, (b) glacial stage, (c) cirque, (d) neve, (e) postglacial.
9. Discuss the origin of the basin of Lake Geneva.
10. Discuss the significance of the outline of the Niagara escarpment of eastern Wisconsin on the question of glacial erosion.
11. Discuss the progressive change in the relative sizes of the Green Bay and Lake Michigan or Illinois Lobes.
12. Discuss the origin, material, and topography of the Interlobate or Kettle Moraine of eastern Wisconsin and tell where studied in the field.
13. Discuss the origin and nature of the glacial drainage channels which cut the Interlobate Moraine in eastern Wisconsin and give examples seen in field.
14. Discuss the origin and distribution of the glacial outwash terraces of the Eagle region in eastern Wisconsin.
15. Give the succession of deposits at the Two Rivers Forest Bed and discuss the history of events which they demonstrate.
16. Outline the stops in the glacial history of northeastern Wisconsin stating very briefly where evidence demonstrating them was seen in the field.
17. Discuss the gravel deposit on Fisher Creek, Manitowoc Co.
18. Outline the history of the lateglacial lakes in the Michigan basin and state where examples of each were seen in the field.
19. Outline the history of the lateglacial lakes of the Fox-Wolf-Winnebago Valley and state where examples demonstrating this history were seen in the field.
20. Account for the color of the Fourth Wisconsin Drift in northeastern Wis.
21. Discuss the methods of correlation of varved clay deposits citing examples of varved clays seen in the field.
22. Discuss with diagrams the errors in estimating a gravel deposit from too shallow test pitting.
23. How do you distinguish between a delta and cross-bedded outwash citing examples seen in the field.
24. How do you differentiate between beach gravel and outwash gravel giving examples seen in the field.
25. Account for the fact that east of Janesville the Illinoian drift is little eroded and near Monroe the topography of the same drift is just like that of the Driftless Area.
26. Discuss the causes of the formation of the Driftless Area.
27. Discuss the causes of the formation of the Green Bay and Lake Michigan Lobes.
28. What is the result on drumlins of a change in direction of ice movement and give examples seen in the field.

29. What is the significance of the exposures of drift and striae at Valders, Wis.?
30. Describe the succession of material formed by the weathering of till under (a) poorly drained, (b) fairly well drained, and (c) well drained conditions
31. Give the commonly recognized glacial succession in the Mississippi Valley and mention which drifts you have seen in the field and where
32. Account for the fact that pits at Janesville find very sandy gravel and those at Beloit, farther downstream, are in stony gravel
33. You are running a traverse through dense timber and brush and note irregular topography, kettle holes, some flat summits, sand and gravel shown by uprooted trees, boulders in low ground and kettles. Interpretation? Where seen in field?
34. You are running a traverse through dense brush and timber and note irregular topography, no flat summits, coarse gravel, sand, and till shown by overturned trees, boulders everywhere. Interpretation? Where seen in field?
35. You are running a traverse through dense brush and timber and note level topography, fine sandy soil as shown by uprooted trees and nature of vegetation, no stones or boulders, area lower than adjacent tracts. Interpretation? Where seen in field?
36. You are running a traverse through dense brush and note level topography except for a few ravines, sand and gravel shown by uprooted trees and in banks, few boulders. Interpretation? Seen in field?
37. Discuss the conditions requsite for the formation of varves (not their correlation). Where seen in field?
38. Discuss the Delavan Lobe in the light of present knowledge
39. Discuss the time relations of the retreat of the Lake Michigan and Green Bay Lobes giving evidences seen in the field
40. Discuss the Iowan drift giving its location, history of nomenclature, material, topography, and correlation with respect to other drifts
41. Discuss the Toronto giving subdivisions, nature of evidence, interpretation
42. Discuss the use of loess deposits as time markers in Pleistocene geology
43. Give two theories of the mode of deposition of loess with evidences bearing on this question including facts seen in the field
44. Discuss and compare two theories of the source of the material of the loess deposits of the Mississippi-Missouri Valley
45. What features in a terminal moraine guide you in looking for stony gravel in the associated outwash plain? Examples seen in field?
46. What features of kames and eskers tell of the kind of material without having to see any exposures?
47. Discuss any of the recognized interglacial or interstage intervals giving the history of nomenclature, materials and other evidences, interpretation, correlation examples seen in field
48. Discuss any of the several commonly recognized glacial stages on same basis as above question
49. Name the several centers of continental glaciation and what drifts came from each
50. Discuss two principal theories of the origin of drumlins
51. Distinguish between (do not discuss origin in detail): (a) varved clay and laminated clay, (b) kame and esker, (c) kame and pitted outwash, (d) drumlin and roche moutonnee, (e) fresh water glacial lake clay and marine glacial clay
52. Outline points of difference between lake terraces and outwash terraces
53. What glacial and glacio-aqueous deposits require moving ice for their formation?
54. What glacial and glacio-aqueous deposits require or might equally well be form by stagnant ice?
55. Discuss two different theories of the origin of eskers and locate eskers seen in field citing any observations which may bear on this question
56. Discuss the origin of the basins of the Great Lakes
57. Discuss the origin of the basins of the Finger Lakes of New York

58. Compare glacial and stream erosion of a valley by a mountain glacier as to efficiency and results; compare normal stream and continental glacial erosion in same way
59. Discuss the origin of cirques
60. Discuss different methods of the formation of hanging valleys
61. Discuss the formation of fiords
62. What is the cause and mechanism of the motion of ice in glaciers?
63. What evidences prove very long duration of the Pleistocene?
64. How have attempts been made to measure postglacial time in years?
65. Discuss Crolls hypothesis of the cause of glaciation
66. Discuss the CO_2 hypothesis of the cause of glaciation
67. State the primary requisites of any theory to explain glaciation
68. Discuss evidences of lateglacial and postglacial earth movements in the eastern U. S. Do not discuss cause of movement
69. Remains of temperate climate animals and plants are discovered in a bed of gravel between two tills. Discuss (a) criteria by which the origin of the gravel might be determined independently of the remains, and (b) significance which might be attached to the remains
70. How may postglacial erosion be used as a time measure of the age of drift? Postglacial weathering?
71. Under what conditions may glacial tills of different ages have distinct lithological characters? Examples seen in the field?
72. State the best single diagnostic feature which will tell the difference between (do not discuss origin): (a) beach gravel and outwash gravel, (b) lake bar and esker, (c) esker and ridge between two kettles of pitted outwash, (d) delta and outwash, (e) outwash and sandy lake bed
73. Name five different important causes of the formation of outwash terraces and give examples seen in the field
74. State in a single sentence the most important single conclusion drawn from (do not discuss origin in detail): (a) presence of scattered glacial boulders in interlaminated clay and silt, (b) plain of sand and gravel having kettle holes in it and located next to a ridge composed of knobs of till, (c) greater depth of water inside of a fiord than just outside its mouth, (d) very abundant granite boulders in drift of a given region, (e) till overlying with irregular contact horizontally stratified sand and gravel
75. Give one outstanding difference which enable you to distinguish between: (a) continental and mountain glacial till, (b) striae and artoficial scratches, (c) till and weathered gravel, (d) fiord and drowned valley, (e) striae and slickensides
76. Explain and contrast the methods of nourishment of mountain and of continental glaciers
77. Explain fully two distinct and positive methods by which you can tell the direction along striae that the ice moved
78. Account for the observed fact that most glacial material was derived from a comparatively short distance from where it is now found
79. It was argued at one time that since very old drifts are deeply oxidized the Red Drift of northeastern Wisconsin is very old. Discuss this hypothesis citing evidences seen in the field
80. On an outline map of eastern Wisconsin mark the area occupied by ice at (a) maximum of Illinoian, (b) maximum of Early Wisconsin, (c) maximum of Late Wisconsin, (d) glacial lakes at each time and their names
81. On an outline map show (a) routes followed on field trips, (b) regions where you saw drumlins, (c) location of the interlobate moraine of eastern Wisconsin, (d) regions of large areas of pitted outwash seen on trips, (e) shoreline and outl of Later Glacial Lake Oshkosh
82. Tell where or locate on outline map where you saw in field (a) kames, (b) eskers, (c) outwash terraces, (d) varved clays, (e) gumbotil

83. (a) In what kinds of glacio-fluvial deposits would you search for stony gravel? (b) Discuss the origin and nature of one of these, (c) In which would you expect to find the largest deposits of well-sorted gravel and why?
84. Define in (a) terms of fact or observation and (b) in terms of interpretation or origin (do not discuss origin in detail) using two parallel columns: (a) varve, (b) till, (c) esker, (d) gravel, (e) kame, (f) hanging valley, (g) hingeline, (h) loess, (i) drumlin, (j) isobase
85. Discuss the statement once used as evidence of equivalent age: "The extreme weathering and the advanced erosion of the drift at Marshfield (in the granite region of northern Wisconsin) is at least equal to that of the oldest drift sheet in Iowa and Kansas" (where the bed rock is Coal Measures).
86. Account for the difference in compsition of the Darien and Marengo Moraines
87. Account for the origin of Lake Winnebago
88. What decisive evidences tend to show that the ice caps of Canada disappeared entirely at least once during the Pleistocene?
89. Logs of wood are found in digging a well through the glacial drift. State what investigations must be made in order to determine their significance
90. Discuss the evidences of interglacial man in North America
91. Account for the quite general presence of a silt covering on outwash plains and give locations where this was seen in the field
92. It is desired to find a water-bearing gravel bed of considerable horizontal extent at or near Manitowoc. Reasoning from observations on the glacial history of this region discuss fully the chances of finding such
93. A well is being drilled through the drift and several feet of coarse gravel is found with till above and below. Bailing exhausts the water in a few minutes. Interpretation?
94. A well was drilled through the drift and found several feet of coarse gravel with till above and below. A short test gave considerable water but when a permanent pumping plant was put in operation the capacity soon fell off to a very slight production. Explanation? (Assuming no failure in well itself)
95. In what type or types of glacial or glacio-fluvial deposits do most relatively small lakes occur?
96. Discuss the significance of the Brooklyn moraine and all other similar features you have seen in the field
97. State in a single sentence a single line of evidence which definitely proves: (a) former presence of a glacial lake in a given area, (b) a topographic evidence which shows the course of former valleys in a region now covered by pitted outwash, (c) whether a moraine is the terminal moraine of a glacial stage or a readvance after some time or a recessional moraine outside of which the ice lay not long before its formation, (d) that a given lake basin was due to glacial erosion, (e) that [illegible] an area was covered by the continental ice sheet
98. Discuss fully the cause and effects of lateglacial earth movement in the Great Lakes region
99. Outline briefly the history and drainage changes of the glacial Great Lakes
100. Account for the difference in topography of the Darien and Johnstown Moraines and the moraines of central Illinois

GEOLOGY 143
GLACIAL GEOLOGY

Final Examination June 10, 1937

Write on 10 questions including the first double question.

1-2. Required. For each picture tell
(a) what it shows
(b) where you saw an example on field trips (letters in pencil circle only).

3. The following well log was recorded at Brodhead in the valley of Sugar River below Monticello. Interpret it in the light of your knowledge of glacial history of this area citing anything you saw on trips to substantiate it.

	Thickness feet	Depth feet
Sand and gravel	70	70
Till, gray	10	80
Clay, dolomitic, brown-gray	45	125
Gravel, mainly local pebbles	20	145
Bed rock.		

4. The following log of a well is at the north end of Lake Winnebago. Give interpretation.

	Thickness feet	Depth feet
Clay, red, dolomitic	18	18
Till, red, dolomitic	11	29
Clay, gray, dolomitic	75	104
Till, gray, dolomitic	20	124
Bed rock.		

5. The following section has been determined at Elkhorn. Give interpretation as above.

	Thickness feet	Depth feet
Till, gray to buff, dolomitic	20	20
Sand and gravel layer of Till in middle	140	160
Till pink, dolomitic, soil at top	30	190
Gumbo till, dark grey	5	195
Till, dark gray	32	227
Bed rock		

6. Discuss evidences seen in field which indicate a progressive change in center of ice accumulation throughout Wisconsin time.

7. What evidencesdid you see in field which indicate two approximately equal maxima of the Cary substage in Wisconsin.

8. Discuss evidences you saw which bear upon the origin of the Kettle Interlobate Moraine.

9. Tell where you saw eskers and crevasse fillings on the trips and how and why they are distinguished.

10. Account for the color of the Mankato till in northeastern Wisconsin. (two hypotheses)

11. Account for the fact that east of Janesville the Illinoian drift in little eroded whereas near Monticello the topography is almost the same as that of the Driftless Area.

GEOLOGY 143

GLACIAL GEOLOGY

Midsemester examination April 1, 1938

Write on any four questions. Please mark on cover of bluebook which one you left out.

1. Complete the following sentences:

   (a) The excellent assortment of some of the thin strata indicate that this sand and gravel deposit is

   (b) The conical form of the gravel hill together with the slope of the layers shows

   (c) The uniformity of level of the summits between kettles shows that the till is probably underlain by

   (d) The levelness of the till plain indicates that

   (e) The vertical layers of gravel in this pit through a thickness of 12 feet indicate that the deposit has been

2. State the best single criterion which will <u>alone</u> distinguish between:

   (a) drumlin and knob of terminal moraine

   (b) terminal moraine and pitted outwash

   (c) sand dune and terminal moraine

   (d) till and weathered gravel

   (e) esker and lake bar

3. Discuss and compare two theories of the origin of drumlins.

4. (a) Define and state briefly origin of cirque.

   (b) In what kind of glacial deposit would you expect to find the drift derived from underlying granite, and why?

5. Explain underlying principle of correlation of varves between different exposures.

GEOLOGY 143
GLACIAL GEOLOGY

Examination March 4, 1938

Write on four (4) only and please place an X on cover to indicate which question was left out. Please be brief as NO OVERTIME can be allowed.

(1) Complete following sentences (no more counted):
(a) Striae can be distinguished from slickensides .....
(b) A glacier can be distinguised from a snowbank by...
(c) Till can be distinguised from weathered gravel because...
(d) Cirques are ascribed to glacial erosion because.....
(e) The agent which deposited the continental glacial drift was a solid because....

(2) Explain (a) origin of chatter marks, (b) their value in field observation

(3) Expalin two distinct methods of estimating the thickness of the extinct continental glaciers.

(4) State (a) three lines of evidence which demonstrate glacial erosion of fresh bed rock by continental glaciers, and (b) two lines of evidence which show that above process did not occur at all localities.

(5) Compare the conditions causing flow in mountain and in continental glaciers.

May 18 used revised questions
3, 14, 30, 41, 44 (1937 ed)

GEOLOGY 143
Glacial Geology

Final examination June 8, 1938

Write on 10 questions including the first double question.

No overtime allowed.

1-2. Required. For each picture tell
(a) what it shows
(b) where you saw an example on field trips (letters in pencil circle only).

3. The following well log was recorded at Brodhead in the valley of Sugar River below Monticello. Interpret it in the light of your knowledge of glacial history of this area citing what you saw on trips to substantiate it.

	Thickness feet	Depth feet
Sand and gravel, top slightly weathered	70	70
Till, gray	10	80
Clay, dolomitic, brown-gray	45	125
Gravel, mainly local pebbles	20	145
Bed rock.		

4. The following section was observed in pit and wells at Fontana. Give interpretation as above.

	Thickness feet	Depth feet
Till, buff, top weathered	20	20
Gravel, coarse, in part cemented with calcite	80	100
Till, gray, dolomitc	20	120
Gravel, sand, clay	18	138
Sand and gravel	42	180
Till, pinkish-gray, dolomitic	8	188
Sand and gravel	22	230
Till, gray, dolomitic	46	276
Gumbotil, black	11	287
Till, dark gray	63	350
Sand and gravel, some layers of clay	55	405
Bed rock		

5. How is the Darien Moraine separated from the Marengo Moraine and how are their relative ages determined?

6. Explain the origin and significance of the postglacial rock gorges of the Old Drift region.

7. Give the succession of deposits at the Two Rivers Forest Bed and discuss the history of events which they demonstrate.

8. You are running a traverse through dense timber and brush and note irregular topography, kettle holes, some flat summits, sand and gravel shown by uprooted trees, boulders in low ground and kettles. Interpretation? Where seen in fields?

9. It is desired to find a water-bearing gravel bed of considerable horizontal extent at or near Manitowoc. Reasoning from observations on the glacial history of this region discuss fully the chances of finding such.

10. Outline the history of the late **glacial** lakes in the Michigan basin and state where examples of each were seen in the field.

11. What glacial and glacio-aqueous deposits require moving ice for their formation? Cite examples seen in field.

GEOLOGY 143
GLACIAL GEOLOGY

Examination March 6, 1939

Write on four (4) only and please place an X on cover to indicate which question was left out. Please be brief as NO OVERTIME can be allowed.

(1) Complete following sentences (no more counted):
(a) Glacial striae can be distinguished from iceberg striations.....
(b) A glacier can be distinguished from a snowbank by.....
(c) Till can be distinguished from talus because.....
(d) Fiords are ascribed to glacial erosion because.....
(e) The fact that water deposited material occurs on the top of the highest hills of this glaciated area indicates that.....

(2) Explain (a) origin of chatter marks, (b) their importance in field observation.

(3) Explain Hobb's theory of nourishment of continental glaciers.

(4) State (a) three lines of evidence which demonstrate glacial erosion of the Great Lakes basin by continental glaciers, and (b) two lines of evidence which show that above process did not occur at all localities in the same region.

(5) Explain the conditions causing flow in continental glaciers and their bearing on dissipation of an ice sheet.

GEOLOGY 143
GLACIAL GEOLOGY

EXAMINATION April 3, 1939

Write on any four questions and please place an X opposite number of questions you left out.

1. Compare merits of two theories of origin of eskers which cross or ascend hills.

2. State the best single criterion which will serve to distinguish between (do not discuss in detail).
   (a) drumlin and terminal moraine (b) Esker and bar (c) varve and lamination
   (d) terminal moraine and pitted outwash (e) stream terrace edge and lake cliff.

3. Complete following sentences (no more counted) .
   (a) The downward gradation of the unstratified pebbly clay soil into horizontal layers of sand and gravel indicates
   (b) The presence of several feet of alternating layers of silt and clay show that this plain was
   (c) Knob and Kettle topography of till in a basin below the level of the plain of sand and gravel indicates
   (d) The outer margin of the sand and gravel plain is level and lobate in form thus indicating depostion as
   (e) Gradation of one end of the narrow ridge of gravel into a plain of sand and gravel shows

4. (a) What is meant by tern "annual rings of the earth?" and of what use are these in glacial geology.
   (b) Discuss origin.

5. (a) Explain relation of glacial erosion to rock jointing giving examples of erosion related to this and prevented by its absence.

GEOLOGY 143
GLACIAL GEOLOGY

Examination May 17, 1939

Write on 4 questions only and please mark which ones you left out.
Those who missed some field trips will find other questions on text.

(1) Give at least two distinct lines of evidence which show that the drift near Monticello is much older than that around Madison. Tell where you observed each fact.
(2) Contrast the sedimentary environment of the gravels at Manitowoc and Fischer Creek.
(3) Discuss age and significance of the Brooklyn Moraine citing evidence at other localities which bears on this question.
(4) Explain conditions which led to formation of moulin kames and describe where examples were seen which demonstrate points.
(5) Discuss two classifications of soil profiles and tell how they are used to determine age of drift.
(6) What causes successive drifts to differ in composition. Discuss fully and mention examples seen in field.
(7) Discuss evaluation of vegetal remains found in drift.
(8) Discuss two theories of the time of deposition of loess in relation to glaciation (not its manner of deposition.).

GLACIAL GEOLOGY

Make-up examination June 1, 1939

Write on four questions only.

1. Interpret glacial history shown by following well log on shore of Lake Winnebago citing evidence seen to on trips to justify your conclusions.

	Thickness feet	Depth feet
Clay, red dolomitic	18	18
Till, " "	11	29
Clay, gray "	75	104
Till, gray "	20	124
Bed rock sound to top		

2. Complete following sentences giving best single proof:

   (a) This ridge seen south of Wales is classed as a crevasse filling instead of an esker because

   (b) The Forest Bed ice retreat was shorter than the Yarmouth Interval because

   (c) The source of ice shifted westward between Tazewell and Cary time because

   (d) The Valders till is red because

   (e) Granite boulders are so abundant in the till of northern Wisconsin because

3. Discuss the Delavan Glacial lobe in light of present knowledge citing where you saw it.

4. Explain how glacial history at Manitowoc bears upon problem of underground water in the drift.

5. Discuss significance of striae at Valders.

GEOLOGY 143

GLACIAL GEOLOGY

Final examination June 6, 1939

Write on 10 questions. Please mark which one you left out.

1. Pictures - For each tell (numbers in red circles)
   (a) What it shows in the way of glacial deposits.
   (b) Where you saw a good example on field trips.
   (c) Explain its origin briefly.

2. Same as 1.

3. The following well log was recorded at Elkhorn (NE of Lake Geneva) Give history of events which caused these deposits.

	Thickness feet	Depth feet
Till, gray	20	20
Gravel and sand	40	60
Till, gray	10	70
Sand and gravel	90	160
Till, pink, soil at top	30	190
Gumbotel, dark gray	5	195
Fill, dark gray	32	227
Bedrock		

4. Complete following sentences giving best proof:
   (a) The Brooklyn moraine is only slightly older than the Johnstown moraine because
   (b) The Forest Bad Trees grew near to where they are now found because
   (c) We found the _____striae at Valders are the youngest because
   (d) The Tazewell and Cary tills near Lake Geneva differ in color because
   (e) Sandstone crags occur near Monticello because

5. Discuss fully the evidence for and the possible causes of late glacial and postglacial earth movement in Great Lakes Region.

6. What evidences show that the ice caps of Canada disappeared at least once during the Pleistocene?

7. It was argued at one time that because ancient drifts are deeply oxidized the Valders till is very old. Discuss.

8. On the outline map show:
   (a) Maximum of Illinoian, (b) maximum of Valders, (c) maximum of Cary, (d) later glacial Lake Oshkosh, (e) Interlobate Moraine.

9. Explain glacial drainage history near Delafield.

10. Explain history of the Eagle terraces.

11. Discuss with diagrams possible errors in estimating size of a gravel deposit in a terrace.

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GEOLOGY 143

GLACIAL GEOLOGY

Examination March 1, 1940

Write on four questions only.

(1) Complete following sentences (no more counted);

(a) Till can be distinguished from weathered gravel because

(b) Striae can be distinguished from slickensides by

(c) Cirques are ascribed to glaciers because

(d) The till of continental glaciers was derived largely from fresh bed rocks because

(e) The agent which deposited the drift was a solid because

(2) Explain significance of caves on problems of glacial erosion.

(3) Explain two methods of estimating the thickness of the extinct continental glaciers.

(4) Discuss conditions in regard to flow of a continental glacier during decay.

(5) Discuss the problem of locating a small concealed area of bed rock which is different from its surroundings.

GEOLOGY 143
GLACIAL GEOLOGY

Examination March 29, 1940

Write on four questions only INCLUDING the first.

(1) 5 pictures For each tell (a) what kind of deposit and/or toppgraphic form it shows and (b) define what it is.

(2) State the best single criterion which alone will serve to distinguish between (a) drumlin and knob of terminal moraine (b) sand dunes and terminal moraine (c) pitted outwash and terminal moraine (d) fresh and salt water clays (e) esker and crevasse filling

(3) Explain five different causes of terracing of glacial outwash

(4) Complete following sentences (no more counted, do not discuss origin):
(a) The steep slope of the plateau of sand and gravel has bedding parallel to the slope on one side showing that----
(b) The vertical position of the layers in the eight foot test pit shows---
(c) The deep scallops in the edge of the terrace were made by----
because the slope is steepest at the bottoms.
(d) Downward gradation of the silty subsoil into sand and gravel shows---
(e) The thin bedding of the deposit and the excellent assortment of some of the layers shows that this ridge is a-----

(5) Discuss two theories of the origin of drumlins

GEOLOGY 143
GLACIAL GEOLOGY

Examination May 15, 1940

Write on four questions only and please mark which you left out.

(1) Discuss age relations of Brooklyn and Marengo moraines in relation to Johnstown Moraine citing field evidence.

(2) Discuss ice drainage phenomena during formation of Kettle Interlobate Moraine from Delafield to North Prairie.

(3) Tell where you saw eskers and crevasse fillings on the trips and how and why discriminated.

(4) A ccount for the fact that west of Walworth the Illinoian drift is little eroded whereas near Monticello the topography is very similar to that of the Driftless Area.

(5) Account for history of outwash terraces found between Eagle and Darien.

GEOLOGY 143

GLACIAL GEOLOGY

Examination March 7, 1941

Write on 4 questions only

1. Explain (a) origin of chatter marks

   (b) on what kinds of rock they occur.

2. Complete the following sentences (no more counted) giving best single proof of statement.

   (a) Striae can be distinguished from slickensides by

   (b) Till can be distinguished from weathered gravel by

   (c) Fiords are ascribed to glacial erosion because

   (d) Headward erosion of a mountain glacier occurs because

   (e) Till of continental glacier differs from that of mountain glacier because

3. Discuss relatively importance of different processes in erosion of underlying material by continental glaciers.

4. Account for the dominance of local material in till near Madison.

5. State five distinct lines of proof of former existence of continental glacier at Madison.

Geology 143

GLACIAL GEOLOGY

Examination April 4, 1941

Write on four questions <u>including</u> the first.

1. 5 pictures. For each tell (a) what kind of deposit and/or topographic form is shown, and (b) define it. Please do not mark the pictures.
2. State best single criterion which will alone serve to distinguish between
   (a) pitted outwash and terminal moraine
   (b) marine and fresh water glacial clay
   (c) esker and crevasse filling
   (d) sand dune and terminal moraine
   (e) delta and outwash
3. Discuss comparative merits of two theories of origin of eskers.
4. (a) What is meant by "annual rings of earth" and of what origin?
   (b) Discuss their correlation.
5. Explain two theories of origin of fiords and how they may be combined.

GEOLOGY 143
GLACIAL GEOLOGY

Examination May 12, 1941

Write on any 4 questions and please mark which you left out.

(1) Explain the "stratigraphic method" of correlating glacial drits.

(2) Discuss three factors other than time which affect amount of postglacial erosion.

(3) Discuss two theories of the source of loess material (not mode of deposition).

(4) What three factors other than difference in age cause differences in soil profiles on drift.

(5) Define BRIEFLY the significanc to glacial geology of the folloing terms: (a) Iowan, (b) Aftonian (c) Toronto (d) Algonquin (e) isostacy

Final exam 10 out of

2, 7, 9, 10, 11, 12, 13, 14, 20, 28, 81, 86

review questions

GEOLOGY 143
GLACIAL GEOLOGY

Ecamination May 8, 1946

Write on any 4 questions

(1) What proves that the Darien Moraine is the product of a distinctly later glaciation that the one which formed Marengo Ridge and that the former continues SE and does not turn NE along side of Lake Geneva?

(2) How can you demonstrate that the Illinoian Drift of Wisconsin is much older than the Wisconsin drift?

(3) Compare conditions of origin using diagrams of gravel in Manitowoc city pits and at Fisher Creek.

(4) Illustrate with diagrams methods of formation of moulin kames

(5) Show with cross sections methods of formation of terraces and other features of Kettle Moraine.

(6) Account for the red color of Valders till and tell how its age relation to the Cary substage is determined.

(7) What is significane of the drumlin area E of Fond du Lac.

GEOLOGY 143
GLACIAL GEOLOGY

Midsemester examination · March 25, 1946

Write on four questions only INCLUDING the first.

(1) 5 pictures. Disregard everything but the inked numbers. Omit picture on back of 1c; 1d and 1e are on same page.
Tell for each one: (a) what topographic form and what nature of deposit it displays and (b) define both.

(2) What criterion would ALONE serve to discriminate between:
(a) drumlin and hill in a terminal or end moraine
(b) sand dune and kame
(c) pitted outwash of extreme degree and terminal (end) moraine.
(d) fresh water clay derived from glacier and till with high clay content.
(e) outwash gravel and xxxxx beach gravel.

(3) Describe variations in topographic form of drumlins, their material and compare briefly two distinct theories of their origin.

(4) Complete following sentences giving best proof of each (no more than a single sentence of reasonable length considered):
(a) The fact that the strata of sand and gravel in west side of this flat-topped hill dip about 25 deg. parallel to the xxxx slope indicates that--
(b) Gradation of the silty unstratifeid subsoil downward into stratified sand and gravel indicates that the surficial material is due to--
(c) The level top of this ridge of sand and gravel indicates that it is--
(d) Abundance of granite boulders in the till of this area shows that--
(e) Constancy in direction of the scratches on the bed rock and the fact that they are confined to the surface demonstrates that they are------.

(5) Explain five causes of terracing of glacial outwash deposits.

GEOLOGY 143
GLACIAL GEOLOGY

Examination Feb. 21, 1946

Write on 4 questions only and please indicate which you left out.

(1) Define (be brief and to the point): (a) till, (b) roche moutonee, (c) cirque, (d) friction crack, (e) arete, (f) gravel, (g) silt, (h) medial moraine, (i) drift, (j) crevasse

(2) Complete following sentences giving best proof of each statement (no more than a single sentence of reasonable length considered):
(a) Glacial till can be distinguised from a boulder bed by--
(b) Simplicity of the outline of the Niagara Escarpment of eastern Wisconsin demonstrates---
(c) Fiords are ascribed to glacial erosion because--
(d) A valley glacier can be distinguised from a snowbank by--
(e) Glacial striae on a ledge can be distinguished from slickensides in same situation by--

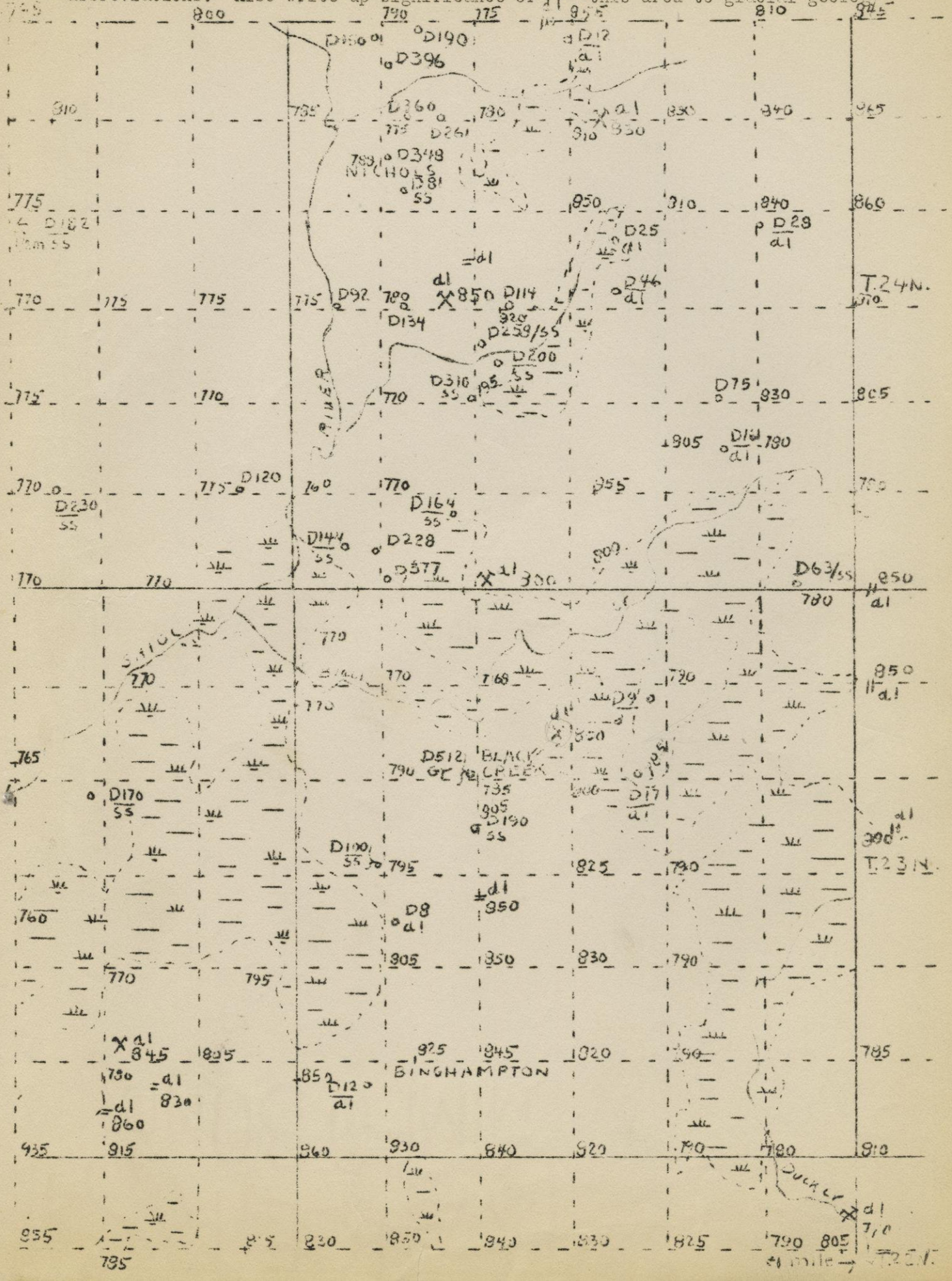
(3) Discuss modern explnation of flow and temperature relations in both valley and continental glaciers, also causes of glacial stagnation.

(4) Compare merits of two distinct theories of nourishment of continental glaciers.

(5) List the different processes which cause glaciers to eroded the bed rock, contrast their efficiency and given examples.

GEOLOGY 143-GLACIAL GEOLOGY — Bedrock topography problem, edition, 1930

Draw 50' contours on rock surface. Ground elevations given; see outline for abbreviations. Also write up significance of this area to glacial geology.



Geology 143

Glacial Geology

Examination March 2, 1942

Write on 4 questions only.

1. Complete following sentences giving proof of each statement:

   (a) Till can be distinguished from mud flow by

   (b) Striae can be distinguished from pack ice scratches by

   (c) Crossing striae prove that glacial abrasion was

   (d) Plucking is more important than glacial grinding because

   (e) Caves are rare in the Niagara dolomite of eastern Wisconsin because

2. Explain two criteria found on bed rock which definitely establish direction of ice movement.

3. Explain two theories of nourishment of continental glaciers.

4. Explain origin of basins of Great Lakes.

5. Explain relations of composition of till to adjacent bed rock.

GEOLOGY 143

GLACIAL GEOLOGY

Examination March 30, 1942

Write on 4 questions and please mark which you leave out.

(1) Complete following sentences giving proof of each statement: (no more counted)

(a) The downward gradation of the unstratified pebbly clay into clean gravel shows

(b) This gravel pit shows thin layers with some of them exceedingly well sorted thus showing that

(c) The uniformity of level of the summits of this area of kettle topography in till shows

(d) The extreme levelness of the till plain shows

(e) The scallops in the edge of the gravel terrace are steepest at the bottoms because

(2) Explain five causes of outwash terraces.

(3) Contrast two leading theories of origin of drumlins.

(4) State best single criterion which serves to distinguish between:

(a) drumlin and knob of terminal moraine

(b) pitted outwash and delta moraine

(c) sand dune and kame

(d) varve and lamination

(e) eskor and bar

(5) Contrast methods of glacial erosion giving examples of each.

GEOLOGY 143
GLACIAL GEOLOGY

Examination May 6, 1942

Write on any 4 questions and please mark which you left out.

(1) Explain the "soil profile method" of correlating and separating glacial drifts.

(2) Discuss two theories of the mode of deposition of loess.

(3) Define BRIEFLY the significance to glacial geology of the following terms:

(a) Illinoian, (b) Yarmouth, (c) Nebraskan, (d) Nipissing,

(e) hinge line.

(4) List five distinct theories of cause of glacial periods stating only the basic principle of each (do not discuss relative merits).

(5) Complete following sentences giving proof of each statement (no more counted):

(a) Tilting of lake beaches is commonly ascribed to relief from ice load because

(b) Tilting of lake beaches may not be due to melting of the ice

(c) Subsoil drainage during the interglacial interval was poor at this locality because

(d) Marl differs in composition from the glacial lake clays of Wisconsin because

(e) The amount of water going over Niagara has not been constant because

GEOLOGY 1 43
GLACIAL GEOLOGY

file

Six weeks examination Feb. 21 , 1947

Write on four questions only

(1) Explain and compare causes of (a) friction cracks and (b) crescentic gouges

(2) Complete following sentences giving best proof of each statement (no more than a single sentence of reasonable length counted):
(a) Glacial striae on a loose stone may be distinguished from slickensides because --
(b) The valleys of the Finger Lake type must have been altered by glacial erosion because----
(c) A stream of glacial meltwater may be distinguised from one fed only by melting snow because---
(d) Fiords differ from drowned valleys because they*--(state fact not inference).
(e) Glacial striae are commonly preserved only where covered by drift because--

(3) Compare the physics of extrusion and gravity flow of glaciers (do not denive any formulas for velocity, why?)

(4) Describe the basins of the Great Lakes and discuss significance in relation to the problem of glacial erosion.

(5) Outline the proofs you could demonstrate near Madison which demonstrate that this region was once covered by a continental glacier.

more

GEOLOGY 143
GLACIAL GEOLOGY

Midsemester examination March 28, 1947

Write on 4 questions and no more . Please indicate which ones you answered.

(1) The sample of sand was submitted on March 27 for advice as to what to do about it. The sand suddenly appeared in the water pumped from a well in glaciated territory. The well was made by driv ing a steel pipe to limestone bed rock at a depth of about 100 feet. No record of material passed through in the drift is available but the well might have reached a sandstone under t he limestone. Examine the s ample to determine its derivation from drift or sandstone and suggest what could be done to get rid of it. Lens furnished.

(2) What is the best single criterion you can use to distinguish between: (a) long sand dune and esker, (b) till with high clay content and lake clay (assume both are unweathered). (c) esker and crevasse filling, (d) esker and lake bar, (e) pitted outwash and terminal moraine.

(3) What are "the annual rings of the earth"? Discuss origin and correlation.

(4) Complete following sentences giving best proof of each statement (no more t han a single sentence of reasonable length will be considered):
(a) Because this deep testpit shows vertical layers of gravel beneath a thin cover of till it is probable that---
(b) The abrupt contact of the underlying sand and gravel with the clay at the surface demonstrates that the latter is----
(c) The presence of alternating layers of silt and caly demonstrate that these folded strata were--------(give complete history).
(d) The fact that the plain of sand and gravel has an abrupt lobate face toward lower ground shows that---
(e) The fact that the fiords and islands have a distinct linear or rectangular pattern along this coast of crystalline rock shows that---

(5) Discuss conditions of formation of so-called recessional moraines telling how you could distinguish the several kinds and why such moraines do do not occur in rough rock topography.

(6) Pictures-please do not mark them. Pay no attention to any but the ink numbers For each tell (a) the land form shown, (b) the kind of deposit, (c) definition of both form and deposit.

GEOLOGY 143
GLACIAL GEOLOGY

Six weeks examination March 10, 1948

Write on 4 questions only.

(1) Complete following statements giving best proof of each (no more than a s ingle sentence of reasonable length considered):
(a) The abrupt contact of mantle and bed rock observed in the quarry demonstate glaciation because--
(b) Glacial plucking produces more spectacular results than does glacial grinding because---
(c) Caverns are rare in the bedrock of eastern Wisconsin because--
(d) The steeply sloping border of the drift at Devils Lake proves that it was deposited by glacial ice because--
(e) Material derived from distant sources forms only a small part of the glacial drift at Madison because--

(2) Compare merits of two different theories of the nourishment of continental glaciers.

(3) Explain the form and origin of cirques.

(4) Define briefly: (a) firn, (b) moulin, (c) extrusion flow of ice, (d) pressure melting of ice, (e) fiord.

(5) How can you distinguish between (give simple criteria preference):
(a) glacier and snowbank
(b) friction crack and crescentic gouge
(c) glacial striae and iceberg scratches
(d) glacial striae and slickensides (both on ledge or bedrock)
(e) lateral moraine and landslide

GEOLOGY 143
GLACIAL GEOLOGY

Midsemester examination April 14, 1948

Write on any four questions and please indicate which you left out.

(1) Pictures. Pay no attention to anything but numbers in ink. Please do not put any marks on them and return them in your book.
Tell what the land form and/or material displayed as principal subject is.

(2) What single criterion would by itself serve to distinguish between:
(a) sand dunes from terminal moraine
(b) drumlins from knobs of terminal moraine
(c) excessively pitted outwash from terminal moraine.
(d) lake clay from clay till
(e) beach gravel from outwash gravel

(3) Complete following sentences giving best proof of each statement (no more than a single sentence of reasonable length counted):
(a) The abundance of granite boulders in the drift in this vicinity proves-
(b) The high content of clay in the till of this region proves that it was derived from----
(c) The uniform elevation of the level tops of some of these knolls of sand and gravel with inclined bedding prove that-
(d) The fact that these striations occur only on exposed surface of the bed rock indicates that they are-
(e) The presence in this vicinity of drumlins which trend in two distinct directions indicates-

(4) Explain five different causes of terraces in outwash deposits.

(5) Discuss origin and interpretation of glacial lake clays.

(6) List in tabular form points for and against at least two different theories of origin of eskers.

GEOLOGY 143
GLACIAL GEOLOGY

Examination May 28, 1948

Write on 4 questions only.

1. Interpret either of following:
   (a) The following well log was recorded at Brodhead in the valley of Sugar River below Monticello. Interpret it in the light of your knowledge of glacial history of this area citing anything you saw on trips to substantiate it.

	Thickness feet	Depth feet
Sand and gravel	70	70
Till, gray	10	80
Clay, dolomitic, brown-gray	45	125
Gravel, mainly local pebbles	20	145
Bed rock.		

   (b) The following log of a well is at the north end of Lake Winnebago. Give interpretation.

	Thickness feet	Depth feet
Clay, red, dolomitic	18	18
Till, red, dolomitic	11	29
Clay, gray, dolomitic	75	104
Till, gray, dolomitic	20	124
Bed rock.		

2. Account for the color of the Valders till in northeastern Wisconsin citing evidence seen.

3. Give distinct lines of evidence which demonstrate that the drift near Monticello is much older than that around Madison. Tell where you observed each fact.

4. Account for the gravels at Fischer Creek, Manitowoc Co.

5. Discuss age and significance of the Brooklyn Moraine citing evidence at other localities which bears on this question.

6. Show by sketch relation of moraines and pitted plains near old Whitewater railroad cut.

GEOLOGY 143
GLACIAL GEOLOGY

Final examination June 7, 1948

Write on 10 questions only. Outline map may be used for more than one question. Please put your name on it and indicate numbers of questions it was used for. Final grades not available until all reports are in.

(1) Indicate on outline map (a) area covered by glacial lakes outside of existing lakes giving names of former, (b) area of Illinoian drift giving general direction of motion.

(2) Use outline map to indicate (a) Johnstown Moraine, (b) Marengo Ridge, (c) Darien Moraine, (d) Milton Moraine, (e) Brooklyn Moraine

(3) Use outline map to indicate (a) Tazewell drift area, (b) Valders drift area

(4) Where did you see moulin kames and discuss origin.

(5) List in one column evidences you saw (where?) in field which demonstrate the major events (in proper order), and in other the conclusions drawn from them which demonstrate the history of Wisconsin glaciation in SE Wis .

(6) Discuss significance of the drumlins east of Fond du Lac.

(7) Discuss important points in problem of the Delavan Glacial Lobe. ✓

(8) Where in field did you see : (a) kames other than moulin, (b) pitted outwash (c) varved clay, (d) cliff of glacial lake, (e) clay till moraine.

(9) Using the outline map for reference but not putting anything on it discuss the causes of the different outwash terraces of the Eagle region.

(10) Discuss the events which led to formation of drainage channels east of Delafield.

(11) Account for the basin which now holds Lake Geneva.

(12) You are prospecting for a large gravel deposit and find a hillside which is entirely covered with coarse gravel. What will you do to estimate the total reserve correctly? Why?

GEOLOGY 143
GLACIAL GEOLOGY

"Six weeks" examination March 9, 1949

Write on four questions only and PLEASE INDICATE on cover of your bluebook which ones they are. Use both sides of paper and please avoid changing order of questions if you possibly can.

(1) Account for friction cracks giving also what type of rock they occur on and name used in older literature for same phenomenon.

(2) State a single criterion which alone would enable you to tell:
(a) glacial striae from slickensides both on loose rocks not ledge.
(b) cirque from plunge pool
(c) fiord from drowned valley
(d) glacier from snowbank
(e) glacial striae from scrathes in river bed.

(3) Explain 5 evidences which you might explain to beginners on a field trip in order to prove that a continental glacier was once present at Madison.

(4) Explain difference between gravity and extrusion flow of glacial ice.

(5) Define briefly:
(a) pressure controlled melting point of ice
(b) glacial anticyclone
(c) roche moutonee
(d) erratic
(e) hanging valley

(6) Explain at least two lines of evidence which should be looked for when observing glacial striae in order to find which way the ice moved along them.

Rebeer

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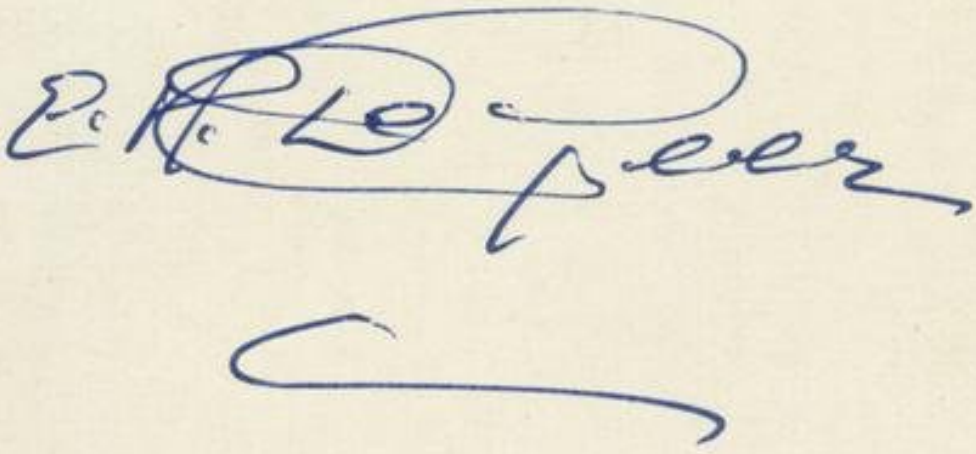
41 N. Roby Road
Madison 5 Wis.
U. S. A.


GEOKRONOLOG. INST.
GOD JUL, GOTT NYÅR!
1954 – 1955

Thanks and
all good wishes.



GEOLOGY 143
GLACIAL GEOLOGY

Midsemester examination April 13, 1949

Write on four questions and no more. Please indicate which you left out. Books cannot be graded until after vacation. No class on Friday, April 15.

(1) State definitely a single criterion which alone will enable you to distinguish between :
   (a) Long sand dune and esker
   (b) Drumlin and kame
   (c) Esker and crevasse filling
   (d) Glacial till and weathered gravel (B horizon of soil profile)
   (e) Till plain from outwash plain

(2) Describe the major variations in form and compare two major theories of origin of drumlins.

(3) Discuss the problem of finding a concealed area of iron formation from its effect on nearby glacial deposits.

(4) Complete following sentences (no more counted):
   (a) In the absence of beaches the level of a glacial lake can be found from----
   (b) Pitted outwash may be distinguised from similar topography by---
   (c) Gravel may be found in some drumlins because--
   (d) The internal structure of a bar differs from that of an esker in--
   (e) The presence of a different kind of till at depth in this area of moraine-like topography suggests that --

(5) Discuss the problems of origin of varved clays and the conclusions drawn from their study.

GEOLOGY 143
GLACIAL GEOLOGY

Exa mination May 23, 1949

Write on four questions only and please indicate which you left out.

(1) For one of the sets of data given below give the glacial history which it demonstrates citing where you observed supporting evidence in the field. What term is applied to such evidence?

(a)Log of test hole at Fond du Lac

	Thickness, feet	Depth, feet
Clay, red, dolomitic	10	10
Till, red, dolomitic, few stones	60	70
Till, very stony, gray, dolomitic, erratics scarce	55	125
Bed rock		

(b)Log of test hole on top of bluff at Fontana

	Thickness, feet	Depth, feet
Till, yellow-gray, dolomitic	20	20
Sand and gravel	190	210
Till, gray, dolomitic	30	240
Sand and gravel	135	375
Gumbotil, dark gray	5	380
Till, leached, gray	10	390
Bed rock		

(2) Where (locate specifically) on recent trips did you observe a good example each of: (a) "Gray" till; (b) Varved clay: (c) Soil profile of pre-Wisconsin drift; (d) Postglacial rock groge not due to meltwaters; (e) Overridden pitted outwash plain.

(3) Explain briefly essential points in problem of source or sources of loess in United States.

(4) Discuss briefly the problem of the existence and form of a "Delavan Glacial Lobe." Cite evidences seen in field.

(5) Describe the observed facts and their interpretation in Pleistocene history as seen at Valders.

(6) Describe different forms of drumlins and tell where you observed them on recent field trips, also any facts bearing on their origin.

GEOLOGY 143
GLACIAL GEOLOGY

Final Examination June 7, 1949

Write on 10 questions and no more. Please indicate which you left out. Please leave a postcard for grade and avoid office or telephone calls. Some final grades will be delayed until all field reports have been read.

(1) Using the outline map show on it (a) Interlobate Moraine, (b) Wingra Moraine, (c) Elkhorn Moraine, (d) Darien Moraine, (e) Marengo Ridge.

(2) On the same map as in question (1) show by shading or lining the areas of: (a) Tazewell drift, (b) Valders drift, (c) Illinoian drift, (d) Lake Oshkosh, (e) Lake Chicago.

(3) Explain the causes of the several outwash terraces observed at the valley of Turtle Creek through the Darien Moraine.

(4) Account for the origin of the conical drift hills of southwestern Sheboygan County. Show this place on your map.

(5) Discuss evidence seen in field which bears upon changes in relative sizes of Lake Michigan and Green Bay lobes from Illinoian time on.

(6) Discuss the origin and significance of the gravels exposed along Fisher Creek.

(7) Outline major events in history of the glacial lakes evidence of which was seen in the field. State where such was observed.

(8) Account for the color, high clay content, and lack of moraines observed in drift of Valders age.

(9) It was once suggested that the Brooklyn Moraine and Marengo Ridge are the same age. Discuss this problem citing evidence seen in field.

(10) Some investigators have doubted that the glacial drift around Monticello is really much older than the Wisconsin glaciation. Discuss points pro and con citing where observed.

(11) Explain the origin of the plain in which lies the basin of Lake Geneva. Give field observations supporting your views.

(12) A well in the valley of Sugar River not far south of where we crossed it shows the following log:

	Thickness	Depth, feet
Sand and gravel	70	70
Till, gray, dolomitic	10	80
lay, gray, dolomitic	45	125
Gravel, mainly local pebbles	20	145
Bed rock		

What events are thus recorded?

(13) Where and why would you find the most stony gravel in a pitted outwash plain?

(14) Explain geological problems connected with the exploration for water at the south end of Devils Lake.

GEOLOGY 143
GLACIAL GEOLOGY

"Six weeks" examination March 8, 1950

Write on 4 questions and no more. Please indicate on cover of book which they are.

(1) What appeals to you as the best single criterion to distinguish between:
(a) friction crack and crescentic gouge
(b) glacial striae and slickensides, both on ledge of bed rock
(c) roche moutonee and exfoliation dome, both in granite.
(d) hanging valley from cirque
(e) glacial striae from iceberg scratches.

(2) Compare merits of two distinct theories of nourishment of continental glaciers.

(3) Discuss problem of flow of a thick continental glacier including causes, distribution, and relative velocity distribution.

(4) List without extensive discussion 5 types of evidence which demonstrate glacial erosion of bed rock under continental glacier and 5 types of evidence which demonstrate little such erosion at point of observation.

(5) Define briefly with no discussion of origin in detail:
(a) firn, (b) moulin, (c) pressure melting, (d) fiord, (e) piedmont glacier

(6) Discuss the form and origin of cirques including what other land forms might be confused with true cirques.

GEOLOGY 143
GLACIAL GEOLOGY

Midsemester examination April 19, 1950

Write on four questions only and please show which you left out.

(1) State definitely and briefly a SINGLE CRITERION which alone would enable you to distinguish:
   (a) That a surface weathered clay is glacial till not due to alteration of underlying stratified deposits.
   (b) Bed of glacial lake from till plain
   (c) Esker from barrier beach containg gravel
   (d) Pitted outwash from eroded outwash.
   (e) Roche moutonee from drumlin

(2) Discuss points for and against two major theories of origin of ESKERS

(3) Complete following statements giving proof of each conclusion (no more than a single sentence of reasonable length considered):
   (a) The uniform summit levels of this bouldery area underlain by till to depth of at least several feet suggest-----
   (b) The fact that the striae on this ledge are confined to its surface demonstratesthat---
   (c) In this region where the ice moved almost directly west the abundance of granite boulders decreases east of a definite N-S line provingthat-----
   (d) The fact that the younger of the two tills of a given region contains much more clay and silt than does the lower till suggests-
   (e) Because the west fact of this flat-topped hill is underlain by layers of sand and gravel which dip parallel to the surface proves-

(4) List and describe five different causes of terraces of outwash.

(5) (a) Condition necessary for formation of a till endmoraine?
   (b) What distinguishes a moraine fo readvance from one due to halt in melting of the ice?
   (c) Why are marginal moraines rare in regions of rough preglacial rock topography?
   (d) What effect has amount of clay-silt content in till on topography of marginal moraines?
   (e) How distinguish a true marginal moraine from excessively pitted outwash?

GEOLOGY 143
GLACIAL GEOLOGY

Examination May 24, 1950

Write on any 4 questions and please indicate on cover of your book which you answered.

(1) Tell as specifically as possible where on trips you saw good a example of each: (a) Cary till, (b) Illinoian gravel, (c) stream diversion of Illinoian age, (d) pitted outwash terraces, (e) till plain, (f) glacial lake plain, (g) Valders till, (h) crevasse filling, (i) abandoned channel of glacial stream, (j) non-pitted outwash

(2) In respect to loess tell (a) definition of term, (b) general distribution, (c) evidence bearing on origin and sources, (d) where seen in field, (e) its importance in glacial geology of Mississippi Valley.

(3) Present facts observed in field which indicate that Valders drift is Much younger than the Cary drift.

(4) Present facts observed in field which indicate that the Cary drift is much younger than the Marengo moraine (Tazewell)

(5) The following well log is located on north shore of Lake Winnebago. (a) outline in proper order the history of glaciation of that region which it dsiplays and (b) tell where deposits of same age were seen on trips.

	Thickness	Depth, feet
Clay, red, dolomitic	18	18
Till, much clay and silt, red, dolomitic	11	29
Clay, gray, dolomitic	75	104
Till, stony, gray, dolomitic	20	124
Bed rock		

(6) Discuss hypotheses to account for variation in trend of drumlins east of Fond du Lac

GEOLOGY 143
GLACIAL GEOLOGY

Final examination June 7, 1950

Write on 10 questions only. Please mark on cover which you left out. In the interest of rapidity of grading please leave a postcard for your grade and avoid office or telephone calls for at least 24 hours after the examination.

(1) Use the outline map given you (be sure YOUR NAME is on it) indicate: (a) Johnstown Moraine, (b) Milton Moraine, (c) area of Cary drift, (d) major drumlin area visited, (e) area submerged by Lake Oshkosh.

(2) Account for the several terraces of pitted outwash which were visited in the region around Eagle, Wis.

(3) Explain origin and nature of material in the prominent conical hills of the Kettle Interlobate Moraine.

(4) Discuss evidence seen in field which bears upon problem of origin of the Kettle Moraine.

(5) Discuss problem of age and origin of the gravel along Fisher Creek.

(6) Compare two possible hypotheses of origin of the sand plain near Cleveland, Wis. Suggest criteria to settle the matter.

(7) Although a Professional paper is entitled "The Delavan Glacial Lobe" it has been asserted that there is no such lobe. What evidence did you see which bears on this problem and what criteria could be used to settle it?

(8) In some reports the Brooklyn Moraine is correlated with Marengo Ridge. What evidence id you see in field which bears on this problem?

(9) What is gumbotil? Discuss its relation to both age, topography and material of drift on which it lies as these facts bear upon problem of its origin.

(10) Valders drift is not recognized on most soils maps west of Green Bay (i.e. northwest of city of that name). Discuss factors of weathering and soil formation which may make it unrecognizable in shallow borings.

(11) You are to explore for stony gravel in a non-pitted outwash plain outside the moraine of the Cary substage. Where and why would you find the best deposits?

(12) Shallow testpitting indicates that a terrace of outwash is all gravel. Show by diagram how this may be in error and why.

(14) The city well at Brodhead (not far from Monticello) encountered:

	Thickness	Depth, feet
Sand and gravel	70	70
Till, gray, dolomitic	10	80
Clay, light gray, dolomitic	45	125
Gravel, mainly local pebbles	20	145
Bed rock		

What glacial history of Sugar River valley is thus indicated?

GEOLOGY 143
GLACIAL GEOLOGY

Final examination June 7, 1951

Write on any 10 questions and please indicate which you left out. In the interest of speed in grading kindly avoid office or telephone calls before Saturday. Leave postcard for your grade either here or in mailbox.

(1) Explain the causes of the several outwash terrace levels where Turtle Creek cuts through the Darien Moraine. 1952

(2) (a) Describe the gravel deposit observed on Fisher Creek and (b) compare at least two hypotheses of its origin.

(3) (a) Describe Marengo Ridge and Brooklyn Moraine and (b) compare hypotheses of their relative age. 1952

(4) Account for the origin of the conical hills of southwestern Sheboygan County.

(5) Compare three theories of origin of the drumlins east of Fond du Lac.

(6) Describe and account for the four different levels of outwash observed west and east of Eagle. Sketch map suggested.

(7) Explain origin of the "beheaded" valley just east of Delafield. Sketch map. 1952

(8) Describe and account for the upland which surrounds the basin of Lake Geneva including the basin itself.

(9) The well log given below is located a short distance from Lake Geneva. What does it add to the glacial history worked out from surface exposures?

	Thickness feet	Depth, feet
Till, gray	20	20
Gravel and sand	40	60
Till, gray	10	70
Sand and gravel	90	160
Till, pink, soil at top	30	190
Gumbotil, dark gray	5	195
Till, dark gray	32	227
Bed rock		

(10) Complete following sentences giving best proof of each:
(a) The trees of the Forest Bed grew close to where they are found------
(b) The ------striae at Valders are the younger---------
(c) The till of Darien Moraine and Marengo Ridge differ in color---
(d) Sandstone crags occur near Monticello ---
(e) Pebbles of Niagara dolomite at Dayton prove-----

(11) Some geologists oncle claimed that the Valders till is very old because it is red. Discuss validity of this hypothesis.

(12) Explain problems connected with exploration for a reliable source of water in the drift at south end of Devils Lake, Wisconsin

(13) (a) Describe evidence for and (b) discuss two theories of the postglacial earth movements of the Great Lakes region.

(14) Discuss the basis for and the reliability of the recent age determination of the Forest Bed wood.

(15) What surface indications should be looked for in evaluating the probability of finding a large deposit of coarse stony gravel.

GEOLOGY 143
GLACIAL GEOLOGY

Examination May 23, 1951

Write on any 4 questions and please indicate which they are.

(1) On the outline map indicate (a) Forest Bed, (b) Brooklyn Moraine, (c) Marengo Ridge Moraine, (d) margin of Valders Drift, (e) area of Illinoian Drift, (f) Interlobate Moraine, (g) Milton Moraine, (h) Johnstown Moraine, (i) overridden pitted outwash plain, (j) non-pitted outwash area.

(2) Although a professional paper is entitled "The Delavan Glacial Lobe" doubt has been thrown on the existance of such a phenomenon. Explain phenomena seen in the field which bear upon this problem.

(3) Describe (a) facts, and (b) the interpretation of the phenomena which were observed at the Valders quarry.

(4) Describe 5 different forms of drumlins which were observed in the field telling where examples of each were seen.

(5) Describe not less than two lines of evidence which bear upon the age difference between the drift near Madison and that around Monticello.

(6) A well in Fond du Lac displays the section given below. Give (a) the history of glacial time thus demonstrated, (b) supporting evidence seen in field for each event, and (c) the name given to this general method of deciphering glacial history.

Log of test hole in Fond du Lac, Wis.

	Thickness, feet	Depth, feet
Clay, red, dolomitic	10	10
Till, red, dolomitic, few stones	20	30
Clay, gray, dolomitic	40	70
Till, mainly dolomite fragments, few erratics, gray, dolomitic	55	125
Bed rock		

(7) A well in the valley of Sugar River below Monticello shows the log given below. Give (a) events thus recorded in proper order, and (b) phenomena seen in field supporting your conclusions and (c) the term given to this type of evidence of glacial history

Log of city well, Brodhead, Wis.

	Thickness, feet	Depth, feet
Sand and gravel, fine	70	70
Till, gray, dolomitic	10	80
Clay, dolomitic, brown-gray	45	125
Gravel, local pebbles	20	145
Bed rock		

GEOLOGY 143
GLACIAL GEOLOGY

Midsemester examination April 11, 1951

Write on 4 questions and no more. Please indicate which they are.

(1) Compare merits of two major theories of origin of drumlins.

(2) Discuss in respect to varves (a) required conditions of origin, (b) how you tell top from bottom, (c) principle of correlation between localities, (d) does this method lead to a "solar curve"?, (e) attempts to connect to historical calendar.

(3) State definitely a single criterion which would enable you to distinguish between:
(a) beach gravel from outwash gravel
(b) Bed of glacial lake from outwash plain.
(c) Esker from elongated sand dune
(d) Pitted outwash from terminal (marginal) moraine.
(e) Lake clay from clay till.

(4) With reference to marginal moraines explain:
(a) effect of character of till on topographic form.
(b) difference in map pattern between moraines of readvance and those formed when rate of ice recession is temporarily reduced.
(c) rarity of moraines in regions of high relief.
(d) how distinguished from areas of overridden pitted outwash
(e) why some glacial advances left no marginal moraines.

(5) You are to examine a heavily drift-covered area for possible presence of iron formation. Explain fully what investigations should be made of the drift in order to settle this question. Explain how nature of rock affects its contribution to the drift considering both till and water-sorted parts.

(6) Complete following sentences giving proof of each (no more than a single sentence of reasonable length considered);
(a) The presence of many granite boulders around the shore of a lake in a pitted sand plain indicates that--
(b) The fact that one test pit in a given sand plain discovered lake clay at shallow depth indicates that--
(c) Thick inclined bedding in a flat-topped hill shows--
(d) A test pit in a level area encounters sand and gravel with vertical bedding because--
(e) A marked color difference in successive tills indicates--

GEOLOGY 143
GLACIAL GEOLOGY

Special "six weeks" examination March 7, 1951

Write on any four and please indicate on cover of bluebbok which they are.

(1) Discuss relative impertance of glacial eresion of Finger Lake valleys of New York.

(2) Compare conditions for formation of friction cracks and crescentic gouges.

(3) Explain results you would obtain in vicinity of Madison from (a) a count of 100 boulders and (b) a count of 100 pebbles as bearing on the derivation of the glacial drift (source area of bulk of drift).

(4) Define briefly with no extended discussion of origin:
(a) nunatak, (b) cirque, (c) hanging valley, (d) moulin, (e) erratic

(5) Which process was most important in producing Yosemite Valley and what evidence leads to this conclusion?

(6) What single criterion for each would enable you to distinguish between:
(a) slickensides and glacial striae, (b) temperate and polar glacier,
(c) material transported by ice from material transported by water,
(d) pothole and kettlehole, (e) landslide and moraine of valley glacier.

GEOLOGY 143
GLACIAL GEOLOGY

"Six weeks" examination March 7, 1951

Write on any 4 questions and no more. Please indicate on cover of bluebbok which they are.

(1) Glacial erosion is both by plucking and grinding. Discuss under headings: (a) total results in a given time, (b) shape of resulting valleys, (c) difference between plucking and sapping, (d) required conditions for important plucking, (e) condi tion required for roche mountonee form.

(2) Give best criteria which would enable you to distinguish between: (a) fiorded coast and coast of submergence, (b) talus deposit and till of valley glacier, (c) plunge pool and glacial rock basin, (d) glacier and snowfield, (e) gravity and extrusion flow of ice.

(3) Define briefly with no extended discussion of origin: (a) pressure melting point, (b) glacial anticyclone, (c) erratic, (d) diluvium, (e) rock flour.

(4) Complete following sentences giving best proof of each statement (no more than a single sentence of reasonable length counted);
(a) Striated bed rock is found in most places only under a till cover because---
(b) Large boulders are composed of hard or thick-bedded rock because---
(c) Meltwater from a glacier is milky-colored because---
(d) Hobbs' theory of nourishment of continental glaciers is not widely accepted because---
(e) Faceted stones are not a certain criterion of glaciation because---

(5) Discuss relative importance of glacial erosion in formation of basins of the Great Lakes of North America.

(6) You find a striated ledge of bed rock. State what you should look for to check direction ice moved along these marks. Explain why.

GEOLOGY 143
GLACIAL GEOLOGY

"Six weeks" examination March 12, 1952

Write on any 4 questions and no more indicating which you left out.

(1) In each of following cases what criterion alone would enable you to distinguish between: (a) glacial s triae and slickensides on bed rock, (b) hanging valley and cirque, (c) roche mountonee and exfoliation dome, (d) lateral moraine of valley glacier and landslide, (e) glacier and snowbank.

(2) Define briefly with no extended discussion of origin: (a) erratic, (b) rock basin, (c) piedmont glacier (d) firn, (e) extrusion flow, (f) pressure melting of ice (g) crevasse, (h) fiord, (i) moulin, (j) medial moraine.

(3) Discuss origin of friction cracksin bed rock including their relation to type of rock, to forces involved, to . direction of ice motion, and to allied markings on rock.

(4) Y ou intend to take a group of beginning geology students on a field trip near Madison; describe 5 different phenomena which you could show them to demonstrate that a continental glacier once covered this region. Caution: do not include phenomena which must be explained by assuming glaciation of t he area.

(5) List 5 different types of evidence which demonstrate extensive erosion of bed rock by a continental glacier.

(6) Explain Hobbs' theory of the nourishment of continental glaciers and the alternative theory.

GEOLOGY 143
GLACIAL GEOLOGY

Midsemester examination April 16, 1952

Write on 4 questions and no more. Please indicate on cover which they are. Books may not be graded until after the recess.

(1) State briefly the essential criteria which would enable you to distinguish
   (a) drumlin from moulin kame.
   (b) esker from crevasse filling
   (c) till from surficial weathered part of outwash
   (d) sand dunes from endmoraine
   (e) pitted outwash from eroded (gullied) outwash

(2) Explain briefly 5 different types of glacial outwash terraces.

(3) Compare merits of three different hypothses of how eskers cross slopes which are opposed to direction of water flow.

(4) With regard to endmoraines (marginal or terminal moraines) state briefly:
   (a) why some ice advances left no moraine at margin
   (b) how you can discriminate a moraine laid down after a marked readvance of the ice front from one due simply to a pause in melting.
   (c) why moraines are uncommon and discontinuous in regions of rough topography like New England and Appalachian Plateau.
   (d) how distingued from pitted outwash
   (e) how topographic form is related to nature of the material.

(5) Compare merits of two major theories of origin of drumlins.

GEOLOGY 143
GLACIAL GEOLOGY

Examination May 28, 1952

Write on any 4 questions and please show on cover which they are.

(1) Explain with a sketch map why there are several different levels of Outwash near Eagle, Wisconsin

(2) (a) Describe material and topography of Marengo Ridge Moraine and Brooklyn Moraine and (b) compare hypotheses of their age relations

(3) (a) Describe in a column the several different kinds of deposits found in the lake bank at the Forest Bed and (b) give the conclusions on glacial history of the region in proper order.

(4) A well was drilled at the bottom of the gravel pit in Fontana encountering the following succession of deposits. Give the glacial history thus indicated with supporting evidence obtained at the surface

Description	Thickness, feet	Depth, feet
Till, gray, top weathered	20	20
Gravel and sand	40	60
Till, gray	10	70
Sand a nd gravel, much water	90	160
Till, pink with soil at top	30	190
Gumbotil, dark gray	5	195
Till, dark gray	32	227
Bed rock		

(5) Show with a sketch the evidences of changes in glacial drainage observed east of Delafield and account for them.

(7) (a) Describe the exposures of driftin the quarry at Valders, Wis. and (b) account for them and for the marks on the surface of the bed rock.

GEOLOGY 143
GLACIAL GEOLOGY

Final examination June 13, 1952

Write on any 10 questions indicating on cover which you left out. Please avoid office or telephone calls before Monday noon.

(1) Compare at least two theories of origin of the drumlins visited east of Fond du Lac including their bearing on general theory of drumlin origin.

(2) Describe evidence bearing on origin of the basin of Lake Geneva and the adjacent upland.

(3) Complete following sentences giving proof of each statement (be brief):
(a) Sandstone crags occur near Monticello because--
(b) Sugar River is eroding its channel in bedrock near Monticello because-
(c) The pebbles of Niagara dolomite found northeast of Monticello prove--
(d) The fact that no more diamonds have come to light in the Wisconsin drift suggests----
(e) The occurrence of drumlins on top of much broken dolomite shows---

(4) Give the evidence for and two theories of origin of postglacial earth movement in the Great Lakes region.

(5) The well at Brodhead along Sugar River south of Monticello shows:

	Thickness ft.	Depth, ft.
Sand and gravel	70	70
Till, gray, dolomitic	10	80
Clay, light gray, dolomitic	45	125
Gravel, few erratic pebbles	20	145
Bed rock		

Give in order the events which led to this succession and correlate same.

(6) Locate clearly on outline map: (a) Brooklyn Moraine, (b) Forest Bed, (c) area submerged by Lake Oshkosh, (d) border of Tazewell drift, (e) border of Valders drift.

(7) Discuss origin and significance of the conical hills along Interlobate Moraine.

(8) Compare (a) two theories of origin of Interlobate (Kettle) Moraine, and (b) proofs that there were two distinct lobes in southeastern Wisconsin.

(9) Account for the origin of the color of the Valders till including more than one hypothesis.

(10) Discuss the problem of the existence of a "Delavan Glacial Lobe" including facts seen in field which bear on it.

(11) Describe and correlate with outwash deposits and ice margins the several terraces observed in the valley of Turtle Creek.

(12) Locate definitely on outline map where the following were seen on field trips: (a) varved clay, (b) esker, (c) twin drumlins, (d) terraces of pitted outwash with ice contact edges, (e) glacial lake plain overridden by readvance of ice.

(14) What evidences were seen in field which indicate time relations of retreat of Lake Michigan Lobe in relation to Green Bay Lobe?

(15) How may deposits of coarse stony gravel be located along border of a moraine giving example seen in field.

GEOLOGY 143
GLACIAL GEOLOGY

Six weeks examination March 11, 1953

Write on four questions only and please indicate on cover which they are.

(1) Give best single criterion which would enable you to distinguish between:
(a) landslide or talus deposit and till of valley glacier.
(b) glacial striae and slickensides, both on loose rocks.
(c) cirque and hanging valley.
(d) fiord and drowned valley.
(e) meltwater from glacier and from snowbank.

(2) Explain the forces necessary to production of cracks in bed rock by glacial action including favorable kinds of bed rock.

(3) Define briefly with no extensive discussion: (a) rock basin, (b) glacier (c) medial moraine, (d) crevasse, (e) pressure melting.

(4) Contrast gravity and extrusion flow of ice in respect to (a) cause, (b) velocity distribution, (c) occurrence, (d) effect on surface of glacier, (e) reason for controversy.

(5) You find what appears to be a glacially striated ledge of bed rock. Explain
(a) how you can use this observation to tell that it is a ledge and not a boulder.
(b) how tell the scratches from result of faulting.
(c)(d) two reliable criteria of which way ice moved along striae.
(e) how find probable amount of ice erosion of bed rock at that point.

(6) State the significance of: (a) the abrupt contact of drift and bed rock in a given locality, (b) angular sides of Yosemite Valley, (c) sloping margin of the glacial drift, (d) the steep headwall of a cirque, (e) the longitudinal profile of a roche moutonee.

GEOLOGY 143
GLACIAL GEOLOGY

Midsemester examination April 15, 1953

Write on 4 questions only and please indicate on cover which you left out. Grades will probably not be ready until after vacation.

(1) State single criterion which alone would distinguish between:
(a) Drumlin and knob of terminal moraine.
(b) Terminal (end) moraine and overridden pitted outwash.
(c) Till and weathered gravel
(d) esker and beach ridge
(e) crevasse filling and ice-push ridge of modern lake.

(2) With reference to marginal (terminal or end) moraines explain:
(a) effect of the mechanical composition of the till on topography.
(b) how you tell deposits due to pause in melting back of ice from those due to a readvance of ice front.
(c) most probable reason for scarcity in eastern U.S.
(d)(e) 2 reasons for lack of continuity.

(3) You are searching for the location of a body of soft hematite which is concealed by drift. Explain what effect this would have on the nature of the drift and how you could trace these effects back to their source.

(4) Complete following sentences giving best proof of each:
(a) The vertical bedding of the gravel in this test pit indicates that--
(b) The shallow depth of the foreset bedding in this pit indicates that the deposit is-
(c) The abundance of granite boulders west of a north-south line demonstrates--
(d) The alignment of this tract of hummocky sand and gravel with enclosed kettles parallel to the direction of ice movement shows that --
(e) Marked disturbance of the varved clay just below the weathered zone shows that this area was--

(5) With respect to glacial lakes explain:
(a) why beach deposits are discontinuous.
(b) the bedding in a bar across a bay
(c) reason for alternating layers of silt and clay
(d) what causes the relative thickness of pairs of these layers to vary
(e) How above relation can be used for correlation of age of deposit.

(6) Explain (a) why it is difficult to distinguish an ice contact face at edge of a terrace of glacial outwash, (b,c) why the long profile of most outwash deposits is concave toward the sky giving more than one reason.
(d) where you would search for the coarsest gravel in outwash, why.
(e) why recession of the ice front must cause erosion of previous outwash into a terrace.

GEOLOGY 143
Glacial geology

Exam on field trips May 27, 1953

Write on any 4 questions only and please indicate on cover which they are.

(1) Explain evidence of origin of basin of Lake Geneva

(2) Give interpretation of history demonstrated by the log of a well on north shore of Lake Winnebago as follows:

	Thickness	Depth, feet
Clay, red, dolomitic	18	18
Till, high in clay and silt, red, dolomitic	11	29
Clay, gray, dolomitic	75	104
Till, stony, gray, dolomitic	20	124
Bed rock		

Tell where similar deposits were observed on trips.

(3) Locate on the outline map: (a) Forest Bed, (b) Brooklyn Moraine, (c) Marengo Ridge Moraine, (d) margin of Valders Drift, (e) margin of Illinoian Drift,

(4) Tell where you saw evidences that the drift near Monticello is much older than that near Madison and explain each.

(5) Describe the exposure at Valders and tell what it indicates in history of glaciation of that region.

(6) Locate on outline map: (a) rock drumlins, (b) twin drumlins, (c) overridden drumlins, (d) overridden pitted outwash plain, (e) non-pitted outwash. (all seen on trips)

GEOLOGY 143
GLACIAL GEOLOGY

Final examination June 11, 1953

Write on first three questions and any 7 others. (10 in all) Please indicate on cover which you left out. Please leave postcard for grade.

(1) Pictures: for each tell (a) what landform or type of deposit it shows; (b) where you saw an example on field trips. Use the numbers in ink only and please make no marks on the pictures.

(2) Using the outline map locate: (a) shore of Lake Oshkosh including its outlet, (b) Johnstown Moraine, (c) Eagle terraces, (d) Darien Moraine, (e) Whitewater cut in Interlobate Moraine (show both).

(3) Using the same outline map show approximately where you saw on trips: (a) esker, (b) rock gorge eroded by meltwaters, (c) overridden lake plain, (d) varved clay, (e) pre-Wisconsin endmoraine.

(4) Explain two theories of the origin of the color of the Valders till.

(5) Explain two rival theories of origin of the Kettle Interlobate Moraine.

(6) Explain with examples seen in field the problem of distinguishing ice contact outwash terraces from erosional outwash terraces.

(7) Give the evidences for and two theories for origin of late glacial earth movement in the Great Lakes region.

(8) Where did you see and what is origin of the conical hills in and near the Interlobate Moraine?

(9) Explain briefly (a) the general basis for the recent age determination of the Forest Bed and (b) the basic method of a rival system of finding age.

(10) Explain with diagrams the origin of the "hanging" valley east of Delafield.

(11) Complete following sentences giving best proof of each statement:
- (a) The E-W striae at Valders are the younger because----
- (b) Pitted outwash outside of a marginal moraine demonstrates-----
- (c) Lake Michigan once extended inland from Point Beach because----
- (d) Lack of an endmoraine at the margin of Valders drift shows that-----
- (e) Similarity in lobation of the Brooklyn and Johnstown moraines suggests that----

(12) Compare two theories of the crossing drumlins east of Fond du Lac.

(13) How does topography along Turtle Creek record changes in ice drainage in the region to northeast? Use diagram.

(14) What could you look for in an endmoraine to aid in locating coarse stony gravel in the adjacent outwash plain? Explain using example seen on field trips.

GEOLOGY 143
GLACIAL GEOLOGY

Six weeks examination March 10, 1954

Write on any 4 questions and please indicate on cover which they are.

(1) Define briefly (no extended discussion): (a) roche moutonee, (b) nunatak, (c) erratic, (d) diluvium, (e) gravel boulder.

(2) State explicitly a single criterion for each which alone will distinguish between:
(a) talus and lateral moraine of a valley glacier
(b) glacial striae and slickensides on bedrock
(c) friction crack and crescentic gouge
(d) residual accumulation due to weathering and glacial deposit.
(e) rock flour and silt derived from weathering of rock

(3) Compare merits of two rival theories of cause of snowfall enough to maintain a continental glacier. Use diagrams.

(4) State concisely the conclusion which can be safely drawn from the following facts:
a) the depth of Finger Lakes extends below sea level.
b) the bottom of a glaciated mountain valley has several abrupt slopes or "steps"
c) portions of the Niagara Escarpment of eastern Wisconsin are very straight
d) small depression in glaciated bedrock surface are more gently sloping on one side than on the opposite.
e) glacial ice deposits lack both assortment and stratification.

(5) Is or is not the motion of a continental glacier different from that of a valley glacier? Consider (a) evidence of motion, (b) effect of thickness of ice on force required to cause flow, (c) temperature distribution in a thick glacier, (d) effect of motion of lower ice on top zones, (e) evidence of erosion beneath thick glaciers at more rapid rate than under thin glaciers.

(6) In regard to erosion of bed rock by glaciers state: (a) (b) two methods, (c) evidence that both occur, (d) relative speed of erosion by each, (e) effect of nature of the bed rock on each.

GEOLOGY 1 43
GLACIAL GEOLOGY

Special six weeks examination March 1954

Write on any 4 and please indicate which they are on cover of your book

(1) Define briefly with no extended discussion: (a) firn, (b) medial moraine, (c) erratic, (d) cirque, (e) rock basin

(2) State explicitly a SINGLE criterion for each which will serve to distinguish between:
(a) roche moutonee and exfoliation dome in massive rock,
(b) glacial striae and iceberg striations
(c) cirque and plunge pool of falls
(d) mantle rock due to weathering of bedrock and glacial deposit which is thicker than soil profile.
(e) products of glacial grinding from products of glacial plucking

(3) State clearly and explicitly 5 evidences proving continental glaciation at Madison which are suitable to show to a class of beginners. Do not confuse cause and effect in choosing proofs such as saying "drumlins are present, hence---".

(4) State concisely the conclusion in respect to glaciation which may de drawn with confidence from the following observations:
(a) The sides of Yosemite Valley are anglular
(b) There are several abrupt slopes in the bed rock marked by waterfalls in the course of Merced River through Yosemite Valley
(c) Certain sections of the Niagara escarpment (dolomite over shale) of eastern Wisconsin display no ouliers
(d) Many glacial striae change from a single scratch to two when followed in direction of ice motion.
(e) Friction cracks are rare on soft rocks such as limestone, dolomite and shale.

(5) A controversy has arisen over the idea of "extrusion flow" of glaciers Discuss considering: (a) definition of two types of flow of ice in respect to location of maximum velocity, (b) evidence that bottom of a thick glacier must be at melting point of ice, (c) major reason for objecting to idea of extrusion flow, (d) why crevasses are confined to margins of continental glaciers, (e) evidence that glacial erosion increases at a rate exceeding that of ice thickness.

(6) State 5 evidences of existance of glacial erosion by continental glaciers and 5 evidences of its unimportance. Evidences need not all occur at same locality.

GEOLOGY 143
GLACIAL GEOLOGY

Midsemester examination April 14, 1954

Write on any 4 and no more. Please indicate on cover which you left out. Grading cannot be completed until after the Devils Lake trip.

(1) State a single criterion which alone enables you to discriminate between
- (a) Overriden outwash plain and outwash which has undergone soil formation to depth of several feet
- (b) drumlin and moulin kame
- (c) sand dunes and pitted outwash
- (d) area of extensive gulleying from endmoraine
- (e) beach gravel from outwash gravel

(2) With regard to endmoraines formed at margin of continental glacier tell:
- (a) Why some ice advances failed to leave any endmoraine
- (b) (c) two lines of evidence to discriminate between moraines formed during a simple pause in melting away of the ice from those at the maximum of a readvance.
- (d) Why moraines differ so widely in topographic form in different areas, for instance why are moraines in Wisconsin much more prominent than those of central Illinois.
- (e) What kind of deposit has been very often confused with moraines.

(3) In respect to the origin of drumlins give (a) two major theories, (b,c) Two major points for each, and (d,e,) Two major objections to each as currently explained.

(4) Explain briefly 5 different causes of formation of terraces of glacial outwash.

(5) With respect to eskers state: (a) why eskers are so important as sources of gravel.
(b) Why the origin of eskers is a major problem.
(c, d, e) three suggestions of how to explain this problem of origin.

(6) With regard to varves explain:
- (a) definition of term
- (b) reasons for the definite separation of layers
- (c) why successive varves differ in thickness
- (d) basic principle by which varves of same age were correlated from one exposure to the next.
- (e) hypothesis that the varves represent a "solar curve".

GEOLOGY 143
GLACIAL GEOLOGY

Exam on Field trips May 26, 1954

Write on four questions only and please show which they are on cover

(1) Locate on the outline map furnished: (a) Forest Bed where visited, (b) Brooklyn Moraine, (c) type locality of Valders Drift, (d) Milton Moraine, (e) Johnstown Moraine

(2) Explain four facts which show that the Valders Drift is younger than the Cary Drift. Give place or places where facts were seen.

(3) Explain two facts which indicate that the Cary Drift is younger than the Marengo Moraine. Give age of latter and tell where facts were seen.

(4) List in order not less than 5 separate deposits found at or near the Two Creeks Forest Bed and from their evidence state the glacial history of the area with events in proper order.

(5) Explain two possible causes of the two directions of drumlin axes observed east of Fond du Lac.

(6) Explain with a diagram the striae and tills observed at Valders quarry and state the "proof of age relation" (no reference to other places.)

GEOLOGY 143
GLACIAL GEOLOGY

Final examination 11 June 54

Write on 10 only and please show those left out. Leave postcard for grade

(1) Pictures Use ink numbers only. For each tell: (a) what glacial landform or deposit it displays (b) where an example was seen by you on field trips of class.

(2) Locate on the enclosed outline map: (a) shoreline of Later Lake Oshkosh, (b) Outlet of Later Lake Oshkosh, (c) Turtle Creek outlet through moraine, (d) Border of Valders drift, (e) Interlobate Kettle Moraine.

(3) Explain two possible causes of the color of Valders till. Evidence seen?

(4) Compare with evidence seen in field two ideas of origin of Kettle Interlobate Moraine

(5) Where were conical gravels hills observed on field trips: Explain origin.

(6) (a) Explain principle of age determination of the Forest Bed.
(b) Compare results with those from one other method stating its principle.

(7) Explain the changes of glacial drainage in the vicinity of Delafield as seen.

(8) It has been asserted that there was a distinct "Delavan Lobe"of Cry age Explain significance of distribution of types of outwash on this conclusion.

(9) State the evidence that the level of water in the Lake Michigan Basin was very low between Algonquin and Nipissing lake levels including the cause of the later rise.

(10) (a) Define "ice contact terrace" (b) How do you distinguish such a terrace from one due to stream erosion? (c) Give examples seen in field.

(11) Explain evidences which demonstrate origin of the basin of Lake Geneva and the surrounding upland. State where seen.

(12) (a) Describe the gravel of Fisher Creek valley (b) What is the significance of these facts on determination of relative age of this gravel deposit?

(13) Explain with aid of diagrams the cause of the several levels of outwash terraces in the vicinity of Eagle.

(14) The city well at Brodhead (below Monticello along Sugar River) shows:

	Thickness	Depth, feet
Sand and gravel	70	70
Till, gray, dolomitic	10	80
Clay, light gray, dolomitic	45	125
Sand and gravel, local origin	20	145
Bed rock		

List in proper order the events which led to this succession and state the term applied to this kind of evidence, the interpretation of sediments.

GEOLOGY 143
GLACIAL GEOLOGY

Six weeks examination March 9, 1955

Write on 4 questions only and please indicate which on bluebook cover.

(1) Define (no extended discussion): (a) firn, (b) medial moraine, (c) erratic, (d) cirque, (e) arete, (f) pot hole, (g) fiord, (h) tarn, (i) hanging valley, (j) till.

(2) State explicitly a SINGLE line of evidence which alone would suffice to distinguish between:

(a) roche mountonee and exfoliation dome both in crystalline rock.
(b) glacial striae and slickensides both on a loose stone.
(c) rock basin due to glacial erosion and plunge pool of river.
(d) mantle rock or residium due to weathering and glacial till.
(e) talus and lateral moraine both in mountain valley.

(3) State clearly and explicitly 5 different lines of evidence which you could show to a class of beginners which prove former presence of a continental glacier (avoid choosing evidences which depend themselves on the proof you desire to show.)

(4) State concisely the conclusion in regard to glaciation which may be drawn from the following facts:

(a) Lake Michigan lies in a rock basin.
(b) The bottom of glaciated mountain valleys show abrupt changes in slope of bed rock (steps).
(c) Parts of the Niagara Escarpment of eastern Wisconsin are very straight compared to the same in unglaciated northwestern Illinois.
(d) Small depressions in surface of the bedrock have a definite shape related to glacial motion.
(e) Friction cracks are rare in dolomite and limestone.

(5) The controversy over the existence of extrusion flow in continental glaciers arises from (a) observation of such flow, (b) fact that crevasses occur only near margin of known ice sheets, (c) physical measurements of relation between flow of ice and amount of pressure on it, (d) presence of enclosed basins of large size in bed rock, (e) amount of discharge from some Greenland glaciers. Discuss bearing of each fact on this problem.

(6) Compare factors which affect relative rapidity of erosion by glaciers with those which affect erosion by streams.

GEOLOGY 143

Glacial Geology

Mid-semester examination April 22, 1955

Write on four questions only and please indicate which on cover of book.
Grading will not be finished until after the field trip tomorrow.

1. Photographs. Take a set and please return it (with no marks) as soon as possible for others to use.

   For each tell: a. what major subject of the picture is.
   b. criteria which enabled you to tell (be brief)
   c. origin (be brief, if controversial give rival theories)

2. State definitely a single criterion which alone would enable you to tell:

   a. weathered zone of stratified deposit from till due to overriding by ice.
   b. drumlin from knob of endmoraine.
   c. pitted outwash from eroded outwash.
   d. esker from beach ridge.
   e. roche moutonee from drumlin.

3. Explain clearly:

   a. why the origin of eskers is debatable.
   b., c., d. three possible positions of the place of original depositions.
   e. criterion showing that deposition was in same place as now found.

4. Describe five different causes of terraces of outwash.

5. With respect to endmoraines explain:

   a. what ice condition is requisite for development of till moraine.
   b. how you distinquish between moraines of minor readvance and moraines due to a balance in melting and movement.
   c. what effect the silt-clay content of the till has on form.
   d. how distinquished from pitted outwash (two criteria)

6. a. Describe major variations in form of drumlins.
   b. compare two rival theories of their origin.
   c. chance of discovering important gravel deposits in them (why).

GEOLOGY 143
Glacial Geology

Exam on Field Trips May 27, 1955

Write on four questions only and please show which they are on cover.

(1) Locate on the outline map furnished: (a) Forest Bed where visited, (b) Brooklyn Moraine, (c) clays of Late Algonquin, (d) Milton Moraine, (e) over-ridden outwash.

(2) A professional paper is entitled "The Delavan Glacial Lobe" but doubt has been thrown on the existance of such a lobe. Explain with sketch phenomena seen in the field which bear upon this problem. Tell where seen.

(3) Explain two facts which indicate that the Cary Drift is younger than the Monticello drift. Give probable age of latter. Tell where facts were seen.

(4) List in order 5 separate deposits found at or near the Two Creeks Forest Bed and from their evidence state the glacial history of the area with events in proper order. Use diagram.

(5) Explain two possible causes of the two directions of drumlin axes observed east of Fond du Lac. What is probable age of older set?

(6) Describe (a) facts, and (b) the interpretation of the phenomena which were observed at the Valders quarry. Use diagram.

GEOLOGY 143
Glacial Geology

Final examination June 8, 1955

Write on any 10 questions and please indicate on cover which they are. Kindly avoid office or telephone calls prior to Friday afternoon. Leave a postcard either here or in mailbox for grade.

(1) Explain why are there several different terrace levels where Turtle Creek crosses the Darien Moraine?

(2) Account with diagram for the beheaded valley just east of Delafield.

(3) Some geologists once thought that the red color of the Valders till is due to great age, i.e. to weathering. Comment on validity of this theory and give the present explanation of the color.

(4) Complete following sentences giving best proof of each statement:

(a) Some of the logs at the Forest Bed may be younger than stumps rooted in place because _____.
(b) The east-west striae at Valders demonstrate west-moving ice because _____.
(c) There is a difference of composition of till in the Marengo and Darien moraines because _____.
(d) Sandstone crags occur near Monticello because _____.
(e) Occurrence of drumlins on much fractured bed rock indicates _____.

(5) Explain surface indications including vegetation which indicate an important deposit of gravel. Where noted in field?

(6) How do you distinguish a crevasse filling from an esker? Compare conditions of origin and describe samples seen in field.

(7) What evidences show late-glacial earth movement in region of Great Lakes and state two possible causes for it.

(8) What evidences indicate a very low level of Lake Michigan and explain when this occurred. Evidences seen in field?

(9) The following is record of a well at north end of Lake Winnebago. Correlate the several deposits and tell where examples of each were seen in field. Why are they "dolomitic"? How known?

	Thickness, feet	Depth, feet
Clay, red, dolomitic	18	18
Till, red, dolomitic	11	29
Clay, gray, dolomitic	75	104
Galena dolomite	20	124

(10) Locate on enclosed outline map: (a) Shoreline of Later Lake Oshkosh (b) its outlet (c) Border of Valders drift (d) Kettle Interlobate (e) Whitewater cut.

(11) What evidences explain the origin of the basin of Lake Geneva?

(12) Explain with diagram the cause of the several terrace levels at Eagle.

(13) (a) What is basic idea of the method now used to obtain age in years of the Forest Bed, (b) compare with one other method.

(14) What is an "Ice contact terrace"? Where seen in field and how known? With what kind of terrace may it be confused? Field example?

SUGGESTIONS FOR PREPARATION OF FIELD REPORTS IN GEOLOGY
F. T. Thwaites, Nov., 1930, partial revision, 1931

Introduction. The poor quality of most field reports received from students in geology prompts the writer to offer a few simple suggestions based on many years experience. All students who intend to follow geology as a profession should also posess the following which can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. at small cost: Wood, G. M., "Suggestions to authors of papers submitted for publication by the United States Geological Survey---", Wood, G. M., "Extracts from the style book of the Government Printing Office", Ridgeway, J. L, "The preparation of illustrations---". The student must first realize that the preparation of scientific reportsis fundamentally different from writing for anewspaper or a book of fiction.

Title. The title of a report should be brief and not begun with "On" or "On the occurrence of". "Report on" or"Map of" are both useless. "Road materials in Dane County, Wisconsin" is a good title.

Outline. The first step in writing any report is to prepare an outline which lists in proper order the separate subjects which are to be discussed. No report should ever be written as a narrative since the exigencies of travel invariably make the order of examination of the phenomena in the field not that of logical description and clear explanation. Every report must be so written that anyone with a reasonable knowledge of geology will be able to follow the line of th ought without hesitation or confusion. Never presuppose a knowledge of the particular area or problem on the part of the reader. Write every report as though it were to be published

Headings. It must be realized at the start that the subjects which you will want to discuss vary in amount of space needed. We must, therefore, have subdivisons of the report which include several paragraphs under each. For instance the subject Bed Rocks will commonly require the discussion of several geologic formations. If the report is detailed each formation will be discussed in several paragraphs devoted to Definition, Description, Thickness, Fossils, etc. Thus it may be that several ranks of headings may be needed as for instance:

Primary heading	GEOLOGY	(written in center of page)
Secondary "	BED ROCKS	"
Tertiary "	Ordovician system	"
Quaternary "	Lower Magnesian formation(group in some reports)	"

Following this the headings of Definition, etc. will denote separate paragraphs. The major headings, primary, secondary, etc. are commonly differentiated by changing the kind of type or size of letters as above. Paragraph headings are commonly underlined. Do not fail to use headings especially for paragraphs; they seve to insure sticking to the subject in each paragraph. Do not neglect them because you have not seen them in books of fiction or in newspapers. Study the following typical outlines. You may want to change your outline after you have started the report but before finishing see that you have followed a consistent plan and a uniform style of typography and order of paragraphs under each general head. Paragraph headings are generally written at start of text as in this outline. Remember that the amount of detail in the report will govern to a large extent the number of paragraphs under each general or center heading. In a short report a single paragraph would do for each formation and in some brief summaries a paragraph might do for all the bed rock formations. Use judgement but always be consistent throughout the report.

THE CONVENTIONAL OUTLINE USED FOR GEOLOGIC FOLIOS AND OTHER DETAILED REPORTS

Introduction
Location and extent of area. Very brief with map.
Geography. A brief description or enumeration of the cities, industries,

routes of travel, etc. sufficient to give the reader a good idea of the setting of the geology, not a detailed account of the human geography.
Method of survey
Acknowledgements of aid
General geology. An exceedingly brief summary of the geology ONLY.
Topography
Relief features. A SHORT descriptive account of the major features. Details must be omitted so as not to bore the reader before he reaches the important part of your report, (especially important in reports on glacial geology)
Drainage. Observe same caution as above
Previous investigations. A brief list of works by others arranged in order of date of publication. Defer criticism to main body of report.
Geology. Begin with oldest formation. Give graphic section. See suggestions above for subordinate headings. Include if needed paragraphs on Origin, Topographic expression, etc.
Structure. Describe the folds, faults, etc. in terms of fact and add paragraphs on origin.
Geologic history. This section in many reports is a rather boresome repetition of much of the foregoing material. Avoid this by making it merely a brief summary of events from the origin of the oldest rocks to the present. This makes it largely an account of the physiography.
Economic geology. Do not forget undeveloped resources, especially non-metalic products, water, etc. and geologic factors which affect engineering work.

CAUTION: The above outline does not give the various headings either in full or in proper typography. Individual judgment must be used on these points to suit the needs of any particular report.

OUTLINE OF REPORT OF A BRIEF FIELD TRIP IN GEOLOGY OR PHYSIOGRAPHY

Introduction
Purpose of trip. Course, instructor, etc.
Route of trip. Include key map.
Geography. Not more than a short paragraph on cities, etc, unless covered under previous head. Just enough to make it clear where the trip went.
Topography. Not more than a short paragraph on the important topographic features seen, example: Western Upland, Niagara Cuesta, etc.
Geology. Begin with oldest formation. Under each tell :
Definition.
Exposures visited.
Interpretation.
Divide bed rock from drift or surface formations. If report is on physiography section on geology must be brief and discuss mainly those features which affect the present topography.
Geologic history (or History of development of topography).
Economic geology (or human geography). If latter be very brief.

Here again the purpose of the report must be a guide to the amount of space devoted to each subject. For instance a visit to a mining district would need a report most of which is devoted to economic geology but a trip in physiography is not concerned with mineral deposits unless their presence is reflected in the present topography.

OUTLINE FOR REPORT ON GLACIAL GEOLOGY

Introduction
Purpose of trip or trips
Route travelled (map)
Geography. Very brief or include in description of route.
Topography. A very brief statement of physiographic regions visited.

Previous investigations. List of works only, no discussion
Geology. Subdivide according to glacial stages beginning with oldest Under each give paragraphs to :
Definition (statement of problem including very brief statement as to distribution of the drift of that age.)
Observations (what you saw yourself in the field and where)
Interpretation (here discuss various theories of origin or topographic features, different kinds of material, and age of the glaciation in question. Tell here what previous writers thought and WHY; what conclusion was reached by the party and WHY. Never cite anyones opinion as evidence but state reasons for conclusions preferably listing them in order (a), (b), etc.
Glacial history. A brief connected summary of events which does not need to repeat discussion of different interpretations but is based on interpretations made by the party.
Economic geology

OUTLINE OF A REPORT DEALING WITH A SINGLE PROBLEM

Introduction (brief statement of the problem and methods used for its solution)
Previous investigations (list of writings in order of publication, no discussion)
Observations or Data (full statement of the results of your investigation with appropriate subdivisions.)
Interpretation. (full discussion of various possible explantions, their merits and demerits, the explanations of others and reasons for evaluation of these in light of new information. It must be made clear just how and why your conclusion was reached.)
Conclusion. (brief summary of the foregoing section.)

Summary. The application of the above suggestions to particular cases requires thought. You must be sure that you understand the major subjects which are to be taken up on any trip. Then you must fit these into a consitent outline. Next arrange them in order of importance. This will serve to put your primary, secondary, and other main headings into proper relation. Write out a tentative outline FIRST. Then think it over and make changes. Then start writing. If in doubt as to final order start a new page with each major change in subject. Then you can rearrange or add more material at proper place without breaking into pages. Above all DO NOT FAIL TO USE HEADINGS in your report both for sections and for paragraphs. A report without headings is not satisfactory for it is hard to read and understand.

OUTLINE FOR REPORT ON PHYSIOGRAPHY OF A LARGE AREA OR PROVINCE

Defintion of area or province
Boundaries of area or province (brief)
Subdivisions (brief summary only with key map)
Geology (only enough to show what affects the present topography with little stress on age of formations except as needed to describe them.
Topography. (description in terms of fact without history or origin)
History of topography. (here discuss origin of features including controverted subjects. Do not discuss origin of bed rocks, etc. any more than is needed to explain the present topography. Discuss subdivisons of area or province in detail.)
Human geography. (stress only those activities of man which are directly affected by the present topography or controlled by major secondary effects of topography such as climate in many regions.)

References. Avoid extensive quotations from the work of others. Quotations must be confined to those which make the discussion clearer and all must be indicated both by quotation marks and, if long, by single spacing. It will also be necessary to refer to published works without quoting verbatim. Notes must be placed immediately after the mention of the name of the author in the text. Notes should be numbered consecutively throughout the report not on each page only. Citation is made either by a number raised above the line or by, what is easier to type, a number placed thus (2). Always use same style throughout a report. Place the notes either (a) as footnotes or (b) in a bibliography at the end of the report. If you elect to use the former, it is better to follow the system of printers copy and place the note immediately below the citation in the text with lines above and below. Do not break lines to do this. Example: " Similar pitted outwash plains have been described by Thwaites (24) in Vilas County, Wisconsin. In the area under discussion--"

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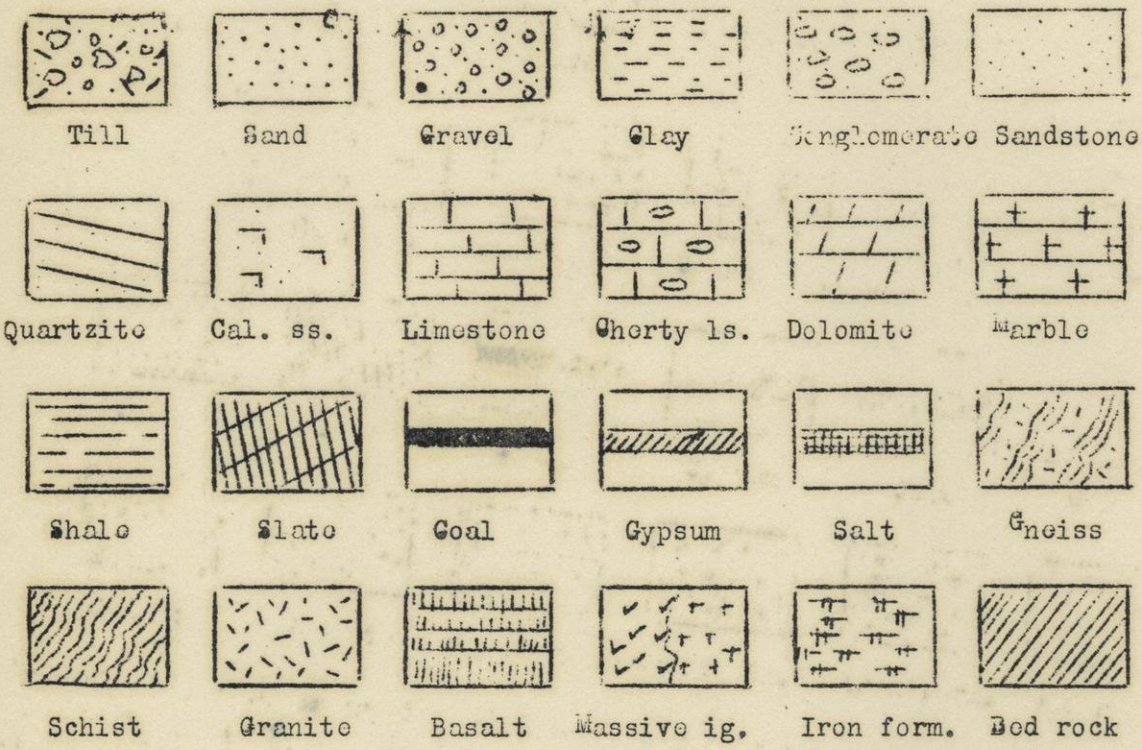
(24) Thwaites, F. T., Glacial geology of part of Vilas County, Wisconsin: Wisconsin Acad. Sci., Trans., vol. 24, pp. 109-125, 1929

Remember that in notes you must give enough information to enable someone else to find the article in the library easily. You must give (a) the name of the author with initials unless no middle name or a woman in which case spell out the first name, [illegible], (b) title of the paper of which part may be ommited for brevity using dashes, (c) the name of the publication normally abbreviated by some consistent system, (d) the number of the volume, (e) the inclusive pages, and (f) the date of publication. The exact punctuation, system of abbreviation, and order of arrangement of the above information is optional but must be uniform throughout the report. If matter is a thesis the typist will put the notes at the bottom of each page and the printer will do the same if published. The above method saves much time both for writer and reader of unpublished reports. Use Arabic numerals for everything discarding original kind.

Illustrations. Illustrations save much writing and present a clearer picture to the reader than any amount of text alone provided that (a) they are clear and (b) they are an integral portion of the discussion. Illustrations isolated from the text mean nothing and are a serious detriment to the report. In general diagrams which are well drawn are far better than photographs. A diagram can be made to show nothing but the essentials and a photograph shows everything much of which has nothing to do with the question under discussion. Most published reports are lacking in diagrams to explain interpretations. Photographs have a definite value and are usefull but each should have indicated on it the important things. In some cases certain lines can be brought out by use of ink. With glossy prints this is hard to do and if the subject is complicated it is better to make a key sketch adjacent to the picture. Suggestions on field photography are contained in the Outline for Geology 11. Number all illustrations as "figures" and use a consecutive series of Arabic numerals throughout the report. In text references give page number as well as figure number if the picture or diagram is not placed immediately next to the place of reference in the text. In general do not place all illustrations at the end of a report but as near as possible to the principal text reference. If matter is for publication, give title and number of figure in same way as a footnote and the printer will fit in the illustration as near to this place as possible. Maps should be colored with hard colored crayon (not wax crayon) rubbed in with high-test gasoline on a rag of cloth. Avoid copying published maps as far as possible. Make maps which bring out special features needed for your report or which are combinations or improvements of published maps. Letter carefully using guide lines. Do not submit maps for publication unless made by a skillful draftsman. For reports type all the names you can especially the title and legend. Never dot a capital I. Do not mix CAPITALS and lower

case letters. Consult published maps and diagrams for suggestions but avoid any attempt · ornate or fancy lettering. If you have to place illustrations in a report someone else types for you indicate clearly just how much space to leave. Even if a full page is devoted to a map have it numbered with the text thus avoiding "Plates". Plates are now largely out of style; they were forced by having to have a different kind of paper than the text.

Symbols for geologic cross sections



Draw all lines which are intended to be straight however short with triangle and ruling pen. Do not drag pen on paper in making dots. Buy a booklet on freehand lettering and always make letters just the same way.

Suggestions on expression. Reports on geology are read for information and not for recreation. Every effort should, therefore, be made to be clear and explicit. If you do not understand a subject do not write anything until you do, for you cannot make anyone else understand what you write until you can understand it yourself. Do not write anything unless it gives a definite idea or concrete fact. Do not try to combine different ideas into a single sentence unless it will obviously help the reader, Make sentences short and definite. Every sentence must contain a verb. Do not worry if the result is jerky, for that is far better than obscurity of meaning. Do not be afraid to rewrite. Always make a rough draft as soon as possible after the work has been done in the field. Allow time enough for this to "cool" before making the final copy. You should by all means make the final copy yourself, for then you will have a chance to correct mistakes in expression (possibly in arrangement also) which if uncorrected might easily mislead someone else as to what you wanted to say. Material for publication should always have several revisions each separated by as long a time as possible.

Typing. Everyone who enters geology as a profession should own a typewriter. Second hand machines are cheap and are good enough for most work. For composition it is not necessary to learn the "touch method" but it saves the eyes so much in most work that it is most desirable. It is not necessarily the

fastest method. To learn it no elaborate exercises are needed. Simply learn the proper fingers to use and practice, looking at the keyboard. After a few weeks practice it will no longer be necessary to look. Portable machines are handiest but have the objection that they are easy to steal.

Common faults. One of the most common faults in writing is misuse of tenses in description. Say: "The Madison sandstone is exposed in sec. 35" rather than "was exposed" if there is no definite reason to think that it has been concealed since your visit. In some cases you may have to say: "In June, 1925 gravel was exposed in the east face of the pit," since you can reasonably suppose that the exposure has since either been dug away or grassed over. Do not say "I" or "we" but "the writer." "We see" or "we have found" can usually be omitted entirely. The same remark applies to "therein", "it is," and so forth. Examples follow in which words not needed are underlined and those substituted are shown in parentheses. "There has been some faulting (occurred) since the deposition of the ore." Avoid all indirect statements but seek the simplest and most direct form. Spare the reader by making every statement in as few and as simple words as is possible. Arrange each sentence correctly so as to mean just what you intend to say. Note the absurdity of the real meaning of the following horrible examples given by Wood. "On Sept. 21 Mr. Martin stated that the trees waved when there was no wind." "There is a band of limestone carrying bunches of garnet-pyrite rock from place to place." Note how a slight rearrangement of the same words would have conveyed the intended meaning. Avoid undesirable repetition of the same word or same phrase too closely together but in seeking variety do not make use of unusual synonyms. Do not use "case" or "instance" to mean "place". Do not add "character" or "conditions" where it is not needed as in "drainage conditions" where "drainage" is enough. Do not use "while" to mean "and," "since", "although", "whereas", notwithstanding", "nevertheless", or "yet." This is awkward in most places. "With" should not be used to mean "and". In giving ranges state only one lower and one upper limit, as "the thickness varies from 30 to 40 feet" instead of "the thickness varies from 30 to 35 and 40 feet." Avoid saying "from 0 to 10 feet" but say "the observed maximum thickness is 10 feet. In portions of the district the formation is absent." In most instances say "east" etc. instead of "easterly" and so on. Above all do not confuse time and place. Instead of saying "The terraces are frequently covered with gravel" put it "Many of the terraces are covered with gravel." Do not say "The Byron dolomite is often red" when you mean that " Locally (or a portion of) the Byron dolomite is red." Do not say "usually" when you mean "locally", or " in most places."

Compound words. The Style Book contains long lists of compound words and should be consulted before any manuscript is ready for publication. Note the following: "base-level", "3-inch pipe", "greenish-gray." Omit hyphen if first word is qualified as "light greenish gray." Hyphenate "well-definend"", etc. but not chemical terms. Hyphenate "brick-red" etc. If a color term does not itself denote color hyphenate with "colored" as "chocolate-colored." Do not hyphenate after "pre" and "post" unless followed by a capital, thus "postglacial" but "pre-Cambrian."

Chemical terms. Avoid chemical formulae as far as possible. Avoid the common error of "lime" for calcium, for lime means a definite commercial product not the metal. The same applies to " potash" for potassium, "soda" for sodium, etc.

Capitalization. For full details see the Style Book. Capitalize all geographic terms such as River, Lake, etc when used in connection with place names. Also capitalize the names of physiographic provinces, Badlands,

Driftless Area (of upper Mississippi Valley), High Plains, etc. If "the" is part of a geographic name capitalize it as "The Dells" (of Wisconsin River), "The Dalles" (of other rivers). Capitalize the prepositional prefixes of foreign names as "DeGeer," when name is used alone but lower case them if name is preceded by forename or some title as "Baron de Geer." Lower case "section" or "sec." (public land divisions) but capitalize Township and Range. Use Town for the civil unit and Township for the 6 mile square unit. Lower case "preglacial" etc. In references capitalize proper names only in titles.

Abbreviations. Standard abbreviations for names of publications are given in "Suggestions to authors" and in "Bibliography of North American Geology." In giving land descriptions say "in the NW¼SE¼ sec. 25, T. 7 N., R. 9 E." Omit RR. or Ry. on maps and spell out in text. Use symbol for "and" only in names of corporations. Use "etc." instead of "&c." Although common usage calls for symbols for degrees and minutes in final copy the writer prefers that they be omitted in manuscripts and does not permit their use in field notes on account of the grave danger of error. Write out "percent" and do not use the symbol for "number" for "No." is preferable. Write "feet" and "inches" instead of using symbols; feet and tenths are preferable although not orthodox. Write "sea level" instead of "above tide" or "A. T." as persons not familiar with the sea will misunderstand the meaning.

Figures. Except in statistical tables spell out figures less than 10. Do not mix common and decimal fractions; the latter are preferable whenever possible. Always be consistent. Always place a 0 before a decimal point and a 0 before less than 10 minutes (anglular measurment).

Punctuation. Use a comma before "and" in a phrase like "clay, sand, and gravel." Avoid as too complex sentences which require a semicolon.

Personal titles. Omit all personal titles such as "Dr." in mentioning anyone except when thanking them for assistance in section on acknowledgements. Correct titles of members of the University staff may be obtained in the University Directory and the University Catalog.

Forms for sections. Use following style for geologic sections or at least be consistent throughout a report. Note position of nouns.

Section in Rock Cut, sec. 35, T. 7 N., R. 9 E.

	Feet	Inches
Sandstone, fine grained, light yellowish gray, dolomitic, layers 3 inches to 12 inches, fossiliferous, soft.....	10	6

Record of Turvill Estate Co. well, sec. 25, T. 7 N., R. 9 E.

	Thickness Feet	Depth Feet
Drift		
Till, sandy, yellowish gray, dolomitic	40	40
Clay, blue-gray, dolomitic.....	65	105

Summary. Above all be brief and spare the reader. Be definite and concise. Avoid long words and involved sentences. Avoid any effort to be amusing or entertaining. If you do not know how to do something look it up in a book which is well edited. Be consistent in usage. Remember that a short report which is to the point is far better than a long one which is involved or indefinite. Do not worry over "split infinitives" or other purely technical errors

SUGGESTIONS FOR PREPARATION OF FIELD REPORTS IN GEOLOGY

F. T. Thwaites, 1936

Introduction. The poor quality of most field reports received from students in geology prompts the writer to offer a few simple suggestions. All students who intend to follow geology as a profession should also possess the following which can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. at small cost: Wood, G. M., "Suggestions to authors of papers submitted for publication by the United States Geological Survey----", Wood, G. M., "Extracts from the style book of the Government Printing Office", Ridgeway, J. L., "The preparation of illustrations----".

Title. The title of a report should be brief and not begun with "On" or "On the occurrence of". "Report on" or "Map of" are both useless.

Outline. The first step in writing any report is to prepare an outline which lists in proper order the separate subjects which are to be discussed. No report should ever be written as a narrative since the exigencies of travel invariably make the order of examination of the phenomona in the field not that of logical description and clear explanation. Every report must be so written that anyone with a reasonable knowledge of geology will be able to follow the line of thought without hesitation or confusion. Never presuppose a knowledge of the particular area or problem on the part of the reader.

Headings. It is essential to subdivide a report into sections each of which is concerned with a single subject. The nature of the subject is indicated by a heading. Some subjects require several paragraphs each of which is devoted to a separate phase of the discussion. Sometimes there will be several different kinds of headings in a single report depending upon the nature of the subject considered. Headings are commonly differentiated by changing the kind of type or size of letters. Paragraph headings are commonly underlined. Do not fail to use headings even for paragraphs; they serve to insure sticking to the subject in each paragraph. Remember that the amount of detail in the report will govern to a large extent the number of paragraphs under each general or center heading. In a short report a single paragraph would do for each formation and in some brief summaries a paragraph might do for all the bed rock formations.

CONVENTIONAL OUTLINE USED FOR GEOLOGIC FOLIOS AND OTHER DETAILED REPORTS

Introduction

Location and extent of area. (Very brief with map.)

Geography. (A brief description or enumeration of the cities, industries, routes of travel, etc. sufficient to give the reader a good idea of the setting of the geology, not a detailed account of the human geography. (Generally unnecessary).

Method of survey. (Generally unnecessary).

Acknowledgements of aid to the author. (Not needed in most reports).

Topography

Relief features. A SHORT descriptive account of the major features. Details must be omitted so as not to bore the reader before he reaches the important part of your report, (especially important in reports on glacial geology.

Drainage. Observe same caution as above.

Previous investigations. A brief list of works by others arranged in order of date of publication. Defer criticism to main body of report. (Can better be removed to bibliography at end of report.)

Geology. Begin with oldest formation. Give graphic section. If needed include paragraphs on Origin, Topographic expressions, etc.

Structure. Describe the folds, faults, etc. in terms of fact with separate paragraphs on origin.

Geologic history. This section in many reports is a rather boresome repetition of much of the foregoing material. Avoid this by making it merely a brief summary of events from the origin of the oldest rocks to the present.

Economic geology.

OUTLINE OF A REPORT DEALING WITH A SINGLE PROBLEM

Introduction (brief statement of the problem and methods used for its solution)

Previous investigations (list of writings in order of publication, no discussion)

Observations or Data (full statement of the results of your investigation with appropriate subdivisions.)

Interpretation. (full discussion of various possible explanations, their merits and demerits, the explanations of others and reasons for evaluation of these in light of new information. It must be made clear just how and why your conclusion was reached.)

Conclusion. (brief summary of the foregoing section.)

Summary. The application of the above suggestions to particular cases requires thought. You must be sure that you understand the major subjects which are taken up on any trip. Then you must fit these into a consistent outline. Next arrange them in order of importance. This will serve to put your primary, secondary, and other main headings into proper relation. Write out a tentative outline FIRST. Then think it over and make changes. Then start writing. If in doubt as to final order start a new page with each major change in subject. Then you can rearrange or add more material at proper place without breaking into pages. Above all DO NOT FAIL TO USE HEADINGS.

References. Avoid extensive quotations from the work of others but confine yourself to those which make the discussion notably clearer. It will also be necessary to refer to published works without quoting verbatim. Notes must be placed immediately after the mention of the name of the author in the text. Notes should be numbered consecutively throughout the report not on each page only. Always use the same style of citation throughout a report. Place the notes either (a) as footnotes or (b) (better) in a bibliography at the end of the report. You must give (a) the name of the author with initials unless no middle name or a woman, in which cases spell out the first name, (b) title of the paper of which part may be omitted for brevity using dashes, (c) the name of the publication normally abbreviated by some consistent system, (d) the number of the volume, (e) the inclusive pages, and (f) the date of publication. The exact punctuation, system of abbreviations, and order of arrangement of the above information is optional but must be uniform throughout the report.

Illustrations. Illustrations save much writing and present a clearer picture to the reader than any amount of text alone provided that (a) they are clear and (b) they are an integral portion of the discussion. Illustrations isolated from the text mean nothing and are a serious detriment to the report. In general diagrams which are well drawn are better than photographs. A diagram can be made to show nothing but the essentials whereas a photograph shows everything much of which has nothing to do with the question

under discussion. Photographs have a definite value and are useful, but each should have indicated on it the important things. In some cases certain lines can be brought out by use of ink. Number all "figures" with a consecutive series of Arabic numeral throughout the report. In your text references give page number as well as figure number if the picture or diagram is not placed immediately next to the place of reference in the text. Do not place all illustrations at the end of a report, but as near as possible to the principal text reference. Maps should be colored with hard colored crayon (not wax crayon) rubbed in either with highest gasoline on a rag or on a blotting paper. Avoid copying published maps as far as possible. Make maps which bring out special features needed for your report or which are combinations of or improvements on published maps. Letter carefully using guide lines. Draw all lines which are intended to be straight, however short, with triangle and ruling pen. Do not drag pen on paper in making dots. Buy a booklet on free-hand lettering and always make letters just the same way. Do not mix CAPITALS and lower case letters.

Suggestions on expression. Reports on geology are read for information and not for recreation. Every effort should, therefore, be made to be clear and explicit. If you do not understand a subject, do not write anything until you do, for you cannot make anyone else understand what you write until you understand it yourself. Do not write anything unless it gives a definite idea or concrete fact. Do not try to combine different ideas into a single sentence unless it will obviously help the reader. Make sentences short and definite. Every sentence must contain a verb. Do not worry if the result is jerky, for that is far better than obscurity of meaning. Do not be afraid to rewrite. Always make a rough draft as soon as possible after the work has been done in the field. Allow time enough for this to "cool" before making the final copy. You should by all means make the final copy yourself, for then you will have a chance to correct mistakes in expression (possibly in arrangement also), which if uncorrected might easily mislead someone else as to what you wanted to say.

Common faults. One of the most common faults in writing is misuse of tenses in description. Say: "The Madison sandstone is exposed in sec. 35" rather than "was exposed" if there is no definite reason to think that it has been concealed since your visit. In some cases you may have to say: "In June, 1925 gravel was exposed in the east face of the pit, since you can reasonably suppose that the exposure has since either been dug away or grassed over. Do not say "I" or "we" but "the writer." "We see" or "we have found" can usually be omitted entirely. The same remark applies to "there is", "it is," and so forth. Do not worry over purely technical errors, but pay attention to those phrases which might be misunderstood. In giving the range of thickness, state only one maximum figure. Do not mix time with place. Do not say "often" when you mean "in most places".

Summary. Be brief and spare the reader. Be definite and concise. Avoid long words and involved sentences. Avoid any effort to be amusing or entertaining. If you do not know how to do something, look it up in a book which is well edited. Be consistent in usage. A short report which is to the point is far better than a long one which is involved or indefinite.

GEOLOGY 143
GLACIAL GEOLOGY
100 Review Questions, revised, 1937

1. Where and what evidences have you seen in the field which bear on the origin of drumlins?
2. How is the Darien Moraine separated from the Marengo Moraine and how are their relative ages determined?
3. Outline the proofs that the Illinoian drift of northern Illinois and southern Wisconsin is really much older than the adjacent Wisconsin drift and state where examples of each kind of evidence were seen in the field.
4. Explain the origin and significance of the postglacial rock gorges of the Old Drift region.
5. Discuss the nature and origin of gumbotil and state why not seen in Wisconsin.
6. Outline the evidences which demonstrate the subdivision of the Wisconsin stage of glaciation into several substages and tell where examples of evidence were seen in the field.
7. Discuss origin of moulin kames stating where seen in field.
8. Define (a) interglacial interval, (b) glacial stage, (c) cirque, (d) neve, (e) postglacial.
9. Discuss the origin of the basin of Lake Geneva.
10. Discuss the significance of the outline of the Niagara escarpment of eastern Wisconsin on the question of glacial erosion.
11. Discuss the progressive change in the relative sizes of the Green Bay and Lake Michigan or Illinois Lobes.
12. Discuss the origin, material, and topography of the Interlobate or Kettle Moraine of eastern Wisconsin and tell where studied in the field.
13. Discuss the origin and nature of the glacial drainage channels which cut the Interlobate Moraine in eastern Wisconsin and give examples seen in field.
14. Discuss the origin and distribution of the glacial outwash terraces of the Eagle region in eastern Wisconsin.
15. Give the succession of deposits at the Two Rivers Forest Bed and discuss the history of events which they demonstrate.
16. Outline the steps in the glacial history of northeastern Wisconsin stating very briefly where evidence demonstrating them was seen in the field.
17. Discuss the gravel deposit on Fisher Creek, Manitowoc Co.
18. Outline the history of the lateglacial lakes in the Michigan basin and state where examples of each were seen in the field.
19. Outline the history of the lateglacial lakes of the Fox-Wolf-Winnebago Valley and state where examples demonstrating this history were seen in the field.
20. Account for the color of the Fourth Wisconsin Drift in northeastern Wis.
21. Discuss the methods of correlation of varved clay deposits citing examples of varved clays seen in the field.
22. Discuss with diagrams the errors in estimating a gravel deposit from too shallow test pitting.
23. How do you distinguish between a delta and cross-bedded outwash citing examples seen in the field.
24. How do you differentiate between beach gravel and outwash gravel giving examples seen in the field.
25. Account for the fact that east of Janesville the Illinoian drift is little eroded and near Monroe the topography of the same drift is just like that of the Driftless Area.
26. Discuss the causes of the formation of the Driftless Area.
27. Discuss the causes of the formation of the Green Bay and Lake Michigan Lobes.
28. What is the result on drumlins of a change in direction of ice movement and give examples seen in the field.

29. What is the significance of the exposures of drift and striae at Valders, Wis.?
30. Describe the succession of material formed by the weathering of till under (a) poorly drained, (b) fairly well drained, and (c) well drained conditions
31. Give the commonly recognized glacial succession in the Mississippi Valley and mention which drifts you have seen in the field and where
32. Account for the fact that pits at Janesville find very sandy gravel and those at Beloit, farther downstream, are in stony gravel
33. You are running a traverse through dense timber and brush and note irregular topography, kettle holes, some flat summits, sand and gravel shown by uprooted trees, boulders in low ground and kettles. Interpretation? Where seen in field?
34. You are running a traverse through dense brush and timber and note irregular topography, no flat summits, coarse gravel, sand, and till shown by overturned trees, boulders everywhere! Interpretation? Where seen in field?
35. You are running a traverse through dense brush and timber and note level topography, fine sandy soil as shown by uprooted trees and nature of vegetation, no stones or boulders, area lower than adjacent tracts. Interpretation? Where seen in field?
36. You are running a traverse through dense brush and note level topography except for a few ravines, sand and gravel shown by uprooted trees and in banks, few boulders. Interpretation? Seen in field?
37. Discuss the conditions requsite for the formation of varves (not their correlation). Where seen in field?
38. Discuss the Delavan Lobe in the light of present knowledge
39. Discuss the time relations of the retreat of the Lake Michigan and Green Bay Lobes giving evidences seen in the field
40. Discuss the Iowan drift giving its location, history of nomenclature, material, topography, and correlation with respect to other drifts
41. Discuss the Toronto giving subdivisions, nature of evidence, interpretation
42. Discuss the use of loess deposits as time markers in Pleistocene geology
43. Give two theories of the mode of deposition of loess with evidences bearing on this question including facts seen in the field
44. Discuss and compare two theories of the source of the material of the loess deposits of the Mississippi-Missouri Valley
45. What features in a terminal moraine guide you in looking for stony gravel in the associated outwash plain? Examples seen in field?
46. What features of kames and eskers tell of the kind of material without having to see any exposures?
47. Discuss any of the recognized interglacial or interstage intervals giving the history of nomenclature, materials and other evidences, interpretation, correlation, examples seen in field
48. Discuss any of the several commonly recognized glacial stages on same basis as above question
49. Name the several centers of continental glaciation and what drifts came from each
50. Discuss two principal theories of the origin of drumlins
51. Distinguish between (do not discuss origin in detail): (a) varved clay and laminated clay, (b) kame and esker, (c) kame and pitted outwash, (d) drumlin and roche moutonnee, (e) fresh water glacial lake clay and marine glacial clay
52. Outline points of difference between lake terraces and outwash terraces
53. What glacial and glacio-aqueous deposits require moving ice for their formation?
54. What glacial and glacio-aqueous deposits require or might equally well be formed by stagnant ice?
55. Discuss two different theories of the origin of eskers and locate eskers seen in field citing any observations which may bear on this question
56. Discuss the origin of the basins of the Great Lakes
57. Discuss the origin of the basins of the Finger Lakes of New York .

58. Compare glacial and stream erosion of a valley by a mountain glacier as to efficiency and results; compare normal stream and continental glacial erosion in same way
59. Discuss the origin of cirques
60. Discuss different methods of the formation of hanging valleys
61. Discuss the formation of fiords
62. What is the cause and mechanism of the motion of ice in glaciers?
63. What evidences proove very long duration of the Pleistocene?
64. How have attempts been made to measure postglacial time in years?
65. Discuss Crolls hypothesis of the cause of glaciation
66. Discuss the CO_2 hypothesis of the cause of glaciation
67. State the primary requisites of any theory to explain glaciation
68. Discuss evidences of lateglacial and postglacial earth movements in the eastern U. S. Do not discuss cause of movement
69. Remains of temperate climate animals and plants are discovered in a bed of gravel between two tills. Discuss (a) criteria by which the origin of the gravel might be determined independently of the remains, and (b) significance which might be attached to the remains
70. How may postglacial erosion be used as a time measure of the age of drift? Postglacial weathering?
71. Under what conditions may glacial tills of different ages have distinct lithological characters? Examples seen in the field?
72. State the best single diagnostic feature which will tell the difference between (do not discuss origin): (a) beach gravel and outwash gravel, (b) lake bar and esker, (c) esker and ridge between two kettles of pitted outwash, (d) delta and outwash, (e) outwash and sandy lake bed
73. Name five different important causes of the formation of outwash terraces and give examples seen in the field
74. State in a single sentence the most important single conclusion drawn from (do not discuss origin in detail): (a) presence of scattered glacial boulders in interlaminated clay and silt, (b) plain of sand and gravel having kettle holes in it and located next to a ridge composed of knobs of till, (c) greater depth of water inside of a fiord than just outside its mouth, (d) very abundant granite boulders in drift of a given region, (e) till overlying with irregular contact horizontally stratified sand and gravel
75. Give one outstanding difference which enable you to distinguish between: (a) continental and mountain glacial till, (b) striae and artificial scratches, (c) till and weathered gravel, (d) fiord and drowned valley, (e) striae and slickensides
76. Explain and contrast the methods of nourishment of mountain and of continental glaciers
77. Explain fully two distinct and positive methods by which you can tell the direction along striae that the ice moved
78. Account for the observed fact that most glacial material was derived from a comparatively short distance from where it is now found
79. It was argued at one time that since very old drifts are deeply oxidized the Red Drift of northeastern Wisconsin is very old. Discuss this hypothesis citing evidences seen in the field
80. On an outline map of eastern Wisconsin mark the area occupied by ice at (a) maximum of Illinoian, (b) maximum of Early Wisconsin, (c) maximum of Late Wisconsin, (d) glacial lakes at each time and their names
81. On an outline map show (a) routes followed on field trips, (b) regions where you saw drumlins, (c) location of the interlobate moraine of eastern Wisconsin, (d) regions of large areas of pitted outwash seen on trips, (e) shoreline and outlet of Later Glacial Lake Oshkosh
82. Tell where or locate on outline map where you saw in field (a) kames, (b) eskers, (c) outwash terraces, (d) varved clays, (e) gumbotil

83. (a) In what kinds of glacio-fluvial deposits would you search for stony gravel? (b) Discuss the origin and nature of one of these, (c) In which would you expect to find the largest deposits of well-sorted gravel and why?
84. Define in (a) terms of fact or observation and (b) in terms of interpretation or origin (do not discuss origin in detail) using two parallel columns: (a) varve, (b) till, (c) esker, (d) gravel, (e) kame, (f) hanging valley, (g) hingeline, (h) loess, (i) drumlin, (j) isobase
85. Discuss the statement once used as evidence of equivalent age: "The extreme weathering and the advanced erosion of the drift at Marshfield (in the granite region of northern Wisconsin) is at least equal to that of the oldest drift sheet in Iowa and Kansas" (where the bed rock is Coal Measures).
86. Account for the difference in compsition of the Darien and Marengo Moraines
87. Account for the origin of Lake Winnebago
88. What decisive evidences tend to show that the ice caps of Canada disappeared entirely at least once during the Pleistocene?
89. Logs of wood are found in digging a well through the glacial drift. State what investigations must be made in order to determine their significance
90. Discuss the evidences of interglacial man in North America
91. Account for the quite general presence of a silt covering on outwash plains and give locations where this was seen in the field
92. It is desired to find a water-bearing gravel bed of considerable horizontal extent at or near Manitowoc. Reasoning from observations on the glacial history of this region discuss fully the chances of finding such
93. A well is being drilled through the drift and several feet of coarse gravel is found with till above and below. Bailing exhausts the water in a few minutes. Interpretation?
94. A well was drilled through the drift and found several feet of coarse gravel with till above and below. A short test gave considerable water but when a permanent pumping plant was put in operation the capacity soon fell off to a very slight production. Explanation? (Assuming no failure in well itself)
95. In what type or types of glacial or glacio-fluvial deposits do most relatively small lakes occur?
96. Discuss the significance of the Brooklyn moraine and all other similar features you have seen in the field
97. State in a single sentence a single line of evidence which definitely proves: (a) former presence of a glacial lake in a given area, (b) a topographic evidence which shows the course of former valleys in a region now covered by pitted outwash, (c) whether a moraine is the terminal moraine of a glacial stage or a readvance after some time or a recessional moraine outside of which the ice lay not long before its formation, (d) that a given lake basin was due to glacial erosion, (e) that [illegible] an area was covered by the continental ice sheet
98. Discuss fully the cause and effects of lateglacial earth movement in the Great Lakes region
99. Outline briefly the history and drainage changes of the glacial Great Lakes
100. Account for the difference in topography of the Darien and Johnstown Moraines and the moraines of central Illinois

GEOLOGY 143
GLACIAL GEOLOGY

Field trip routes, 1952

Car drivers please observe all speed limit and traffic signs carefully. No attempt will be made to keep cars in contact(convoy)on main highways. Top speed in convoy will be 50. Always maintain a safe distance to next car.

Walworth trip. Assemble near Science Hall and leave at 7:30 sharp. Langdon to Wisconsin Ave.; right to Gorham, left onto Gorham; pick up 30 and follow to a town road turning south (R) about 2 m. E. of intersection with D in Jefferson Co. about 7 m. E. of the grade crossing near Johnson Creek. Form convoy. After you reach 30 again keep on east on old route. Watch for Cushing Memorial State Park close to Delafield. Reform convoy in parking ground. At gravel pit stop turn back north and return to Delafield on 30. Turn left (S) and go to lookout tower. After reaching 18 turn left, then right in about a mile onto 83 going S. Reform convoy if broken. Keep closed up after this for several sharp turns. Lunch stop at picnic ground in Kettle Morain State Forest, about 4 m. N. of Eagle on a side road to east. After lunch return to Eagle and there turn right (W) onto 59. In Palmyra leave 59 by keeping straight ahead. CAUTION for crossing of 12 at LaGrange; leader will wait until all are across. Contact may be lost when we reach 14. Watch for a left turn (E) off 14 onto town road about 4 m. beyond Darien at Tennies Spaghetti shop. Reform convoy here and keep together to the last stop near Big Foot Prairie. Trip ends here. 14 is advised for return.

Total about 220 miles.

Two Rivers trip. Get passengers assigned and then assemble near Science Hall. Leave at 5:00 sharp. Langdon to Wisconsin; Wisconsin to Gorham; Gorham to 151. Get breakfast in Fond du Lac. Then take 23 east to foot of steep hill and form convoy in Y in front of St. Marys Springs Academy. Continue east on 23 to first 4 corners. Turn left (N). Leader will wait for all to make contact. We rejoin 151 at a school house about 2 m. N. of Peebles. Continue north and thence E. on 151 to Valders. At far side of village turn left (N) on 148 reforming the convoy. After quarry stop return to 151 and continue to 119. Left (N) on 119, pick up 10 (E), then Wis. 42 to Two Rivers. Stay on 42 and go north to County line which is about 12 miles north of the bridge in the city.

Park there for Forest Bed stop. On return reverse above and go south on 42 to a sign near where highway bends to left. There turn left (E) to shore road to Point Beach State Forest. Lunch stop will be at shelter house near refreshment stand. After lunch form convoy and take shore road to Two Rivers, join 42 and keep ahead to Manitowoc noting that highway turns right (W) away from the lake (here a divided highway). Keep straight ahead on this superhighway across bridge over railroad and then turn left (S) onto 119. Follow 119 thru Manitowoc Rapids to junction with 151. Here turn left (E)and follow 151 about a mile. Turn right (S) on 141. Go on south. Watch for a stop at Fisher Creek 3 m. south of the second sharp left turn in highway. Follow leader on side road to right (W) Turn left (S) on 42. Pick up at Howards Grove. Follow W. to Elkheart Lake and thence thru Greenbush (with short jog to left on 23). On reaching 67 keep right (W) and close up convoy. Follow leader to Dundee. Thence take 67 to Lomira, 41 to Theresa, 28 to Horicon, 33 to Beaver Dam and 151 to Madison. Total about 340 miles.

Monticello trip. Assemble as assigned at 2:20, leave 2:25 sharp. South on Park St. to foot of hill about 7/10 mile beyond underpass. Turn right and form convoy. From Monticello take 69 to Madison (optional shortcut on PB from Paoli). Total about 85 miles.

McFarland trip. Assemble and leave as for previous trip. Pick up city 12 and follow to junction with 51 going S. (right). Follow 51 to road leading to McFarland, left (E). Then follow leader.

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GLACIAL GEOLOGY

Field trip references - if not called on in class, please hand in written summary, (not over one page).

1. Forest Bed - Wilson, L. R., The Two Creeks forest bed, Manitowoc County, Wisconsin. Wisconsin Acad. Sci., Trans., vol. 27, pp. 31-46, 1932.
2. Forest Bed - Wilson, L. R., Further fossil studies of the Two Creeks Forest Bed, Manitowoc County, Wisconsin. Torr.Bot. Club., vol. 66, pp. 317-525, 1936.
3. Forest Bed - Goldthwait, J. W., Abandoned shorelines of eastern Wisconsin: Wisconsin Geol. and Nat. Hist. Survey. Bull. 17, pp. 61-62, 1907.
4. Red Drift - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey. Prof.Paper 106, pp. 310-324, 1918.
5. Beaches - Goldthwait, J. W., Abandoned shorelines of eastern Wisconsin: Wisconsin Geol. and Nat. Hist Survey. Bull. 17, pp. 57-61, 1907.
6. Beaches - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey, Prof Paper 106, pp. 326-339, 1918.
7. Lake Oshkosh - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey, Prof Paper 106, pp. 324-325, 1918.
8. Interlobate moraine and lake border moraines - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey, Prof. Paper 106, pp. 301-309, 1918.
9. Glacial erosion - Martin, Lawrence. Physical geography of Wisconsin: Wis. Geol. and Nat.Hist.Survey, Bull. 36, pp. 237-253, 1932.
10. Drumlins - Alden, W. C., Drumlins of southeastern Wisconsin: U. S. Geol. Survey Bull. 273, 1905.
11. Drumlins Alden, W. C., Quaternary geology of southeastern Wisconsin: U. S. Geol. Survey Prof Paper 106, pp. 253-256, 1918.
12. Soil Profiles - Kellogg, C. E., Preliminary study of the profiles of the principal soil types of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 77A, 1930.
13. Striae - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, pp. 203-208, 1918.
14. Origin of Lake Michigan - Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, pp. 126-130, 1918.
15. Origin of Lake Michigan - Chamberlin, T. C., Geology of Wisconsin, vol I, pp. 253-259, 1883.
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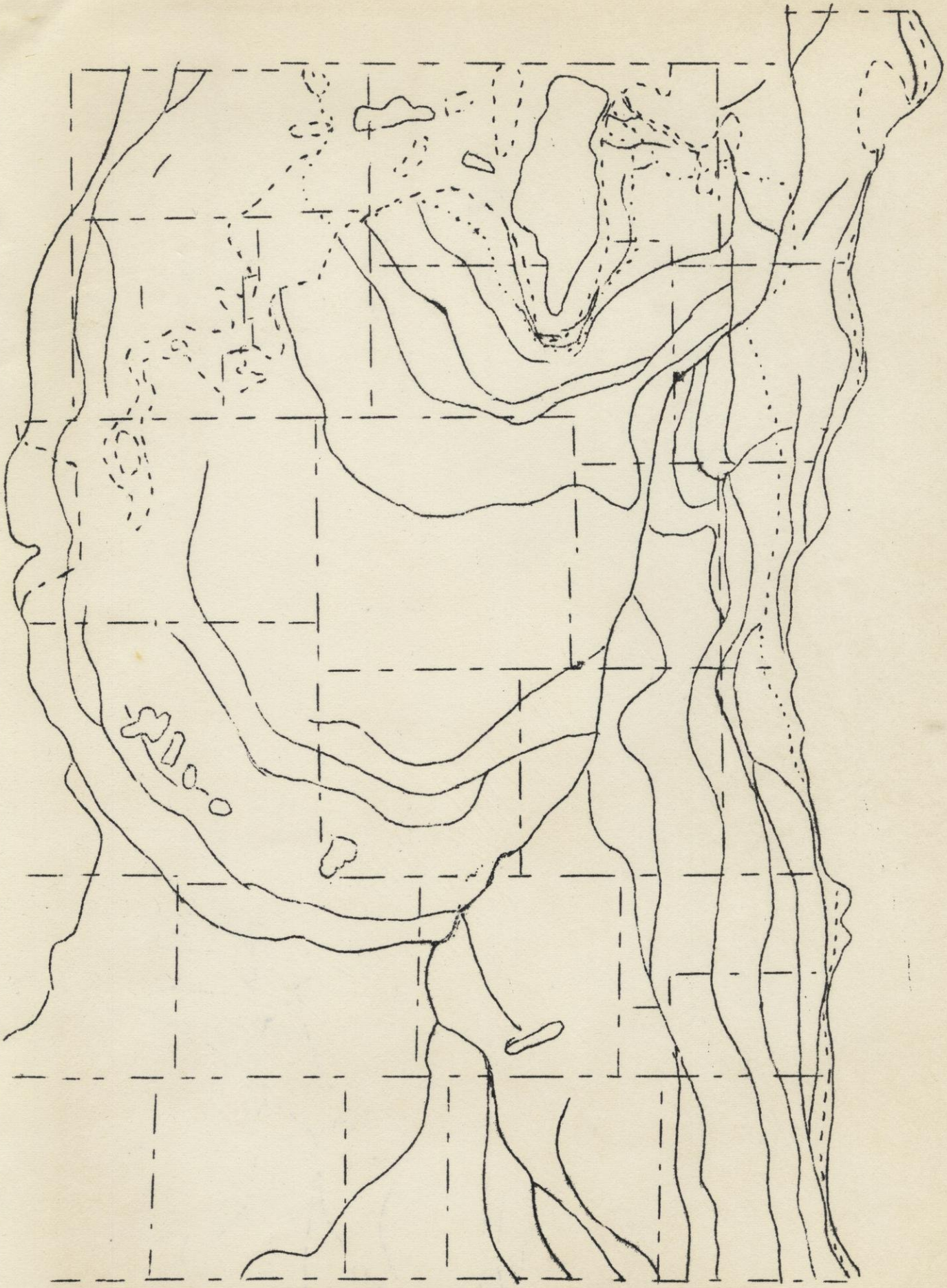

GLACIAL GEOLOGY OF SOUTHEASTERN WISCONSIN AND NORTHEASTERN ILLINOIS
Scale 1: 1,000,000