Course material from Geology 130 - Physiography of the US - 5. 1929-1947

Thwaites, F. T. (Fredrik Turville), 1883-1961
[s.l.]: [s.n.], 1929-1947

GEOLOGY 13 0
PHYSIOGRAPHY OF EASTERN UNITED STATES

Advance examination Dec. 18, 1947

Write on four questions only; No. 1 is required of all. Majors in geology or geography must include not less than one of next two questions. Grades will not be ready until after vacation. Please indicate which questions you wrote.

(1) Required question on separate sheet

(2) Explain at least two distinct hypotheses to account for the drainage system of Ridge and Valley province.

(3) Account for three different types of topography which occur in the Finger Lake District of New York.

(4) Complete following sentences giving proof of each statement (no more than a single sentence of reasonable length considered):
(a) It has been concluded that the divide along Blue Ridge is shifting to the northwest because:----
(b) It is known that there was neither the Allegheny nor Ohio Rivers in preglacial time because---
(c) Emergence of the Coastal Plain in relatively recent time is proved by--
(d) The upland surface of the Piedmont Plateau is not the same age as the surface of the hard rocks beneath the Coastal Plain because---
(e) It has been ~~xxxxxxx~~ widely thought that there was a Schooley Peneplain because--

(5) Describe briefly the location, geology a nd topography of Catskill Mts.

(6) Show with diagrams: (a) syncline, (b) monocline, (c) anticline, (d) anticlinal mountain, (e) monoclinal mountain, (f) s ynclinal mountain, (g) pitching fold, (h) thrust fault, (i) entrenched meander, (j) cuesta

(7) Account for: (a) greater summit elevations of Appalachian Plateau compared to Ridge and Valley
(b) why shale is found on some of the highest summits.

(8) Where and what are: (a) Hockley scarp, (b) Walden Ridge (c) Fall Zone Peneplain, (d) Ashville basin, (e) Harrisburg Peneplain, (f) Western Cross Timbers, (g) Reelfoot Lake, (h) Yazoo B asin, (i) Everglades, (j) Sea Islands .

Geology 13 0

Special exam, Nov. 23, 1945

Write on 4 only

(1) List in proper sequence the observations made at Weidman Falls which demonstrate the physiographic history of the area

(2) Account for rapids and falls found in Driftless Area giving examples of each kind

(3) Discuss origin of Crowleys Ridge and associated drainage changes

(4) Complete following:
(a) The mountains of ~~Superior Upland~~ Piedmont were destroyed before Upper ~~Cambrian~~ Ordovician time because
(c)(b) The interlobate moraine of eastern Wisconsin is such a prominent topographic feature because (two reasons)
(d) halk forms lowlands in xix Alabama whereas in Texas it caps a cuesta because
(e) The Driftless Area escaped glaciation primarily because

(5) Where on field trip did you see a good eample of each:
(a) Franconia sandstone
(b) toppgraphic break between two different uplands
(c) lake enclosed by terminal moraine
(d) bed of lake enclosed by glacial outwash
(e) peneplain on quartzite
(f) water gap
(g) gravel which must once have filled valley to great depth
(h) vertical strata
(i) clinkstone
(j) ~~Sixxxtone~~ Jordan sandstone

(6) Discuss the ~~xxx~~ Piedmont ~~xxx~~ as to
boundaries
geology
topography

GEOLOGY 130

PHYSIOGRAPHY OF THE UNITED STATES

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F. T. Thwaites, Sept., 1939

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PHYSIOGRAPHY OF THE UNITED STATES

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37 Bates R E Geomorphic history of the Rockford region Wisconsin
GSA 50, 819-880, 1939

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES
100 Review questions, first semester
Third edition, 1936-37

These questions are for review study. They contain questions which were used in past examinations and others which may be used or similar to those which may be used in the future. Study them in connection with both your text book and the Lobeck Diagram of the U. S. Check also with notes, readings, laboratory excercises, and field trip reports. Be sure to understand just where and WHY departures from textbook conclusions have been made. Be familiar with both definition and map limits of every physiographic province which has been taken up.

1. Show by a cross section the nature of the boundary line between the Laurentian Upland and the Interior Lowland. (a) in Wisconsin., (b) in eastern Adirondacks.
2. Describe and account for the different land forms which occur in the Laurentian Upland dividing them into (a) destructional and (b) constructional.
3. Into what two great groups (from topographic standpoint) may the bed rocks of the Laurentian Upland be divided? Describe the land forms and drainage patterns of each and name the ages of rocks in which typical examples of each occur.
4. How is it known that local glaciers once existed in eastern United States? Give locations of examples.
5. Describe and account for the different kinds of lakes which occur in the Laurentian Upland.
6. Outline in parallel column the facts and interpretations which demonstrate the physiographic history deduced in the Baraboo district, Wisconsin.
7. State in a single sentence a definite evidence which proves that: (a) local mountain glaciers once existed in the Adirondacks, (b) the Laurentian Upland was once a mountain country, (c) the pre-Cambrian mountains where destroyed before the coming of the Upper Cambrian sea, (d) The Laurentian Upland was not all glaciated at the same time, (e) the Superior Highland was once entirely covered by the rocks which are now confined to the Interior Lowland.
8. In the Laurentian Upland locate examples of: (a) trellis drainage, (b) fault controlled drainage, (c) monodnock on peneplain, (d) lake in rock basin, (e) old drift, (f) fault escarpment, (g) pitted outwash, (h) terminal moraine, (i) sandstone plain, (j) water gap.
9. What significance in erosional history is to be attached to a hill of granite which has a flat top? to a hill of horizontal sedimentary rock which has a flat top?
10. Outline with diagrams the stages in the development of the topography of the Superior Highland including the basin of Lake Superior.
11. Explain theorigin of the basin of Lake Superior.
12. Discuss with diagrams the effect on topography of three distinct types of bed rocks which occur in the Lake Superior region.
13. Outline the evidences which whow the post glacial history of the Lake Superior Basin.
14. Discuss the subdivisions of the Laurentian Upland in the U.S. giving definition, boundaries, geology and topography.
15. Where and what are in physiographic sense: (a) Apostle Islands, (b) St. Louis Bay, (c) Rib Hill, (d) South Range, (e) Rib Hill, (f) Keweenaw Point, (g) Isle Royal, (h) Mesabi Range, (i) Manitou Falls, (j) Huron Mts, (k) Apostle Ids.
16. Discuss with diagrams three possible explanations of the level uplands of the Barabbo Range.

17. Explain with diagrams the effects of glaciation on the topography of the Laurentian Upland.
18. Name, define, bound, and discuss briefly seven subdivisions of the Interior Lowlands.
19. Discuss theories of origin of basins of lower Great Lakes.
20. Locate, describe, and account for the principal cuestas of the Great Lakes region, illustrating with a section from north-central Wisconsin east to the Laurentian Upland in Ontario.
21. Describe, account for and illustrate with diagrams the different land forms which occur in the Interior Lowland and locate examples of each.
22. Discuss the different types of topography which occur in the Baraboo District, Wisconsin, including evidence of their ages.
23. Account for the Driftless Area.
24. Describe and account for falls and rapids in the Driftless Area.
25. Describe and account for topographic features in the Driftless Area, which are due to glaciation of the surrounding region.
26. Discuss two theories of the origin of drift or till plains.
27. Account for the differences in glacial topography between southeastern Wisconsin and central Illinois.
28. Describe the effects of loess on the topography of Iowa.
29. State in a single sentence a fact which definitely proves that: (a) the Niagara excarpment of eastern Wisconsin was altered by glacial erosion, (b) the glaciated portion of the Interior Lowland was not all covered with ice at one time, (c) the Baraboo Range was once buried under Paleozoic rocks, (d) the flat land in central Wisconsin is NOT a peneplain, (e) Weidman Falls was not always located where it now is.
30. Where have you seen on field trips in their course (a) sink hole, (b) sand dune lake, (c) excarpment due to sandstone, (d) terminal moraine, (e) upland on dolomite (f) upland on quartzite, (g) outwash plain, (h) abandoned lake bed, (i) superimposed stream, (j) water gap?
31. Discuss the postglacial history of the Great Lakes including the effect upon Niagara River.
32. Discuss evidences which indicate considerable glacial erosion in eastern Wisconsin?
33. Discuss with diagrams the Wichita and Arbuckle Mountains comparing them with the Baraboo District, Wisconsin.
34. Describe and account for the land forms of the southern Illinois old drift region.
35. Locate in Interior Lowlands examples of (a) drumlins, (b) glaciated karst topography, (c) superimposed drainage, (d) sand dunes, (e) abandoned lake bed, (d) lake basin shut in by glacial outwash, (e) eroded drift plain, (f) pitted outwash, (g) clay till moraine, (h) excarpment capped by shale, (i) cuesta, (j) exhumed pro-Cambrian monodnock.
36. Discuss three different interpretations of the uplands of the Driftless Area (excluding those of Baraboo Bluffs.).
37. Discuss the drainage pattern of the Crystalline Appalachians.
38. Discuss evidence of stream contest along the Blue Ridge.
39. Account for and describe the boundary between the Crystalline Appalachians and the Piedmont Plateau, (Give several hypotheses).
40. Where and why do some rivers cross the Crystalline Appalachians from southeast to northwest and others in reverse direction?
41. Discuss physiographic history of Piedmont Plateau citing evidence for each stop.
42. Compare similarities in topography of the Piedmont Plateau and the Baraboo Bluffs and give two possible explanations which might apply to both.

the Palisades

43. Where and what are: (a) Blue Ridge, (b) South Mountain, (c) Mt. Mitchell, (d) Richmond Basin, (e) Spencer Mt., (f) Fall Line, (g) French Broad River, (h) Trenton Prong, (i) Carlisle Prong, (j) Great Smoky Mts.
44. Discuss line of division of Piedmont and Coastal Plain using diagram.
45. In single sentences state evidences which alone prove that: (a) the Piedmont was once mountainous, (b) the Piedmont was once more level than it is today, (c) the Piedmont was once covered by Coastal Plain sediments, (d) the Blue Ridge is not in harmony with the stage of erosion cycle of districts to west and to east, (e) rejuvination of streams has occurred in the Crystalline Appaladhians.
46. List the land forms which are well developed in the Trissic lowland section of the Piedmont.
47. Explain by means of diagrams the effect of faulting on the topography of a ridge of trap rock interbedded with sandstone and shale and which has been tilted to a considerable angle.
48. Why is New England considered as a separate physiographic province?
49. Draw an east-west cross section of New England north of latitude of Boston to illustrate the several geographic features.
50. Account for the stony soils of New England and tell where else the same phenomenon is found.
51. Give and discuss fully three different interpretations of the level skyline of southern New England including attempts to date this surface.
52. Discuss two different interpretations of the drift terraces of Connecticut Valley.
53. Outline with diagrams the physiographic history of New England giving proofs of each step.
54. Where in New England would you find: (a) evidence of local or mountain glaciation, (b) drumlin, (c) ice-contact terrace, (d) sand-plain, (e) ridge made by tilted trap rock, (f) valley of rejuvinated stream, (g) valley formed because of limestone, (h) superimposed stream, (i) eskers, (j) granite mountains.
55. Where and what are: (a) Watchung Mts., (b) Stone Mt., (c) Palisades, (d), Mt. Monadnock, (e) Mt. Washington, (f) Lower Connecticut Valley, (g) Upper Connecticut Valley, (h) Reading Prong, (i) Manhattan Prong, (j) Highlands of Hudson.
56. Account for the irregular shoreline of New England.
57. List five different land forms which occur in New England and account for each.
58. Discuss location of west boundary of New England Province.
59. Discuss explanations of the absence of recessional moraines in southern New England.
60. Discuss evidence for and against the presence of many partial peneplains in Folded Appalachians.
61. Explain with diagrams: syncline, anticline, monocline, normal fault, thrust fault, synclinal valley, synclinal ridge, anticlinal valley, anticlinal ridge, monoclinal ridge, pitching anticline, pitching syncline.
62. How is direction of dip of tilted sediments reflected in the topography; use diagrams.
63. How may direction of pitch of a fold be determined from topography; use diagrams.
64. Under what conditions of dip and of rock character do the criteria worked out above fail to work? Use diagram.
65. Using diagrams outline the physiographic history of the Folded Appalachians giving evidence for each step.

66. Discuss fully at least four explanations of the present courses of streams which cross the Folded Appalachians from northwest to southeast.
67. Discuss the theories which have been applied to explain the course of the Tennessee River including that part in the Interior Lowland.
68. Discuss evidence for and against regional pleneplanation of the folded Appalachians.
69. What is meant in speaking of the Folded Appalachians by the terms "Cretaceous Peneplain", and "Tertiary Peneplain?" Explain fully and include discussion of how ages were fixed.
70. Discuss causes and evidence of drainage adjustment in Folded Appalachians.
71. Account for the present drainage pattern of the Folded Appalachians.
72. In Folded Appalachians cite definite examples of (a) superimposed stream, (b) subsequent stream, (c) watergap, (d) wind gap, (e) zig-zag ridge, (f) entrenched meandors, (g) rock terrace (partial peneplain), (h) glacial drift, (i) anticlinal ridge, (j) synclinal mountain.
73. State for each in single sentence a proof that shows that: (a) more streams once flowed from Folded Appalachians directly to Atlantic Ocean than do today, (b) the Folded Appalachians were once of much lower relife than today, (c) the uplift of the Folded Appalachians in recent geologic time has been intermittent, (d) the northern Folded Appalachians were once covered by the Coastal Plain, (e) crests of Folded Appalachians do not connect with surface beneath Cretaceous sediments.
74. Where and what is: (a) Fall Zone-peneplain, (b) Harrisburg peneplain, (c) Schooley peneplain, (d) Delaware Watergap, (e) Lookout Mountain, (f) Upper Hudson Valley, (g) Walden Ridge, (h) Shenandoah Valley, (i) Allegheny Front, (j) New River.

75. Illustrate by an east-west section the geologic structure and topography from Nashville or Blue Grass Basin to Atlantic Ocean showing peneplains.
76. What relation exists between rock structure and elevation of ridge crests in Folded Appalachian.
77. Discuss the significance of entrenched meanders both in Folded Appalachian and elsewhere.
78. Discuss different views on origin of rock terraces or partial peneplains in Folded Appalachians including causes of local base levels.
79. In Folded Appalachians what kinds of rocks form ridges and what kinds the valleys? Compare with conditions in Wisconsin.
80. Discuss the boundaries of the Coastal Plain.
81. Account for the change in width and shore outline of the Coastal Plain from south to north.
82. Account for five distinct types of shore features found in Coastal Plain and locate examples.
83. Classify as to origin the lakes and swamps of the Coastal Plain and locate examples.
84. Discuss five different land forms of the Coastal Plain and locate examples of each.
85. Outline with diagrams the physiographic history of the Coastal Plain and give evidence for each stop.
86. Using single sentences, for each state a phenonenon which proves that: (a) the Coastal Plain has been recently uplifted with little deformation, (b) the Coastal Plain once stood much higher than at present, (c) wave work has advanced parts of the shore of the Coastal Plain seaward without change in relative levels of sea and land, (d) the Fall Zone Peneplain is not the same as the Piedmont Plateau, (e) Coastal Plain sediments once extended farther inland than they now do.
87. Locate in Coastal Plain examples of: (a) barrier beach, (b) hook, (c) drowned river valley, (d) raised barrier beach, (e) karst topography,

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(f) cuesta, (g) subsequent stream, (h) consequent stream, (i) atoll, (j) coral reef.

88. Discuss the relatively horizontal abandoned shorelines of the Coastal Plain and theories to account for them.

89. Discuss physiographic significance of fresh water in Coastal Plain below sea level.

90. What and where are : (a) salt domes, (b) Florida peninsula, (c) Mississippi embayment, (d) Reelfoot Lake, (e) Long Island, (f) Cape Cod, (g) Geoges Banks, (h) Black Belt, (i) Cheseapeake Bay, (j) Lake Pontchartrain.

91. Draw geologic and topographic sections across Coastal Plain in (a) Long Island, (b) New Jersey, (c) Georgia, (d) Alabama, (e) east Texas.

92. Discuss the formation of the Mississippi delta and its relation to the stream above.

93. Discuss the boundaries of the Appalachian Plateau using diagrams to illustrate various parts.

94. Discuss effects of glaciation in Appalachian Plateau and outline area affected. Include effects on drainage south of ice margin.

95. Discuss four theories of the formation of the youthful valleys of the Appalachian Plateau of New York.

96. Discuss relation of Appalachian Plateau to/ character and rock structure.

97. Discuss the drainage phenomena of the Catskill Mountains.

98. Where and what are: (a) Tughill Plateau, (b) Black River Valley (N. Y.), (c) Pocono Plateau, (d) Mohawk Valley, (e) Cumberland Plateau, (f) Onondaga escarpment, (g) Allegheny River, (h) Short Mt., (Tenn.), (i) Natural Bridge (Va.), (j) Teas Valley.

99. State evidence for and against the conclusion that the Appalachian Plateau was peneplained at least once.

100. Locate and describe in Appalachian Plateau examples of : (a) consequent stream, (b) recent stream capture, (c) obsequent stream, (d) subsequent stream, (e) river terraces, (f) entrenched meandors, (g) tributary valley blocked by outwash in main valley, (h) glacial stream diversion, (i) hanging valley, (j) cuesta.

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(f) cuesta, (g) subsequent stream, (h) consequent stream, (i) atoll, (j) coral reef.

88. Discuss the relatively horizontal abandoned shorelines of the Coastal Plain and theories to account for them.
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95. Discuss four theories of the formation of the youthful valleys of the Appalachian Plateau of New York.
96. Discuss relation of Appalachian Plateau to rock character and rock structure.
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98. Where and what are: (a) Tughill Plateau, (b) Black River Valley (N.Y.), (c) Pocono Plateau, (d) Mohawk Valley, (e) Cumberland Plateau, (f) Onondaga escarpment, (g) Allegheny River, (h) Short Mt., (Tenn.), (i) Natural Bridge (Va.), (j) Teas Valley.
99. State evidence for and against the conclusion that the Appalachian Plateau was peneplained at least once.
100. Locate and describe in Appalachian Plateau examples of: (a) consequent stream, (b) recent stream capture, (c) obsequent stream, (d) subsequent stream, (e) river terraces, (f) entrenched meanders, (g) tributary valley blocked by outwash in main valley, (h) glacial stream diversion, (i) hanging valley, (j) cuesta.
101. Account for (a) Boston Mts., (b) Springfield Platform, (c) St. Francis Mts., (d) Athens Plateau, (e) Novaculite ridges.
102. Discuss evidence bearing in interpretation of uplands of Ozark Plateau.
103. Discuss separation of Interior Lowland Plateau from Central (Interior) Lowland.
104. Account for (a) Shawnee Hills, (b) Dipping Springs escarpment, (c) Pottsville escarpment, (d) the Knobs, (e) Pennyroyal Plateau, (f) Nashville Basin, (g) Blue Grass.
105. Discuss relation of "Highland Rim peneplain" to "Cumberland peneplain."

The following questions are for majors and graduates:

16, 36, 39, 47, 51, 52, 60, 62, 63, 64, 66, 67, 68, 69, 70, 78, 88, 95, 102, 105.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES
100 Review questions, first semester
Second edition 1933

These questions are for review study. They contain questions which were used in past examinations and others which may be used or similar to those which may be used in the future. Study them in connection with both your text book and the Lobeck Diagram of the U. S. Check also with notes, readings, laboratory excercises, and field trip reports. Be sure to understand just where and WHY departures from textbook conclusions have been made. Be familiar with both definition and map limits of every physiographic province which has been taken up.

1. Show by a cross section the nature of the boundary line between the Laurentian Upland and the Interior Lowland.
2. Describe and account for the different land forms which occur in the Laurentian Upland dividing them into (a) destructional and (b) constructional.
3. Into what two great groups (from topographic standpoint) may the bed rocks of the Laurentian Upland be divided? Describe the land forms and drainage patters of each and name the ages of rocks in which typical examples of each occur.
4. How is it known that local glaciers once existed in eastern United States? Give locations of examples.
5. Describe and account for the different kinds of lakes which occur in the Laurentian Upland.
6. In what kinds of glacial and glacio-fluvial deposits are lakes abundant? Locate examples of each.
7. State in a single sentence a definite evidence which proves that: (a) local mountain glaciers once existed in the Adirondacks, (b) the Laurentian Upland was once a mountain country, (c) the pre-Cambrian mountains where destroyed before the coming of the Upper Cambrian sea, (d) the Laurentian Upland was not all glaciated at the same time, (e) the Superior Highland was once entirely covered by the rocks which are now confined to the Interior Lowland.
8. In the Laurentian Upland locate examples of: (a) trellis drainage, (b) fault block mountains, (c) monadnocks on peneplain, (d) lake in rock basin, (e) old drift.
9. What significance in erosional history is to be attached to a hill of granite which has a flat top? to a hill of horizontal sedimentary rock which has a flat top?
10. Outline with diagrams the stages in the development of the topography of the Superior Highland including the basin of Lake Superior.
11. Explain the origin of the basin of Lake Superior.
12. What evidence indicates that waters in the Lake Superior basin once stood much higher?
13. What evidence indicates recent earth movements in the Lake Superior Basin?
14. Discuss the difficulties of field tracing of the boundary of the Superior Highland in different places.
15. Where and what are in physiographic sense: (a) Apostle Islands, (b) St. Louis Bay, (c) Rib Hill, (d) South Range, (e) Skunk Hill, (f) Keweenaw Point, (g) Isle Royal, (h) Mesabi Range, (i) Manitou Falls, (j) Huron Mts.
16. Discuss with diagrams three possible explanations of the level uplands of the Baraboo Range.
17. Name and locate five inliers of rocks like those of the Laurentian Upland which occur in the Interior Lowland and name which have been seen on field trips.
18. Name, bound, and discuss briefly seven subdivisions of the Interior Lowlands.

19. Discuss theories of origin of basins of lower Great Lakes.
20. Locate, describe, and account for the principal cuestas of the Great Lakes region, illustrating with a section from north-central Wisconsin east to the Laurentian Upland in Ontario.
21. Describe, account for and illustrate with diagrams the different land forms which occur in the Interior Lowland and locate examples of each. Where and what are: (a) Franconia Cuesta, (b) Hamilton Mounds, (c) Glover Bluff, (d) The Dells, (e) Mile Bluff (f) School Section Bluff, (g) Sand Ridge, (h) Dripping Springs escarpment, (i) Ponnyroyal Plateau, (j) Shawnee Hills.
22. Discuss fully the physiographic history proved by the rock exposures at Nokoosa, Wisconsin.
23. Account for the Driftless Area.
24. Describe and account for falls and rapids in the Driftless Area.
25. Describe and account for topographic features in the Driftless Area which are due to Pleistocene deposits.
26. Discuss two theories of the origin of drift or till plains.
27. Account for the differences in glacial topography between southeastern Wisconsin and central Illinois.
28. Describe the effects of loess on the topography of Iowa.
29. State in a single sentence a fact which definitely proves that: (a) the Niagara escarpment of eastern Wisconsin was altered by glacial erosion, (b) the glaciated portion of the Interior Lowland was not all covered with ice at one time, (c) the Baraboo Range was once buried under Paleozoic rocks, (d) the flat land near Mauston, Wis. is NOT a peneplain, (e) Weidman Falls was not always located where it now is.
30. Discuss the origin of the Weidman Kettle Hole including a discussion of other enclosed depressions found in the Interior Lowland.
31. Describe the geology and topography of the Osage Plains illustrating with a cross section.
32. Describe the geology and topography of the Nashville Basin illustrating with a cross section.
33. What evidences show that water once stood much higher in the Great Lakes?
34. Describe and account for the land forms of southern Illinois.
35. Locate in Interior Lowlands examples of (a) drumlins, (b) karst topography, (c) superimposed drainage, (d) sand dunes, (e) abandoned lake bed, (d) lake basin shut in by glacial outwash, (e) eroded drift plain, (f) pitted outwash, (g) clay till moraine, (h) escarpment capped by shale, (i) [illegible], (j) exhumed pre-Cambrian monadnock.
36. Discuss two different interpretations of the uplands of the Driftless Area excluding those of Baraboo Bluffs.
37. Discuss the drainage pattern of the Crystalline Appalachians.
38. What kinds of rocks make up the mountain summits in the Crystalline Appalachians and why?
39. Account for and describe the boundary between the Crystalline Appalachians and the Piedmont Plateau.
40. Where and why do some rivers cross the Crystalline Appalachians from southeast to northwest and others in reverse direction?
41. Discuss physiographic history of Piedmont Plateau citing evidence for each step.
42. Compare similarities in topography of the Piedmont Plateau and the Baraboo Bluffs and give two possible explanations which might apply to both.
43. Where and what are: (a) Blue Ridge, (b) South Mountain, (c) Mt. Mitchell, (d) Richmond Basin, (e) Spencer Mt., (f) Fall Line, (g) French Broad River, (h) Trenton Prong, (i) Carlisle Prong, (j) Great Smoky Mts.
44. Discuss line of division of Piedmont and Coastal Plain using diagram.
45. In single sentences state evidences which alone prove that: (a) the Piedmont was once mountainous, (b) the Piedmont was once more level than

it is today, (c) the Piedmont was once covered by Coastal Plain sediments, (d) the Blue Ridge is not a fault scarp but is due to erosion, (e) rejuvination of streams has occurred in the Crystalline Appalachians.

46. Explain the fact that the Triassic Lowland has always been such a favorite field for physiographic study.

47. Explain by means of diagrams the effect of faulting on the topography of a ridge of trap rock interbedded with sandstone and shale and which has been tilted to a considerable angle.

48. Why is New England considered as a separate physiographic province?

49. Draw an east-west cross section of New England north of latitude of Boston to illustrate the several geographic features.

50. Account for the stony soils of New England and tell where else the same phenomenon is found.

34 51. Give and discuss fully three different interpretations of the level skyline of southern New England.

35 52. Discuss two different interpretations of the terraces of Connecticut Valley. Wing

53. Outline with diagrams the physiographic history of New England giving proofs of each step.

54. Where in New England would you find: (a) evidence of local or mountain glaciation, (b) drumlins, (c) ice-contact terraces, (d) drumlins, (e) ridges made by tilted trap rock, (f) valley of rejuvinated stream, (g) valley formed because of limestone, (h) superimposed stream, (i) eskers, (j) granite mountains

33 55. Where and what are: (a) Watchung Mts., (b) Stone Mt., (c) Palisades, (d) Mt. Monadnock, (e) Mt. Washington, (f) Lower Connecticut Valley, (g) Upper Connecticut Valley, (h) Reading Prong, (i) Manhattan Prong, (j) Highlands of Hudson.

56. Account for the irregular shoreline of New England.

57. List five different land forms which occur in New England and account for each.

58. Under the idea that the summits of southern New England are remnants of an uplifted and dissected peneplain how was the geologic age of this surface ascertained?

59. Discuss possible explanations of the scarcity of recessional moraines in southern New England.

60. Discuss the topography and geology of the Taconic Mts, telling why they are now included in New England.

61. Explain with diagrams: syncline, anticline, monocline, normal fault, thrust fault, synclinal valley, synclinal ridge, anticlinal valley, anticlinal ridge, monoclinal ridge, pitching anticline, pitching syncline.

34 62. How is direction of dip of tilted sediments reflected in the topography; use diagrams.

63. How may direction of pitch of a fold be determined from topography; use diagrams.

64. Under what conditions of dip and of rock character do the criteria worked out above fail to work?

34 65. Using diagrams outline the physiographic history of the Folded Appalachians giving evidence for each step.

66. Discuss fully four possible explanations of the present courses of streams which cross the Folded Appalachians from northwest to southeast. Wing

67. Discuss the theories which have been applied to explain the course of Tennessee River including that part in the Interior Lowland.

35 68. Discuss two explanations of the even crests of the ridges of the Folded Appalachians. Wing

69. What is meant in speaking of the Folded Appalachians by the terms "Cretaceous Peneplain", and "Tertiary Peneplain?" Explain fully and include discussion of how ages were fixed.

70. In what physiographic provinces are even-crested ridges also found? (besides in Folded Appalachians).

71. Account for the drainage pattern of the Folded Appalachians.
72. In Folded Appalachians cite definite examples of (a) superimposed stream, (b) subsequent stream, (c) watergap, (d) wind gap, (e) zig-zag ridge, (f) entrenched meanders, (g) rock terrace (partial peneplain), (h) glacial drift, (i) anticlinal ridge, (j) synclinal mountain.
73. State for each in single sentence a proof that shows that: (a) more streams once flowed from Folded Appalachians directly to Atlantic Ocean than do today, (b) the Folded Appalachians were once of much lower relief than today, (c) the uplift of the Folded Appalachians in recent geologic time has been intermittent, (d) the northern Folded Appalachians were once covered by the Coastal Plain, (e) crests of Folded Appalachians do not connect with surface beneath Cretaceous sediments.
74. Where and what is: (a) Fall Zone peneplain, (b) Harrisburg peneplain, (c) Schooley peneplain, (d) Delaware Watergap, (e) Lookout Mountain, (f) Upper Hudson Valley, (g) Walden Ridge, (h) Shenandoah Valley, (i) Alleghony Front, (j) Blue Mt.
75. Illustrate by an east-west section the geologic structure and topography from Nashville or Blue Grass Basin to Atlantic Ocean.
76. How are former baselevels in Folded Appalachians given geologic dates?
77. Discuss the significance of different kinds of entrenched meanders.
78. Account for streams which cross the Folded Appalachians from southeast to northwest and locate examples.
79. In Folded Appalacians what kinds of rocks form ridges and what kinds the valleys? Compare with conditions in Wisconsin.
80. Discuss the boundaries of the Coastal Plain showing how each section is located and the phenomena along each part.
81. Account for the changes in width and shore outline of the Coastal Plain from south to north.
82. Account for five distinct types of shore features found in Coastal Plain. Locate examples.
83. Classify as to origin the lakes and swamps of the Coastal Plain and locate examples.
84. Discuss five different land forms of the Coastal Plain and locate examples of each.
85. Outline with diagrams the physiographic history of the Coastal Plain and give evidence for each step.
86. Using single sentences, for each state a phenomenon which proves that: (a) the Coastal Plain has been recently uplifted with little deformation, (b) the Coastal Plain once stood much higher than at present, (c) wave work has advanced parts of the shore of the Coastal Plain seaward without change in relative levels of sea and land, (d) the Fall Zone Peneplain is not the same as the Piedmont Plateau, (e) Coastal Plain sediments once extended farther inland than they now do.
87. Locate in Coastal Plain examples of: (a) barrier beach, (b) hook, (c) drowned river valley, (d) raised barrier beach, (e) karst topography, (f) cuesta, (g) subsequent stream, (h) consequent stream, (i) atoll, (j) coral reef.
88. Discuss the relatively horizontal abandoned shorelines of the Coastal Plain and theories to account for them.
89. Discuss significance of fresh water in Coastal Plain below sea level.
90. What and where are: (a) salt domes, (b) Florida peninsula, (c) Mississippi embayment, (d) Reelfoot Lake, (e) Long Island.
91. Draw geologic and topographic sections across Coastal Plain in (a) Long Island, (b) New Jersey, (c) Georgia, (d) Alabama, (e) east Texas.
92. Discuss the formation of the Mississippi delta and its relation to the stream above.
93. Discuss the boundaries of the Appalachian Plateau, using diagrams to illustrate various parts.
94. Discuss effects of glaciation in Appalachian Plateau and outline area.

95. Discuss four distinct theories of the formation of the youthful valleys of the Appalachian Plateau of New York.
96. Discuss origin of the Finger Lakes of New York.
97. Discuss the drainage phenomena of the Catskill Mountains.
98. Where and what are: (a) Tughill Plateau, (b) Black River Valley (N.Y.), (c) Pocono Plateau, (d) Mohawk Valley, (e) Cumberland Plateau, (f) Portage escarpment, (g) Alleghany River, (h) Short Mt., (Tenn.), (i) Alleghany Cuesta, (j) Teas Valley.
99. What evidence favors the conclusion that the Appalachian Plateau was peneplained at least once?
100. Locate and describe in Appalachian Plateau examples of: (a) consequent stream, (b) recent stream capture, (c) obsequent stream, (d) subsequent stream, (e) river terraces, (f) entrenched meanders, (g) tributary valley blocked by outwash in main valley, (h) glacial stream diversion, (i) hanging valley, (j) cuesta.

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GEOLOGY 130

PHYSIOGRAPHY OF THE UNITED STATES

100 Review questions, first semester

These questions are for review study. They contain many questions which were used in past examinations and others which may be used or similar to those which may be used in the future. Study them in connection with your textbook but remember that it is not up to date or everywhere reliable. Check against notes of readings, laboratory exercises, and field trip reports. Be sure to understand just where and WHY departures from textbook conclusions have been made. Every student should be familiar with both definition and map limits of every province thus far taken up. Mark their limits on your Physiographic Diagram and use the Diagram in reviewing.

1. Draw a cross section showing underground relations between the Laurentian Upland of Wisconsin and the Interior Lowlands.
2. Do the same for the Adirondacks and the Mohawk Valley.
3. What is ment by the terms Banded Rocks, Massive Rocks? Give examples of each and some localities where each may be found and show with sketches the characteristic drainage pattern of each.
4. Name localities where local glaciation occured in provinces studied thus far studied; tell how this is known and how its age in reference to the continental glaciation can be fixed.
5. Name some of the outliers of pre-Cambrian rocks in the Interior Lowlands: could these area be treated as parts of another Province?
6. On your Physiographic Diagram outline the areas of Young and Old Drifts; give the names applied to these different ages of drift and tell how you could tell the difference between the two general classes in the field.
7. In what types of glacial deposits are lakes abundant and in what age or ages of drift?
8. Name at least five monadnocks on the peneplane of the Superior Highlands; account for their preservation.
9. Be able to state concisely without ambiguity the evidences which definitely prove: (a) former mountains in northern Wisconsin, (b) pre-Cambrian age of the peneplane in same region, (c) that Paleozoic rocks once covered the vicinity of Wausaw, (d) that faulting has occured in the Adirondacks since Cambrian time, and (e) not all of the Superior Highland was glaciated during the Young Glaciation.
10. What significance in terms of erosional history is to be attached to (a) a hill of granite with a flat top, (b) to a hill of horizontal sediments with a flat top?
11. Where would you find (a) undissected remnants of the pre-Cambrian peneplane, (b) a younger peneplane on pre-Cambrian rocks, (c) pre-Wisconsin glacial drift on pre-Cambrian bed rock?
12. How is the age of the pre-Cambrian peneplane determined?
13. Outline the stages in the development fo the topography of the Adirondacks begining with the formation of the oldest rocks.
14. Have the Adirondacks been uplifted since pre-Cambrian time? Has northern Wisconsin?
15. Explain theories of the origin of the basin of Lake Superior illustrating with a cross section showing the pre-Cambrian peneplane.
16. What evidence is there that the Superior Highland was glaciated more than once?
17. What evidence is there that the Lake Superior Basin once overflowed via St. Croix River?
18. What types of drainage pattern are present in the Superior Highland? In the Adirondacks? Where are these different types found?
19. Outline the stages in the development of the topography of the Superior Highland beginning after the deposition of the youngest pre-Cambrian rocks.
20. Outline three different interpretations of the level summit of the Baraboo Bluffs; draw a cross section to show each.
21. Illustrate by a single cross section the structural relations, topography, and general character of bed rocks from Charleston, S. C., to Chicago.

22. Define and give general characteristics of 7 subdivisions of the Interior Lowlands.
23. Be familiar with the general structure of the bed rocks of the Interior Lowlands, the basins, domes, areas of faulting and of igneous intrusions.
24. Name three important coal areas of the interior lowland and describe their structure.
25. Discuss the theories of the origin of the basins of the lower Great Lakes.
26. Locate and describe the important cuestas of the lower Great Lakes region, illustrating with a cross section showing geology from the Laurentian upland of Wisconsin through Lower Michigan to Ontario.
27. Draw a NE-SE cross section showing geology and topography of the Driftless Area starting at the vicinity of Wisconsin Rapids.
28. Discuss different interpretations of the erosional history of the Driftless Area.
29. Discuss the origin of the Driftless Area.
30. What deposits due indirectly to glaciation are present in the Driftless Area and how do they affect its soils and topography?
31. Into what two general types of topography can the area of Young Drift be divided? Explain.
32. Draw a cross section showing geology and topography of the Osage Plains.
33. What relation have the courses of the Missouri and Ohio Rivers to glaciation?
34. Account for the difference in the topography of the glacial deposits in southern Wisconsin and central Illinois.
35. Locate three important areas of drumlins in the U. S.
36. Locate at least one important area of karst topography.
37. Where and what are (give physiographic interpretation): Keweenaw Point, Mesabi Range, Rib Hill, Niagara Cuesta, Franconia Cuesta, Nashville Basin, Highland Rim, Shawnee Hills, Michigan Basin, Blue Mounds, Feidman Falls, Glover Bluff, Onondaga Cuesta, Blue Grass Region.
38. Name at least five glacial lakes and give their outlets.
39. How could you tell in the field when you leave the Interior Lowland and enter the Superior Highland? Why is this easier to tell in eastern Wisconsin than in western Minnesota?
40. What types of drainage pattern do you find in the Interior Lowlands?
41. What kinds of rocks form the higher summits of the Older Appalachians?
42. What shape do granite mountains have and why?
43. What forms the boundary between the Older Appalachians and the province to the southeast of them? Explain its origin.
44. What rivers cross the Older Appalachians from northwest to southeast? Why?
45. Explain why some rivers flow northwest through the highest parts of the Older Appalachians.
46. What types of drainage pattern occur in the Older Appalachians? Why?
47. What name is applied to the northeastern end of the Older Appalachians?
48. Why is preservation of the natural forest cover more important in the Older Appalachians than in the Superior Highland?
49. Is there evidence of peneplanation in the Older Appalachians? Explain.
50. Using original data compute the average slope in feet per mile of the uplands across the Piedmont Plateau.
51. What evidence is there that the Piedmont once had less relief than at present?
52. What relation has the slope of the Piedmont uplands to the surface beneath the sediments of the Coastal Plain?
53. Locate several monadnocks in the Piedmont Plateau.
54. Why is much of the soil of the Piedmont like that of an arid area although the rainfall is very heavy?
55. Explain why the Piedmont is generally regarded as a good agricultural area, although in fact is is far inferior to large portions of the Interior Lowlands.
56. Why has the Triassic Lowland been a favorite field for physiographic study?
57. Explain by means of diagrams the effect of faulting on the topography of a ridge of tilted trap rock in sandstone and shale.

58. Where and what are (give explanation of origin): Palisades, Watchung Mts., Stone Mt., Fall Line, Brushy Mt., Blue Ridge, South Mountain, Lake Passaic, Trenton Prong, Mt. Mitchell, Asheville Basin, Great Valley, French Broad River, Great Smoky Mts., Unaka Mts., Baraboo Range School Section Bluff, Johnstown moraine.

59. Explain with diagrams: syncline, anticline, monocline, normal fault, thrust fault, synclinal valley, synclinal ridge, anticlinal valley, anticlinal ridge, monoclinal ridge, pitching anticline, pitching syncline.

60. Illustrate either by contour maps or block diagrams the effect on topography of resistant layers in pitching anticlines and pitching synclines after erosion. The resistant layer is to be of some considerable thickness and separated from other hard rocks by a great thickness of softer rocks. What part does peneplanation play in the result?

61. Discuss explanations of the course of Tennessee River ~~near Chattanooga~~.

62. Account for and locate streams which cross the Folded Appalachians (a) from southeast to northwest, and (b) from northwest to southeast.

63. What kinds and what geologic ages of rocks are found in the Folded Appalachians?

64. Discuss explanations of the relatively even elevations of the ridges in the Folded Appalachians and Triassic Lowland.

65. In the Folded Appalachians cite examples of antecedant, superimposed, and subsequent streams.

66. What drainage pattern is present in the Folded Appalachians and why?

67. Explain reasons for thinking that the Folded Appalachians had been reduced to a peneplane before Cretaceous time and the modern objections to this interpretation.

68. What evidences are there of changes in the level of the land during the erosional history of the Folded Appalachians?

69. Draw a contour sketch of a meandering stream which has entrenched itself as a result of uplift and show how its direction of flow can be deduced from the shapes of the ridges adjacent to the valley.

70. What and where is: Shenandoah Valley, area of zig-zag ridges, Coosa valley, Sequatchie valley, Lookout Mt., Walden Ridge, Alleghany Front, Delaware Watergap, Blue Mt., Champlain lowland, Cumberland Valley, Juniata River, Kanawha-New River.

71. What bearing have wind gaps on erosional history?

72. State what physiographic provinces bound the Folded Appalachians ~~on the east and southeast~~.

73. Why is New England considered as a separate province and what provinces does it resemble?

74. Account for the irregular coastline of New England. Should any part be considered as a fiorded coast?

75. Draw an east-west section across New England showing main physiographic features and general character of bed rock and structure.

76. Where in New England would you find: evidences of local glaciation, drumlins, ~~river~~ terraces, eskers, granite mountains, mountains of folded metamorphosed sediments, faulted trap ridges, coal deposits, superimposed drainage, sandstone bed rock, watergap, evidence of postglacial marine submergence, ~~lake terraces~~.

77. Outline the modern interpretations of the erosional history of New England giving the evidence on which it is based.

78. What was meant by "Cretaceous Peneplain", "Tertiary Peneplain"; how were the geologic ages of these features inferred?

79. What and where are Boston Basin, Narragansett Basin, Connecticut Valley, Green Mt., Taconic Mts., Berkshire Hills, Mt. Monadnock, Bunker Hill, Hudson Highlands, Reading Prong, Manhattan Prong.

80. What geographic influences have favored the growth of New York and Philadelphia instead of Boston, a very old settlement? Explain fully.

81. Draw a geologic cross section to show the relation of the Adirondacks to the New England province.

82. Account for the stony soils of New England; where else do similar conditions exist?

83. Considering the differences in bed rock why is the actual difference between the soils of the Piedmont and the Coastal Plain so slight?
84. Why does the Coastal Plain end at the northeast where it does?
85. Account for the large bays and inlets of the northern Coastal Plain.
86. Why are these valuable harbors while groups behind the sandbeaches along the coast farther south are not? Explain fully.
87. Where and what are Marthas Vineyard, Long Island Sound, Cape Cod, Cape [illegible] Hatteras, a district of many lakes in the Coastal Plain, Black Belt, Crowleys Ridge, Chesapeak Bay, Florida Keys, Tortugas, salt domes, Balcones escarpment, Mexia fault, Black Prairie, Yazoo Basin, South Pass.
88. What part of the Folded Appalachians has been glaciated? To what extent has the topography been altered as compared with the Interior Lowlands and why?
89. What is the geologic age or ages of the sediments of the Coastal Plain? What kinds of materials are present?
90. What part of the Coastal Plain has been glaciated? How may the outermost moraine be distinguished and it discovered that the ice probably never went out to the deep sea?
91. Account for the swampy condition of much of the Coastal Plain. How may the limit of tides be determined on maps?
92. Explain with diagrams the relation between unconformites in the Coastal Plain sediments and peneplanes to the northwest. What practical difficulty is found in connecting these in order to fix the geologic ages of the peneplanes?
93. What evidence suggests that the Coastal Plain sediments once extended much farther inland?
94. What evidences show that the coast line has frequently migrated in the geologic past?
95. What types of drainage pattern and what stages in the erosion cycle are found in the Coastal Plain including the salt marshes?
96. Why is the Appalachian Plateau separated from the Interior Lowlands?
97. Why in much of the southeastern U. S. are the ridges made of sandstone and the valleys of limestone although in Wisconsin the reverse is true?
98. Why has it been thought that the summit of the Appalachian Plateau is a dissected peneplane?
99. What portion of the Appalachian Plateau was covered by the continental glacier? Is there evidence of local glaciation? To what extent has the topography been altered?
100. What and where are Finger Lakes, Mohawk valley, Tughill Plateau, Cumberland Plateau, Catskill Mts, Alleghany Mts, salt marsh, Helderberg escarpment, Pocono Plateau.

New theory of narrow valleys
gives a possible depth.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES
LABORATORY

Central Lowland, East of Mississippi River
Edition of 1940-41

Every student who takes this course for five credits is expected to put a minimum of four (4) hours a week on laboratory work. DO NOT LET YOURSELF GET BEHIND. Completion dates must be adhered to for unexcused overdue reports will be DENIED ANY CREDIT. Ordinarily all laboratory work will be done in Room 206. If you have to remove any maps PLEASE RETURN THEM AT ONCE. University maps should not be taken from the building or to offices without advance permission. Please pick up all maps on the tables when leaving the room and place them in a neat pile. Maps will be furnished on which to show the boundaries of all provinces and the LOCATION OF ALL SMALL MAPS USED. Maps of physiographic provinces, geology, and physiographic features are available in the laboratory. Consult references in library or models in hall whenever necessary. Keep rough notes in pencil which may be copied in ink or typewritten. Completed reports should be handed in on 8½ x 11 inch paper in a folder. Use of colored diagrams adds to effectiveness of report. Colored pencil may be made to look better by rubbing with a scrap of blotting paper or cloth with gasoline if possible. Your general map must be kept up to date because it may be inspected at any time. You may keep this map in a drawer in laboratory at your own risk. A ruler or cross section paper (any number of divisions to the inch) may be used for sections. Scales are limited to avoid misleading exaggeration.

GENERAL: Place on your general map: (a). The location of all small maps (number and place key in margin), (b). Boundaries of all subdivisions of the province from text, (c). Niagara escarpment, (d). Magnesian escarpment, (e). Onondaga-Dundee escarpment from geological map of U. S., (f). Areas outside present Great Lakes with name and outlets of Glacial Lakes Wisconsin, Chicago, and Maumee, (g). Actual boundary of unglaciated part of the Drftless Section from map of glacial drifts of U. S.

GREAT LAKES SECTION:

Urbana, Illinois and model of Illinois on 3rd floor.
Account for Yankee Ridge; for the surrounding flat areas. Describe the post-glacial valleys of the area. See pp. 512-515.

Oconomowoc, Wisconsin and map of Quaternary geology of southeastern Wisconsin. Contrast the complex topography with that of Urbana. Explain. How were the higher areas formed? p. ~~447~~ 417 What are the flat areas around the lakes? What name is applied to the lake basins? What are the oval hills in the S. E. corner?

South Haven, Michigan.
What topography due to glaciation is very similar to the range of hills? Why are these hills more abundant here than in Wisconsin on the west shore of the lake?

Berea, Ohio. See pp. 490-497.
Draw a cross section (vertical scale not less than 400 feet to an inch) from Lake Erie to Berea, northwest to southeast and account for the topography shown. What other province is shown?

Central Lowland, East of Mississippi River

Niagara River and vicinity. New York; Folio 190 (consult in library or draw for laboratory period only.) Also pp. 495 & 499.
Read legend on back of the map. Account for the falls and for the variations in width of the gorge below them. (Be brief).

Woodsport, N. Y.
Account for and name the oval hills. Account for valley of Seneca River and that followed by Erie Canal (text, pp. 495-498).

Till Plains Section.
Areal geology, Belleville, Ill.. (Folio 195 and Ill. Geol. Survey Rept. Invest. 19, pt. 1). See pp. 507-511.
List which of MacClintock's types of topography are present here? What has been the dominant process here in making the flat floors of the valleys, widening or filling? Explain how you know.

Dixon, Ill. See Illinois Geol. Survey Bull. 49, plate IV, p. 98.
Account for the curve of Rock River. Temperance Hill School is on the moraine of a late glacier. Compare hills there with topography along streams farther north.

Driftless Section.
Galena, Ill. (Illinois Geol. Survey Bull. 26 or Folio 200). See pp. 522-525.
Note the "two story" nature of the topography and illustrate by a cross section, (vertical scale not less than 1 inch to 800 ft.) from Guilford to Council Hill. Geology students show the several formations present. What two explanations have been advanced for such topography?

SUMMARY: When you have completed your notes, the summary can be finished elsewhere if you desire. However, do not cut your regular laboratory periods to do this, but start ahead with the next province. Make all answers explicit and not just "yes" or "no." Make it clear to anyone just what you are trying to say. After the answers to the foregoing questions, write a brief, (LIMIT FOUR PAGES), summary of the province on following outline. You may, if desired, incorporate answers and diagrams called for above in body of report as "examples" instead of giving them separately, in which case more than four pages will be allowed.

Definition of province, first in terms of FACT, then, if necessary, in terms of INTERPRETATION. Give briefly any alternative names for the province and explain how derived.

Boundaries of the province and its main subdivisions, not merely what it adjoins but the nature of the boundary, for instance as "escarpment", "change in geology", "edge of glacial drift", etc.

Geology Kind rather than age of rocks is more important but give column
Topography in terms of facts. Distinguish between "relief" and "elevation".

History of the topography, that is, the interpretation of the foregoing information on geology and topography. Explain fully all essential steps in origin of present surface. USE DIAGRAMS wherever this helps, but MAKE THEM A PART OF THE DISCUSSION. Make these clear and neat. Defer the peneplain controversy to report on field trip.

Geology 130

PHYSIOGRAPHY OF THE UNITED STATES

Laboratory
Central Lowland, West of Mississippi River
Edition of 1940-41

General: Place on general map (a) limits of sections (see also Fig. 174. p. 617) (b) border of unglaciated areas. (c) pre-Cambrian areas (map of U. S.) (d) Flint Hills (e) Niagara escarpment of Iowa (f) Lake Agassiz (p. 580 and glacial map of Minnesota) (g) maps as usual.
Young drift and dissected till plains, sections.
St. Paul (geological) Minn. (Folio 201)
Account for the difference in size of valleys of Mississippi River and Minnesota River above Fort Snelling (Text p. 585)

Camp Dodge, Iowa: Read legend on back. Explain why there is so gradual a transition at edge of young drift. Why was valley of Des Moines river so deeply eroded? Contrast topography of old drift and young drifts where distant from the main streams. Use cross sections if desired of typical parts. Do not use less than 400 feet to inch for vertical scale.

Elk Point--see folio 156 (library)
What two sections are shown? Compare their topography--See Fig. 3. p. 3. Was the rock valley of the Missouri River present before Wisconsin Glaciation? See section on p. 7. Compare your conclusions on sections with Plate V in text.

Wall map of outlet of Lake Agassiz, White Rock and Beardsley, Minn.
See map of glacial deposits of Minnesota. How are beaches indicated? Why are they at several levels? What is the origin of Traverse Lakes, of Cottonwood Slough? (Big Slough valley) (text pp. 579-583)

Osage Section. Foraker, Oklahoma. See geological map of Oklahoma. Account for the escarpment and draw a cross section of it showing the hard layer which causes it. (Geology students give names of formation).

Tishomingo, Indian Territory, (Folio 98)
Read sections on topography, p.p, 1, 2; geologic structure, history of the Arbuckle mountain structures, p. 7. Account for the ridges near Nebo and Sylvan. Account for the levelness of the granite areas. When was most of the erosion of the folded rocks done? See also Geol. Soc. America, vol. 39, p. 1047, second section. Near the center of the mountains, remnants of Pontotoc lie nearly horizontal. See Plate 16, p. 56, Oklahoma Geol. Survey Bull. 46.

Wichitas. See above reference, first section, for structure. Copy sections in your report.

Geological map of Kansas
Account for the ridges of eastern Kansas. Why is province boundary located where it is? (text p. 606) What causes the escarpments?

Summary as usual. Discuss under boundaries the suggested exclusion of major pre-Cambrian area of Minnesota.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

Laboratory questions, Superior Upland, Edition of 1940-41.

Wausau, Wisconsin. See also geological maps and Wis. Bull. 16, 592-600; 36, 369-375, text p..540. What evidences indicate that this area once had a higher relief than it now has? Where are remnants of the pre-Cambrian peneplain still preserved? Reasoning from these areas, what has happened since the area once had so low relief? If you went in the field, would you find it as easy to tell what part of this area had been glaciated as it is around Madison? Explain fully. What do we depend upon as proofs of glaciation?

Houghton and Calumet, Michigan. pp. 543-544. Make a small sketch without much exaggeration of vertical scale showing the geological structure of this ridge. See 1935 map of geology of Lake Superior region or consult map of structure in laboratory. Do not use same symbols as on map. Consult map from Professional Paper 154. Describe the differences in topography above and below the highest beach line. Explain. Account for the great escarpment of southeast side of the Range. Why do the rocks northwest of this form hogbacks? Locate a good example of a hogback.

Brainerd, Minn. and map of surface formations of Minnesota. pp. 544-551. Account for topography (a) S. E. of Brainerd including the oval hills, (b) W. of Brainerd, (c) along Long Lakes and in N. W. part of map, (d) N. E. of Woodrow.

Superior and Duluth, Wisconsin-Minnesota. pp. 551-552. See map of Lake Superior structure and from them draw a sketch cross-section showing the relation of this valley to the main syncline to the southeast. Show only (a) old hard rocks, (b) Keweenawan lava flows, and (c) sandstones. Account for the escarpment south of the lake. Account for escarpment north of the lake. (See discussion in Monograph 52 or K. G. S. 226). Make a table showing origin: (a) Minnesota Point, (b) irregular topography in extreme south of map, (c) Manitou Falls, (d) smooth topography at Superior, (e) V-shaped valley of Nemadji River, (f) shore ridge of Spirit Lake, (g) shoreline of St. Louis Bay, (h) curves in state boundary. (See Bull. 36, 447-452, also chart of harbor).

Map of bottom of Lake Superior--see also same map in guidebook of Kansas Geological Society, p. 226, text pp. 551-558. (Faults as located on this map do not agree with other interpretations), and map of structure of Lake Superior basin. Account for the plateau of the Apostle Islands. Account for the enclosed depression in eastern part of the lake. Account for the submerged ridge northeast from Keweenaw Point. Geology students draw cross sections (vertical scale not less than 2000 feet to inch) (a) from Saw Tooth Mt. S. E. through Outer Island to Porcupine Mts., (b) east from Stannards Rock to Theano Point. Indicate (a) pre-Keweenawan, (b) flows, (c) sandstones.

On your general map show (a) the corrected boundary of the hard rocks from geological maps of Minnesota and Wisconsin, (b) areas of Lake Superior sandstone Aku (1935 map of Lake Superior region) (c) Middle Keweenawan lava flows Akmb, (d) border of young drift, and (e) old (pre-Wisconsin) drift.from map of Wisconsin. Contrast in summary the topography of these four divisions with that of the massive igneous and metamorphic rocks and explain why there is a difference. Explain why this difference is not equally shown at all places. Explain difficulty of locating the border of the province. Change border in Minnesota to agree with (a) above.

Summary on outline previously given. The limit of four pages will be strictly enforced. Do not forget history of Lake Superior Basin.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES
Laboratory, Coastal Plain, Edition 1940-41.

Floridian Section

Tsala Apopka, Florida, See fig. 16, p. 47.
Account for the moraine-like topography with lakes and for the comparatively level northeastern part of the map. (p. 50.)

East Gulf Section

Memphis, Tenn.-Ark.
Describe in simple words the topography of the west half and then the east half of the map. Next account for these differences stating the geologic age of one half of the map, stating also the age of each in terms of the cycle of erosion. Why does the Wolf River join the main stream here? (Text, p. 91). Account for Horn Lake Cutoff and for the location of Memphis.

Embayed Section.

Sandy Hook, New Jersey. Text pp. 22-23.
See also block diagram of N. J. and geologic map of N. J. Account for the row of hills which ends in the Highlands of Navesink. Account for the shape of Sandy Hook.

Choptank, Maryland, geological edition. See Folio 182 and text pp. 24-34.
State definitely in proper order the recent physiographic history which explains the topography of this area only.

Camp Upton (Moriches), New York.
Read parts of the legend on the back which bear on the subject. Draw a diagrammatic cross section of Long Island showing the Cretaceous cuesta, the terminal moraines, and the outwash plains. See text, pp. 19-21. Why is outwash between the moraines pitted? Account for Fire Island Beach.

Norfolk, Va. (Folio 80).
Account for (a) the Desert, (b) the shape of the Atlantic coast, and (c) the shape of the Elizabeth River Coast.

Mississippi Alluvial Plain

Reelfoot Lake, Tenn., Mo., Ky.
Account for the lake (pp. 85-87) and for the high area north of Tiptonville. Why should the effects of shaking be more manifest on the floodplain than in the adjacent uplands?

In the Summary attention should be directed to (a) the nature and origin of the Fall Line, (b) evidence of former extent of the Coastal Plain Inland, (c) two hypotheses to explain the marine terraces, (d) extension of Piedmont hard rocks under the Coastal Plain (Geol. Soc. Am. 48, 753-812), (e) salt domes. Show in map (a) Black Belt, (b) terminal moraine, (c) Mississippi floodplain, (d) Crowley's Ridge, (e) the major cuesta escarpments shown on the Lobeck diagram. Show quadrangles as usual.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

Laboratory-Piedmont Plateau, Edition 1940-41

Gastonia, North Carolina--See Geological Map of U. S.: For air views of this province see Geogr. Rev. 29, pp. 562-564.
Locate on this map streams which have been influenced by structure of the rocks. Why do the main streams of the area apparently disregard geology? (Text pp. 124-125). Outline reasons for thinking that this region once had greater relief than it has today, illustrating this by a sketch-section which shows the geology and its relation to original surface. Next outline your reasons for thinking that this area once has less relief than it has today and illustrate this with an actual profile from some part of the map on which the surface before uplift is restored with a dotted line.

Elkton-Wilmington Folio No. 211.
Read the sections on Physiographic Divisions and Surface Features of the Piedmont, pp. 1-4 and on Geologic History of the Piedmont, pp. 15-16. Compare the slope of the top of the older rocks below the Coastal Plain with average slope of the exposed Piedmont using a ruler on Fig. 4, p. 15. (Note and determine error on its legend). What physiographic term is given to this surface under the Coastal Plain? See Text p. 126.

Passiac, New Jersey-New York; block diagram of New Jersey; geological map of N. J. or Folio No. 157. Text pp. 145-152.
Account for the straight border of the hills in the northwest corner of the map. Give reason for the hypothesis that this area once had a level topography. What significance has the name "Short Hills"? Account for the gaps in the trap ridges and for the fact that some now have no streams in them. Geology students show structure of area by a cross section.

Talking Rock, Georgia.
What physiographic provinces are shown? Plate III, text. What is the significance of (a) entrenched meanders (b) steep slopes adjacent to main streams? Text, p. 134.

Warm Springs, Ga. (See Water Sup. Paper 819 or Geol. map of Georgia). Account for Oak and Pine Mountains and for the course of Flint River. Name other similar stream courses. Note distribution of tertiary gravel, etc.

Write a summary on same outline as previous provinces. Discuss, in proper places, (a) reasons for and against making the Piedmont crystallines and the Triassic of New Jersey-Virginia separate physiographic provinces; (b) three possible methods by which the relatively even surface of the Piedmont could have been produced from the ancient mountains, and (c) state evidence for the burial of Piedmont by coastal plain sediments. Put on your map (a) areas of Triassic rocks, (b) name Trenton Prong, (c) terminal moraine, (d) border of glaciated area, (e) three prominent monadnocks with names.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

Laboratory, Blue Ridge, Edition 1940-41

For information on geology refer either to Geological map of United States or to maps of states where there are such. Folios may be consulted in the library or withdrawn for duration of laboratory period. For air views of Blue Ridge see Geogr. Review, vol. 29, p. 565, figs. 7 and 8.

Pisgah, North Carolina-South Carolina. See Folio No. 147.
Account for the difference in average level of the French Broad and South Saluda river valleys. Locate examples of past drainage changes along the Blue Ridge and account for them. What is the drainage pattern? Explain. (Text p. 179).

Mt. Mitchell, North Carolina-Tenn. See Folio No. 124.
What determined the relative resistance to weathering of the different kinds of rocks? (Text, p. 176). Describe the kinds of summit outlines which you find on the peaks (Text, p. 174). What is the significance (a) of entrenched meanders, (b) of broad parts of the valleys within the mountains?

Antietam, Va.-Md. See geological maps of states.
What is the cause of the three prominent ridges?
Do the entrenched meanders seem to have any relation to these belts of hard rocks? Explain.

Fairfield, Pa. See Folio 225.
What are topographic results of faulting on the contact of Blue Ridge rocks with the Gettysburg Plain to the east? What kind of rock makes up the tops of the highest ridges? What fact has been used as evidence (Text, p. 167) that the ridges were once part of a lowland? Is another conclusion possible?

Saluda, N. Carolina, S. Carolina.
Distinguish remnants of (a) subsummit peneplain (Text, p. 179) and (b) Ashville peneplain (pp. 180-182). What evidence shows that the divide is now shifting northwestward (p. 191)? Draw a cross section with vertical scale not less than 2000 feet to the inch from Hendersonville to Columbus. Label peneplain levels. Geology students show bed rocks.

Greenville, Tenn.-N. C. (structure sections) (Folio 118)
Account for Bald Mts., their structure, and elevation above remainder of Blue Ridge.

Speedwell, Va. . Geol. map of Virginia.
Describe geological justification for border of Blue Ridge shown by Fenneman on Plate II.

In your summary pay particular attention to the several hypotheses of the origin of the Blue Ridge (Text, pp. 163, 186-194). Diagrams will help to explain these. The problem of water gaps will be deferred to report on Ridge and Valley Province. Illustrate your history with a series of generalized cross sections, each of which shows a major step in development of the Blue Ridge and Piedmont. Label carefully and explain in text. Besides the quadrangles and boundary , show on map (a) Carlisle Prong, (b) Mark with symbol)(water gaps of three large rivers which cross the province from west to east into names (c) gap of a stream which flows in reverse direction with name.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

Laboratory questions, Ridge and Valley, Edition 1940-41.

Refer to geological maps and to models in halls. For air views see Geogr. Rev., vol. 29, pp. 566-576, 1939.

Ghattanooga (Folio No. 6).
Why has so much interest been aroused in accounting for the course of the Tennessee River? Explain fully the two major hypotheses which have been advanced for this particular gap, but reserve discussion of their merits to summary. (Text, pp. 276-277).

Delaware Watergap, edition of 1922.
First read the legend on the back. What evidence seen on this map is commonly to demonstrate that the region was once almost level? That since then there have been other cycles? Geology students use one of the figures on the back as a guide and the data obtained from the cross section in the Elkton-Wilmington Folio make a new section which shows how it has been attempted to attach geologic dates to the old land surfaces. (Section must include coastal Plain) (Text, p. 256). Show bed rocks.

Greenland Gap; geological map of West Virginia. (See air views cited above). Draw a cross section from near the NW corner southeast across the main ridges in NW part of the map. USE SAME VERTICAL AND HORIZONTAL SCALES. On this show the geological formations with names of ridge formers.

Natural Bridge special; geological map of Virginia. See Jour. Geol. 44, pp. 604-616. Discuss origin of the Natural Bridge. What physiographic provinces are shown on the map? Account for the valley of Cedar Creek in Short Hills. Geology students draw section showing structures just north of Spring Gap.

Eagle Rock, Virginia
Name the formation responsible for each mountain which is named. Account for the irregular topography of region around Timber Ridge. Account for the meanders of Craig Creek including their size and evidence of changes in them. Geology students draw cross section showing geology between Lignite and Fincastle. Do not exaggerate vertical scale.

Wardensville, West Virginia, Va.
Explain structure of (a) Paddy Mt., (b) North Mt., (c) Anderson Ridge, (d) Short Mt., using diagram for each. Explain the underground course of the River through Sandy Ridge. What other areas of underground drainage do you find? Geology students make structure section from Waterlick Run to SE corner.

Harrisburg and New Bloomfield, Pa.
What structure (anticline or syncline) is shown north of Harrisburg? How known? Geology students draw structure section right angles to strike from Hockert Gap north.

Hollidaysburg, Pa.
Account for the form of Loop Mt. How can you tell direction of dip?

Write summary on regular outline. In the section on Topography include a series of diagrams showing (a) monoclinal mountain, (b) synclinal mountain, (c) anticlinal mountain. Also explain the criteria by which you can read geologic structure from

the contour map. In the section on History include discussion of (a) evidences for and against former regional and partial peneplains, (b) how these were dated in the geologic time scale, with reference to cross section of Delaware water gap, and (c) origin of water gaps and wind gaps, the last including a comparison pf the several hypotheses advanced (pp. 257-360). Show on map (a) watergaps with names of three rivers which cross from NW to SW, (b) gaps and name of two rivers from SE to NW, (c) terminal moraine and (d) border of unglaciated area (map of Pennsylvania).

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES
Laboratory questions, New England, Edition 1940-41

Eastport, Maine, geological and structure maps. See Folio No. 192.
How does the topography show the gelogic structure? What relation exists between topography and the direction of glacial movement? How does this bear upon the amount of glacial erosion? List in order the events which have occurred in this area since the ice retreated.

Hartford, Ct. and wall map of surface geology of Connecticut.
Explain the two theories of the origin of the terraces using diagrams given in class. See Bull. 47 Ct. Geol. Survey, pp. 19-27. Text, pp. 373-376, 386-391.

Rochester, Vermont.
What mountains are shown and what kinds of bed rock? Suggest two distince factors which helped produce the rounded summits.

Passadumkeag, Maine. See glacial map of Maine (wall).
Draw a sketch outline of the quadrangle showing the eskers. What is the origin of such ridges?

Hawley, Mass., Vt.
Is there evidence of rejuvination of the streams of this area? Explain. What kind of topography was present before (state average relief)? Draw a cross section with vertical scale not exaggerated over five times to show evidence of uplift. Choose location carefully and show restored old surface. Geology students show bed rocks.

Write summary on same outline as before. Include in proper places a discussion of (a) why New England is considered a separate province and (b) reasons for and against the existence of dissected peneplains in New England (Text, pp. 358-368). (c) Under glacial history discuss both local glaciation and the hypothesis of stagnation of the continental ice sheet. Letter on map (a) Mt. Monadnock, (b) Green Mountains, (c) White Mountains, (d) Connecticut valley Triassic area, (e) Reading Prong, (f) Manhattan Prong, (g) Highlands of Hudson.

GEOLOGY 130
PHYSIOGRAPHY OF EASTERN UNITED STATES
Laboratory

Adirondacks, Edition 1940-41

Lake Placid, N. Y. See pictures in New York State Museum. Bull. 193. Account for the rounded mountains. Locate examples of drainage changes due to glaciation (Text, pp. 393-407).

Elizabethtown, N. Y.
How does this map show the effects of faults on topography (text, pp. 393-394)? What demonstrates the presence of local glaciers (pp. 408-409)?

Lowville, N. Y. (Text, PP. 325-326, 395-396, 406-407).
Account for the land areas with kettles in eastern part. Where did the ice last longest? What might have occupied the spaces ascribed by some geologists to open water lakes? Compare the shapes of hills in eastern hard rock part of the map with those west of Black River.

On map besides boundaries and quadrangles, show areas of (a) intrusive rocks, (b) gneiss. Letter on map (a) Mt. Marcy (b) Whiteface

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

Laboratory questions, Interior Low Plateau, Edition 1940-41

Greenbrier, Tenn.; See geological map of Tennessee.
What name is given to the escarpment north of Nashville? Account for it. (text, pp. 415-419 and 431-434).

Georgetown, Kentucky, (pp. 427-431).
What name is given to the kind of topography found on tops of the ridges? Account for it. What suggests that relief was once less than now?

Cub Run, Kentucky, (pp. 445-448).
Account for the formation of the valley of Nolin River. Account for the upland in northwest part of map and for the sink holes in east part.

Hollow Springs, Tennessee, (pp. 415-419).
Account for the Plateau of the Barrens. (See geological map of Ky.)

Vienna, Illinois, (pp. 434-440).
What formation is cause of the high bluffs in north part?
Draw a cross section with a reasonable vertical scale from Mermet through Gannatown N. E. to Johnson Creek to edge of map and account for features shown. Show the hard layers which are sandstones. What is origin of the wide valley from Karnak east through Mermet? (p. 90)

Summary as usual. As an illustration show on an E. W. cross section of Kentucky (from geological map) the probable position of Highland Rim peneplain. Explain why this surface is not preserved in the Nashville Basin? On map show (a) limits of Blue Grass and Nashville Basins, (b) Dripping Springs escarpment (edge of Chester), (c) Pottsville escarpment, (d) Mammoth Cave, (e) Knobstone escarpment in Indiana (fig. 116).

Kasmosdale, Ky.-Ind.
Account for the escarpment and give the name (pp 318, 425). Account for the course of Pond Creek and mention other examples of this phenomenon. What is the type example of such streams? What two explanations may be made for the downstream narrowing of the Ohio bluffs?

This is the last laboratory exercise and must be handed in long enough before the final examination to be graded.
Your map should also be handed in for final grading. Remember that neatness counts.

GEOLOGY L30
PHYSIOGRAPHY OF THE UNITED STATES
LABORATORY

Central Lowland, East of Mississippi River
Edition of 1939-40

Every student who takes this course for 5 credits is expected to put a Minimum of four(4) hours a week on laboratory work. It is very important to keep this work up to date: DO NOT LET YOURSELF GET BEHIND. Completion dates must be adhered to for unexcused overdue reports will BE DENIED ANY CREDIT. Ordinarily all laboratory work will be done in Room 206. If you have to remove any maps PLEASE RETURN THEM AT ONCE. University maps should not be taken from the building or to offices without advance permission. Please pick up all maps on the tables when leaving the room and place in a neat pile. Maps will be furnished on which to show the boundaries of all provinces and the LOCATION OF ALL SMALL MAPS USED. Maps of physiographic provinces, geology, and physiographic features are available in the laboratory.. Consult references in library or models in hall whenever necessary. Keep rough notes in pencil which may be copied in ink or typewritten. Completed reports should be handed in on 8½ x 11 inch paper in a folder. Use of colored diagrams adds to effectiveness of report. Colored pencil may be made to look better by rubbing with a scrap of blotting paper or cloth. Your general map must be kept up to date and may be inspected with each exercise. You may keep this map in a drawer in laboratory. A ruler is needed or cross section paper (any number divisions to the inch) may be used.for sections.

GENERAL: Place on your general map (A). The location of all small maps (number and place key in margin), (B). Boundaries of all subdivisions of the province, (C). Niagra escarpment, (D). Magnesian escarpment, (E). Onondaga-Dundee escarpment, (F). Areas with name and outlet of Glacial Lake Wis. Chicago, and Maumee, (G) Actual boundary of unglaciated part of the Driftless Section.

GREAT LAKES SECTION:

Urbana, Illinois and model of Illinois on 3rd floof.
Account for Yankee Ridge; for the surrounding flat areas. Describe the post-glacial valleys of the area. See pp. 512-515.

Oconomowoc, Wisconsin and map of Quaternay geology of southeastern Wisconsin. Contrast the complex topography with that of Urbana . Explain. How were the higher areas formed? p. 147 What are the flat areas around the lakes? What name is applied to the lake basins? What are the oval hills in the S. E. corner?

South Haven, Michigan.
What very similar topography is due to glaciation? Why are these hills more abundant here than in Wisconsin on the west shore of the lake?

Calumet City, Illinois-Indiana. See pp. 490-497
Draw a cross section (vertical scale not less than 80 feet to an inch) from southwest to northeast and account for the topography shown. The beaches starting at southwest are Glenwood, Calumet,Toleston group. Lable each.

Chart of Lake Huron.
Account for the ridges of (A) Saugeen Peninsula-Manitoulin Island and (B) Pt. Clark to North Point. See Physiographic Diagram of U. S.

Niagara River and vicinity. New York; Folio 190 (consult in library or draw for laboratory period only.) Also pp. 495 & 499.
Read legend on back of the map. Account for the falls and for the variations in width of the gorge below them (be brief).

Sun Prarie, Wis. (See mapof Quaternary geology of southeastern Wisconsin). Account for and name the oval hills. What topographic features occur in the terminal moraine strip? Contrast with ground moraine areas.

Camp Custer, Michigan. Read legend on back.
How do the contours show the difference between pitted outwash and terminal moraine? What other name is given to a till plain? Draw a cross section from Gull Lake northeast to Dunn School near Fair Lake through Hickory Corners. Vertical scale not less than 400 feet to the inch. Lable moraine and pitted plain.

Till Plains Section

Areal geology, Breese, Ill. (Folio 195 and Ill. Geol. Survey Rept. Invest. 19, pt. 1.) See pp. 507-511.
How many of Mac Clintock's types of topography are present here. List them.
Account for the narrows in the valley crossed by the B. and O. R. R. east of Trenton.
What has been the dominant process here in making the flat floors of the valleys, wkdening or filling? Explain how you know.

Driftless Section

Kendall Wis. See pp. 522-525.
Note the "two story" nature of the topography and illustrate by a cross section, (vertical scale 1 inch to 800 or more feet) from Meyers Hill northeast to the plains. Account for the level plain to the north. Account (see 1932 edition of Bull. 36, pp. 4 and37) for the double escarpment. Lable each. Geology students should show the several formations present.

SUMMARY:When you have completed your notes, the summary can be finished elsewhere if you desire. However, do not cut your regular laboratory periods to do this, but start ahead with next province as soon as directions are ready. Make all answers explicit and not just "yes" or "no". Make it clear to anyone just what you are trying to say. After the answers to the foregoing questions, write a brief, (LIMIT FOUR PAGES) summary of the province on following outline. You may, if desired, incorporate answers and diagrams called for above in body of report as "examples" instead of giving them separately,in which case more than four pages will be allowed.

Definition of province, first in terms of FACT, then, if necessary, in terms of INTERPRETATION. Give briefly any alternative names for the province and explain how derived.

Boundries of the province and its main subdivisions not merely what it adjoins but the nature of the boundary, for instance as "escarpment", "change in geology", "edge of glacial drift", etc.

Topography in terms of facts. Destinguish between"relief" and "elevation".

History of the topography, that is, the interpretation of the foregoing information on geology and topography. Explain fully all essential steps in orgin of present surface. USE DIAGRAMS wherever this helps, but MAKE THEM A PART OF THE DISCUSSION.

Sometimes it is desirable to make a series of cross sections, each of which illustrates a step in development. Such are generally, but not always, given in class first. Make them carefully with no line or mark unless it means something.

Geology 130

PHYSIOGRAPHY OF THE UNITED STATES

Laboratory
Central Lowland, West of Mississippi River
Edition of 1939-40

General: Place on general map (a) limits of sections (see also Fig. 174, p. 617) (b) border of unglaciated areas. (c) pre-cambrian areas (d) Flint Hills (e) Niagara escarpment of Iowa (f) Lake Agassiz border (p. 580) (g) maps as usual.

Young drift and dissected till plains, sections.

Camp Dodge, Iowa: pp. 574, 594-600
Read legend on back. Explain why there is so gradual a transition at edge of young drift. Why was valley of Des Moines river so deeply eroded? Contrast topography of old drift and young drifts where distant from the main streams. Use cross sections if desired.

Elk Point--see folio 156
What two sections are shown ? Over this conclusion check Fenneman's map. Compare their topography--See Fig. 3, p. 3. Was the rock valley of the Missouri River present before Wisconsin glaciation? See section on p. 7.

White Rock, Minnesota--South Dakota and wall map of outlet of Lake Agassiz. The map of glacial deposits of Minnesota. How are beaches indicated? Why are they at several levels? What is the origin of Traverse Lakes, of Cottonwood Slough? See pp. 579-583.

Osage Section
Foraker, Oklahoma. See geological map of Oklahoma and pp. 606-615.

Account for the escarpment and draw a cross section of it showing the hard layer which causes it. Geology students give names of formation.

Tishomingo, Indiana, Tennessee, Oklahoma--Folio 98 (Library) also pp. 622-626
Read sections on topography, pp. 1, 2; geologic structure, history of the Arbuckle mountain structures, p.7. Account for the ridges near Nebo and Sylvan. Account for the levelness of the granite areas. When was most of the erosion of the folded rocks done? See also Geol. Soc. America, vol. 39, p. 1047, second section. Near the center of the mountains, remnants of Pontotoc lie nearly horizontal. See Plate 16, p. 56, Oklahoma.

Wichitas. See above reference, first section, for structure.
Read pp. 626-628
Copy section and explain what it means and what district in Wisconsin it resembles.

Summary on outline previously given.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

Laboratory questions, Superior Upland, Edition of 1939-40

Wausau, Wisconsin. See also geological maps and Wis. Bull. 16, 592-600; 36, 369-375, text p. 540. What evidences indicate that this area once had a higher relief than it now has? Where are remnants of the pre-Cambrian peneplain still preserved? Reasoning from these areas, did or did not the area once have a lower relief than it does now. Reconcile these two results. If you went in the field, would you find it as easy to tell what part of this area had been glaciated as it is around Madison? Explain fully. Explain the flat floors of the large valleys.

Houghton and Calumet, Michigan. pp. 543-544. Make a small sketch without much exaggeration of vertical scale showing the geological structure of this ridge. See 1935 map of Lake Superior region or consult map of structure. Do not use same symbols as on map. Consult map from Professional Paper 154 and then describe the differences in topography above and below the highest beach line. Explain. Account for the great excarpment of southeast side of the Range. Why do these rocks from hog-backs? Locate a good example of a hogback.

Brainerd, Minn. and map of surface formations of Minnesota. pp. 544-551. Account for topography (a) S. E. of Brainerd including the oval hills, (b) W. of Brainerd, (c) along Long Lakes and in N. W. part of map, (d) N. E. of Woodrow.

Superior and Duluth, Wisconsin-Minnesota. pp. 551-552. See map of Lake Superior structure and from them draw a sketch cross-section showing the relation of this valley to the main syncline to the southeast. Show only (a) old hard rocks, (b) Keweenawan lava flows, and (c) sandstones. Account for the escarpment south of the lake. Account for escarpment north of the lake. (See discussion in Monograph 52, or K. G. S. 226). Make a table showing physiographic significance of: (a) Minnesota Point, (b) irregular topography in extreme south of map, (c) Manitou Falls, (d) smooth topography at Superior, (e) V-shaped valled of Nomadji River, (f) shore ridge of Spirit Lake, (g) shoreline of St. Louis Bay, (h) curves in state boundary. (See Bull. 36, 447-452, also chart of harbor).

Map of bottom of Lake Superior--see also same map in guide book of Kansas Geological Society p. 226, text pp. 551-558. (Faults incorrectly located on this map), and map of structure of Lake Superior basin. Account for the plateau of the Apostle Islands. Account for the enclosed depressions in eastern part of the lake. Account for the submerged ridge northeast from Keweenaw Point. Biology students draw cross sections (vertical scale not less than 2000 feet to inch) (a) from Saw Teeth Mt, S. E. through Outer Island to Porcupine Mts., (b) east from Stannards Rock to Theano Point. Indicate (a) pre-Keweenawan, (b) flows, (c) sandstones.

On your general map show (a) the corrected boundary of the hard rocks from geological maps of Minnesota and Wisconsin, (b) areas of Lake Superior sandstone Aku (see 1935 map of Lake Superior region) (c) Middle Keweenawan lava flows Akmb, (d) border of young drift, and (e) old (pre-Wisconsin) drifts from map of Wisconsin. Contrast in summary the topography of these four divisions with that of the massive igneous and metamorphic rocks and explain why there is a difference. Explain why this difference is not equally shown at all places. Explain difficulty of locating the border of the province. Change border in Minnesota to agree with (a) above.

Summary on outline previously given. Limit four pages. (strictly enforced)
Do not forget history of Lake Superior Basin.

GEOLOGY 130

PHYSIOGRAPHY OF THE UNITED STATES
Laboratory, Coastal Plain, Edition 1939-40

Floridian Section

Tsala Apopka, Florida. See fig. 16, p. 47
Account for the moraine-like topography with lakes and for the comparatively level northeastern part of the map. p. 50.

East Gulf Section

Vicksburg, Mississippi.
Describe in simple words the topography of the west half and then the east half of the map. Next account for these differences stating the age of each half of the map. Next account for these differences stating the age of each in terms of the cycle of erosion. Why does the Yazoo River join the main stream here? (Text, p. 91) How did this affect the military importance of Vicksburg in the Civil War? (See Physiographic diagram of U. S.). What evidences do you find that the course of the Mississippi has changed during historic time? Explain fully. What name suggests the date of such a change? Explain why the Mississippi has large meanders and the Yazoo smaller ones. Explain why meanders on a flood plain are smaller than entrenched meanders of similar sized streams.

Embayed Section.

Sandy Hook, New Jersey. Text pp. 22-23.
See also block diagram of N. J. and geologic map of N. J. Account for the row of hills which ends in the Highlands of Navesink. Account for the shape of Sandy Hook.

Choptank, Maryland, geological edition. See Folio 182 and text pp. 24-34.
State definitely in proper order the recent physiographic history which explains the topography of this area only.

Camp Mills, New York.
Read parts of the legend on the back which bear on the subject. Draw a diagrammatic cross section of Long Island showing the Cretaceous cuesta, the terminal moraines, and the outwash plain. See text, pp. 19-21.

Mississippi Alluvial Plain

Reelfoot Lake, Tenn., Mo., Ky.
Account for the lobe (pp. 85-87) and for the high area north of Tystonville. Why should the effects of shaking be more manifest on the floodplain than in the adjacent uplands?

In the Summary attention should be directed to (a) the nature and origin of the Fall Line, (b) evidence of former extent of the Coastal Plain inland, (c) hypotheses to explain the marine terraces, (d) extension of Piedmont hard rocks under the Coastal Plain (Geol. Soc. Am. 48, 753-812), (e) salt domes. Show in map (a) Black Belt, (b) terminal moraine, (c) edge of drift where different, (d) Mississippi floodplain, Crowley's Ridge, (f) the major cuesta escarpments shown on the Lobeck diagram. Show quadrangles as usual.

GEOLOGY 130

PHYSIOGRAPHY OF THE UNITED STATES
Laboratory-Piedmont Plateau, Edition 1939-40

Gastonia, North Carolina--See Geological Map of U. S.: For air views of this province see Geogr. Rev. 29, pp. 562-564.
Locate on this map streams which have been influenced by structure of the rocks. Why do the main streams of the area apparently disregard geology? (Text pp. 124-125). Outline your reasonsfor thinking that this region once had greater relief than it has today, illustrating this by a sketch-section which shows the geology and its relation to original surface. Next outline your reasons for thinking that this area once had less relief than it has today and illustrate this with an actual profile from some part of the map on which the surface before uplift is restored with a dotted line.

Elkton-Wilmington Folio No. 211
Read the sections on Physiographic Divisions and Surface Features of the Piedmont, pp. 1-4 and on Geologic History of the Piedmont, pp. 15-16. Compare the slope of the top of the older rocks below the Coastal Plain with average slope of the exposed Piedmont using a ruler on Fig. 4, p. 15. (Note error on its legend). What physiographic term is given to this surface under the Coastal Plain? See Text p. 126.

Passiac, New Jersey-New York; block diagram of New Jersey; geological map of N. J. or Folio No. 157. Text pp. 145-152.
Account for the straight border of the hills in the northwest corner of the map. Give reason for the hypothesis that this area once had a level topography. What significance has the name "Short Hills"? Account for the gaps in the trap ridges and for the fact that some now have no streams in them.

Talking Rock, Georgia
What physiographic provinces are shown? Plate III, text. What is the significance of (a) entrenched meanders (b) steep slopes adjacent to main streams? Text, p. 134.

Write a summary on same outline as previous provinces. Discuss, in proper places, (a) reasons for and against making the Piedmont crystallines and the Triassic of New Jersey-Virginia separate physiographic provinces; (b) two possible methods by which the relatively even surface of the Piedmont could have been produced from the ancient mountains, and (c) state evidence for the burial of Piedmont by coastal plain sediments either marine or alluvial. Put on your map (a) the areas of Triassic rocks, (b) Trenton Prong, (c) terminal moraine, (d) border of glaciated area, (e) three prominent monadnocks with names.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

Laboratory, Blue Ridge, Edition 1939-40

For information on geology refer either to Geological map of United States or to maps of states where there are such. Folios may be consulted in the library or withdrawn for duration of laboratory period. For air views of Blue Ridge see Geogr. Review, vol. 29, p. 565, figs. 7 and 8.

Pisgah, North Carolina-South Carolina. See Folio No. 147.
Account for the difference in average level of the French Broad and South Saluda river valleys. Locate examples of past drainage changes along the Blue Ridge and account for them. What is the drainage pattern? Explain. (Text p. 179)

Mt. Mitchell, North Carolina-Tenn. See Folio No. 124.
What determined the relative resistance to weathering of the different kinds of rocks? (Text, p. 176) Describe the kinds of summit outlines which you find on the peaks (Text, p. 174). What is the significance (a) of entrenched meanders (b) of broad parts of the valleys within the mountains?

Antietam, Va.-Md. See geological maps of states.
What is the cause of the three prominent ridges?
What relation may the entrenched meanders have to these belts of hard rocks?

Fairfield, Pa. See Folio 225.
What are topographic results of faulting on the contact of Blue Ridge rocks with the Gettysburg Plain to the east? What kind of rock makes up the tops of the highest ridges? What fact has been used as evidence (Text, p. 167) that the ridges were once part of a lowland?

Saluda, N. Carolina, S. Carolina
Distinguish remnants of (a) subsummit peneplain (Text, p. 179) and (b) Ashville peneplain (pp. 180-182). What evidence shows that the divide is now shifting northwestward (p. 191)? Draw a cross section with vertical scale not less than 2000 feet to the inch from Hendersonville to Columbus. Label peneplain levels. Geology students show bed rocks.

In your summary pay particular attention to the several hypotheses of the origin of the Blue Ridge (Text, pp. 163, 186-194). Diagrams will help to explain these. The problem of water gaps will be deferred to report on Ridge and Valley Province. Illustrate your history with a series of generalized cross sections, each of which shows a major step in development of the Blue Ridge and Piedmont. Label carefully and explain in text. Besides the quadrangles and boundary, show on map (a) Carlisle Prong (b) Mark with symbol)(water gaps of three large rivers which cross the province from west to east into names (c) gap of a stream which flows in reverse direction with name.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

Laboratory questions, Ridge and Valley, Edition 1939-40

Refer to geological maps and to models in halls. For air views see Geogr. Rev., vol. 29, pp. 566-576, 1939.

Chattanooga (Folio No. 6).
Why has so much interest been aroused in accounting for the course of the Tennessee River? Explain fully the two major hypotheses which have been advanced for this particular gap, but reserve discussion of their merits to summary. (Text, pp. 276-277).

Delaware Watergap, edition of 1922.
First read the legend on the back. What evidence seen on this map has been used to demonstrate that the region was once almost level? That since there have been other cycles? Using one of the figures on the back as a guide and the data obtained from the cross section in the Elkton-Wilmington Folio make a section which shows how it has been attempted to attach geologic dates to the old land surfaces. (Section must include coastal Plain) (Text, p. 256). Geology students show bed rocks.

Greenland Gap; geological map of West Virginia. (See air views cited above). Draw a cross section from near the NW corner southeast across the main ridges in NW part of the map. USE SAME VERTICAL AND HORIZONTAL SCALES. On this show the geological formations with names of ridge formers.

Natural Bridge special; geological map of Virginia. See Jour. Geol. 44, pp. 604-616. Discuss origin of the Natural Bridge. What physiographic provinces are shown on the map? Account for the valley of Cedar Creek in Short Hills. Geology students draw section showing structures just north of Spring Gap.

Huntington, Penna.
Account for course of Juniata River. Show structure diagrams of (a) Tussey Mt. (b) Terrace Mt. (c) Broadtop Mt.

Write summary on regular outline. In the section on Topography include a series of diagrams showing (a) monoclinal mountain, (b) synclinal mountain, (c) anticlinal mountain. Also explain the criteria by which you can read geologic structure from the contour map. In the section on History include discussion of (a) evidences for and against former regional and partial peneplains, (b) how these were dated in the geologic time scale, with reference to cross section of Delaware water gap, and (c) origin of water gaps and wind gaps, the last including a comparison of the several hypotheses advances (pp. 257-360). Show on map (a) watergaps with names of three rivers which cross from NW to SW, (b) gaps and name of two rivers from SE to NW, (c) terminal moraine and (d) border of unglaciated area (map of Pennsylvania).

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

Laboratory-Appalachian Plateau, Edition 1939-40.

For air views, see Geogr. Review, vol. 29, pp. 577-584, 1939

Foxburg quadrangle, Pennsylvania, edition showing structure; (Folio No. 178). Study the map and see how geologic structure is shown. What relation is there between structural and topographic "highs"? Explain two theories of the bearing this has on the erosional history of the area. (Text, pp. 250-293). In what stage of the erosion cycle is the area now? What other evidence do you find of relatively recent uplift or of increase in stream volume? Last, list in order steps in the physiographic history of this area which are demonstrated by evidence of this map alone. (Text, pp. 301-304, 317-319).

Watkins Glen, New York; Folio No. 169. Text, pp. 313-319.
Locate examples of (a) mature preglacial surface, (b) post-Wisconsin gorge, (c) outwash filled valley, (d) stream diverted by glaciation, (e) hanging valley, (f) youthful glaciated valley containing lake, (g) youthful glaciated valley without lake and not parallel to direction of ice movement.

Elkland, Pennsylvania, glacial geology and structure sections, Folio 93.
What dominates the topography, constructional features of glacial origin or erosional features of older age? Suggest two distinct explanations of the valley between Little Marsh and Phillips. Locate outliers of Pottsville formation and account for their preservation.

Katterskill, New York. See International Geological Congress Guidebook 9A and Text, pp. 204-206.
What physiographic provinces are shown? Explain with diagrams the drainage changes which have recently taken place on this area and tell why they took place. Text, pp. 319-323.

Davis, W. Va.
What geologic structure causes Cannan Valley. Geology students draw cross sections from Allegheny Front Northwest showing cause of hills in center of valley. Show formations and do not exaggerate vertical scale more than twice.

In the summary include in proper places in your discussion a statement as to the cause of preservation of the Plateau, summarize the problem of finding evidence of successive uplifts in this Province as compared to the Folded Appalachians, and the four hypotheses of the peculiar glaciated youthful topography of western New York. Show on map (a) Finger Lakes, (b) Cumberland Plateau, (c) Catskill Mts., (d) Tughill Plateau, (e) Mohawk Valley, (f) Teays Valley, (g) Pine Mt., Ky., (h) terminal moraine, (i) border of glaciated area (last two from map of Pennsylvania).

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES
Laboratory questions, New England, Edition 1939-40

Eastport, Maine, geological and structure maps. See Folio No. 192.
How does the topography show the geologic structure? What relation exists between topography and the direction of glacial movement? How does this bear upon the amount of glacial erosion? List in order the events which have occurred in this area since the ice retreated.

Hartford, Ct. and wall map of surface geology of Connecticut.
Explain the two theories of the origin of the terraces using diagrams given in class. See Bull. 47 Ct. Geol. Survey, pp. 19-27. Text, pp. 373-376, 386-391.

Rochester, Vermont.
What mountains are shown and what kinds of bed rock? Suggest two distinct factors which helped produce the rounded summits.

Passadumkeag, Maine. See glacial map of Maine.
Draw a sketch outline of the quadrangle showing the eskers. What is the origin of such ridges?

Hawley, Mass., Vt.
Is there evidence of rejuvination of the streams of this area? Explain. What kind of topography was present before (state average relief)? Draw a cross section with vertical scale not exaggerated over five times to show evidence of uplift. Choose location carefully and show restored old surface. Geology students show bed rocks.

Write summary on same outline as before. Include in proper places a discussion of (a) why New England is considered a separate province and (b) reasons for and against the existence of dissected peneplains in New England (Text, pp. 358-368). Under glacial history discuss both local glaciation and the hypothesis of stagnation of the continental ice sheet. Show on map (a) Mt. Monadnock, (b) Green Mountains, (c) White Mountains, (d) Connecticut valley Triassic area, (e) Reading Prong, (f) Manhattan Prong, (g) Highlands of Hudson.

GEOLOGY 130
PHYSIOGRAPHY OF EASTERN UNITED STATES
Laboratory
Adirondacks, Edition 1939-40

Lake Placid, N. Y. See pictures in New York State Museum. Bull. 193.
Account for the rounded mountains. Locate examples of drainage changes due to glaciation (Text, pp. 398-407).

Elizabethtown, N. Y.
How does this map show the effects of faults on topography (Text, pp. 393-394)?
What demonstrates the presence of local glaciers (pp. 408-409)?

Lowville, N. Y. (Text, pp. 325-326, 395-396, 406-407).
Account for the land areas with kettles in eastern part. Where did the ice last longest? What might have occupied the role ascribed to open water lakes?
Compare the shapes of hills in eastern hard rock part of the map with those west of Black River.

On map besides boundaries and quadrangles, show (a) intrusive rocks,
(b) gneiss

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

Laboratory questions, Interior Low Plateau, Edition 1939-40.

Greenbrier, Tenn.; See geological map of Tennessee.
What name is given to the escarpment north of Nashville? Account for it. (Text, pp. 415-419 and 431-434).

Georgetown, Kentucky, (pp. 427-431).
What name is given to the kind of topography found on tops of the ridges? Account for it. What suggests that relief was once less than now?

Lockport, Kentucky, (pp. 445-448).
Account for the formation of the abandoned valley near Bethel Church in SE part. Locate other examples of same process.

Hollow Springs, Tennessee, (pp. 415-419).
Account for the Plateau of the Barrens. (See geological map of Ky.)

Vienna, Illinois, (pp. 434-440).
What is cause of the high bluffs in north part?
Draw a cross section with a reasonable vertical scale from Mermet through Ganntown N. E. to Johnson Creek to edge of map and account for features shown. What is origin of the wide valley from Karnak east through Mermet?

Summary as usual. As an illustration show on an E. W. cross section of Kentucky (from geological map) the probable position of Highland Rim peneplain. Explain. Why is this surface not preserved in the Nashville Basin? On map show (a) limits of Blue Grass and Nashville Basins, (b) Dripping Springs escarpment (edge of Chester), (c) Pottsville escarpment, (d) Mammoth Cave, (e) Knobstone escarpment in Indiana (fig. 116).

This is the last laboratory exercise and must be handed in long enough before the final examination to be graded.
Your map should also be handed in for final grading. Remember that neatness counts.

SUMMARY-LAURENTIAN UPLANDS

Definition. The Laurentian ~~Highland~~ Upland is an area of pre-Cambrian rocks, ~~for the most part~~ mainly crystalline, ~~which is mainly~~ of fairly high altitude and yet over a large part of comparatively low relief. The province takes its name from the Laurentide ~~Mountains~~. mountains north of the St. Lawrence River in Canada.

Boundaries. The main portion of the Laurentian Upland, otherwise spoken of as the Archean or Pre-Cambrian Shield, ~~and~~ sometimes as the Basement Complex is located in Canada. Two projections enter the United States, (a) around Lake Superior- the Superior Highlands, ~~and (b)~~ in Minnesota, northern Wisconsin, and the northern peninsula of Michigan, and (b) the Adirondack Mountains in northeastern New York. The Superior Highland is divided into two parts by the trough of Lake Superior and its westward extension. The Laurentian Highland abuts on the Interior Lowlands from the western boundary in Minnesota east to the Mohawk Valley in New York. The exact line is defined as the contact between the pre-Cambrian and the Paleozoic rocks. ~~For a short distance in the Mohawk region~~ The Appalachian Plateau lies to the south and southwest of the Adirondacks and the Folded or Younger Appalachians to the east. Owing to iregularites in the surface of the old rocks a number of isolated areas of pre-Cambrian occur south and west of the Laurentian Uplands; these are called inliers. The largest ~~of these~~ are (a) Baraboo Bluffs in southern Wisconsin, and (b) Sioux quartzite ~~ranges~~ in southwestern Minnesota and southeastern South Dakota.

Topography. The Superior Highland of Minnesota is an upland which rises steeply from Lake Superior to an average elevation of nearly 1800 feet above the lake or ~~1600~~ feet above the sea. For the most part the surface is of low relief, not much over 100 feet, but several prominent ridges, which for the most part trend northeast-southwest, rise to a maximum altitude of about 2000 feet above sea level. Among these the Giants Range, Jasper Peak, and a large number of linear ranges between these and Lake Superior in Minnesota may be mentioned.

The basin trough in which Lake Superior is situated extends in a great arc from the Interior Lowland at the eastern end of the northern peninsula of Michigan north, thence west, and southwest into central Minnesota. South of this depression the highlands of northern Michigan and northern Wisconsin rise abruptly to an average elevation of about 1100 feet above the lake or 1700 feet above the sea. Prominent spurs which project into the basin toward the northeast are the Bayfield Peninsula with the Apostle Islands at its tip, and Keweenaw Point. Rising above the general level of the upland are a number of ranges and isolated hills among which the Gogebic Range, Porcupine Mountains, Huron Mountains, Rib Hills and McCaslin Mountain may be mentioned. The upland of this region slopes gently down to elvations of from 1000 to 800 feet where is passes under the younger rocks on the west, south, and southeast sides. The entire Superior Highland contains many lakes; an exception is the area around Wausau, Wisconsin where a slightly modified dendritic system of valleys with maximum depth of 300 feet diversifies the topography. Elsewhere the surface is for the most part of relatively low relief. Falls and rapids are abundant in the streams

The Adirondacks differ markedly from the highlands around Lake Superior. They rise from the very low Mohawk, Black, and Champlain, and St. Lawrence valleys to a maximum elevation of 5344 ft. They are a wooded wilderness of rather rounded mountains which rise abruptly in the midst of a well-settled farming country. The eastern portion of the mountains is highest and most rugged. Toward the west the tops of the mountains form a kind of plateau at elevation about 2000. There are nowhere any marked parallel ranges. Valleys may be divided into three classes: (a) broad and smooth, (b) wide and steep-sided, and (c) narrow and steep-sided. Many peaks are smooth and rounded domes.

Geology. The rocks of the Superior Highland may be divided into (a) massive rocks, that is granite, gabbro, gneiss, slate in large areas, etc., (b) banded rocks, that is alternating slate and quartzite or iron formation in relatively thin inclined formations as well as inter bedded lava flows and sediments (Keweenawan), and (c) sandstone and shale (Upper Keweenawan called Cambrian on most maps). The massive rocks form rounded dome-like hills such as in parts of northeastern Minnesota, around Wausau and Mountain, Wisconsin The linear ranges are made of the second class of rocks and the areas of Kweenawan lava flows exhibit this kind of hogback topography to best advantage. Keweenaw Point is a ridge of this type whose heigth is accentuated by the fact that the east and west sides are both soft sandstone of the third class. The Porcupine Mountains of northern Michigan show concentric hogback topography since they are an eroded anticline. The sandstone and shales underlie the valley east of Keweenaw fault where they are faulted against the Keweenawan flows. West of the Point the beds are steeply inclined to the northwest and form a series of sharp folds in the basin of Chequamegon Bay, east of the Bayfied Peninsula. From there west the south coast of the lake is underlain by these soft rocks which are faulted against the Keweenawan flows to the south. The same rocks undoubtedly underlie most if not all of the basin lke itself. To the southwest the same rocks are mostly concealed by drift but unquestionably account for the lowland which extends down to positively known Paleozoic rocks of the Interior Lowland. The geologic age of these rocks sandstones and shales has been disputed for many years but the best informed judgment places them as pre-Cambrian on account of the intense faulting and local folding they exhibit, features unknown in most of the Interior Lowland Paleozoic strata. Many long ridges are formed of Huronian metamorphic sedimentary rocks, mainly quartzite and hard iron formation or jasper.

next page

Good examp es are the Gogebic (Penokee) Range of Michigan and Wisconsin Rib Hill, Barron Hills of Wisconsin, as well as many hills and ranges in both Michigan and Minnesota.

The Baraboo Range is an inlier in south central Wisconsin; ~~it is made~~ of quartzite, slate, and iron formation. The maximum rock elevation is about 1460 at which level a dissected plain bevels ~~the edges of~~ the folded rocks. Valleys in the range may be divided into (a) broad mature ~~type~~, and (b) narrow, cliffed ~~type~~ as at Devils Lake. ~~Large portions of the Range are covered by the edges and outliers of the adjacent Paleozoic rocks.~~

Little information is available about the areas of Sioux quartzite; they do not form pronounced topographic features.

The contact of all these areas with the Paleozoics is one of overlap. The younger sediments thin out like wedges onto the old rocks and in many
even many miles distant from the boundary at surface, in wells to lie
places the old rocks of the Laurential Upland have been found beneath the young rocks at moderate depth. A number of instances of disintegrated pre-Cambrian rock beneath the young rocks have been ~~found; relationsxshowxthatx thisxdisintegrationxmustxhavexoccurred~~ In northern Minnesota a few outliers of Cretaceous rocks ~~are known~~. Except ~~where the young rocks rest on the flanks of the isolated~~ hills and ranges the surface of the old rocks is an undulating plane not only where it lies under the Paleozoics but also for some miles from the contact. Instances of Paleozoics faulted against the pre-Cambrian are rare in the Superior Highland district.

The Adirondacks consist of (a) highly metamorphosed sediments, ~~which include considerable marble~~, and (b) massive intrusive rocks such as gabbro. These rocks are not prominently banded but the weaker metamorphics, such as marble, form wide valleys. The steep-sided valleys are due to several systems of faults which run NE-SW mainly, fewer NW-SE, with very few N-S. Except along the west side the contact with the Paleozoics is along faults. ~~All the size~~

In many places narrow belts of Paleozoics have been faulted down into the old rocks and now underlie the wider valleys, The narrower valleys seem to follow zones of sheared and crushed rock along faults.

Glaciation. It is probable that the enitre Laurentian Upland, with the exception of parts of some of the separated inliers, has been glaciated by the continental ice sheet. An area around Wausau is marked as unglaciated on many maps but close study shows that it although it is almost devoid of drift this is due to erosion since the ancient glaciation which it suffered. Adjacent to this equivocal district, where the soil is residual, is a large area of much weathered and eroded pre-Wisconsin drift throughout which much of the topography is due to rock control. The remainder of the province was glaciated during the Young or Wisconsin glaciation. The drift is everywhere excessively stony and bowldery. Rugged terminal moraines with knob and kettle topography, sandy pitted outwash with abundant kettles contain most of the lakes. Areas of ground moraine seem not to be very extensive save in regions where the drift is thin and the rock hills stick through. Over immense areas in Minnesota and Wisconsin the drift is so thick that not only the nature of the bedrock but the boundaries of the province are yet unknown. Where the ice moved onto the old rock the margin of bowlders derived from it marks the boundary, but where the ice moved away from the Laurentian area no such clue can be obtained. Despite claims to the contray the west end of the Baraboo area does not seem to ever have been glaciated. In the Adirondacks there is little but assorted drift and that is confined to the valleys. Cirques with associated moraines tell of late Wisconsin mountain or alpine glaciation. Small lakes lie in these cirques but most of the larger bodies of water are in blocked valleys.

In the valleys of the Adirondacks and the basin of ~~the~~ Lake Superior retreat of the continental glacier ~~left~~ allowed large marginal lakes to form. In the Champlain valley the sea entered in late glacial time. Throughout these area level tracts of lake or marine sediments and associated beaches occur.

History of topography. The Superior Higlands had a most complex history in pre-Cambrian times. The truncated folds and coarse grained intrusive rocks now at the relatively low surface tell of former mountains which were much more extensive than the present limits of the province. Several periods of mountain making separated by erosion intervals locally to the state of a peneplane, occured but their details need not concern us here. The upland plane on the crests of the Baraboo Range may possibly be a peneplain formed during this complicated history. Before the Cambrian sea covered the lands ~~the pre-Cambrian~~ this plane, granting it were formed then and neither by later marine planation, nor by post-Silurian peneplanation, had been dissected with broad mature valleys and the softer rocks reduced to a peneplain at a much lower level. That this level, the great pre-Cambrian peneplane, was formed in pre-Cambrian time is demonstated by (a) the continuity of slope of the exposed surface of the old rocks beneath the younger rocks where the peneplane is buried and (b) the presence of residual deposits which, both from the local interbedding with Cambrian sandstone, and the depth at which they are found below the zone of modern weathering, must have been formed before submergence of the region. It is not clear that the Adirondacks were penplaned before Cambrian time. If they were, the old surface was later uplifted in the form of a dome, and virtually all remnants of the plane removed by later erosion. Sedimentation continued in the Laurentian region ~~are~~ until at least the close of the ~~Silurian and~~ ~~or possibly~~ Devonian. By then the entire province in the U. S. had certainly been buried under the marine sediments. Uplift of the land then took place without much movement on the old faults and folds except in the Adirondacks. Erosion began with streams superimposed above the buried remnants of the ancient mountains.

Examples of superposed rivers are Wisconsin River at Wausau, ~~Wisconsin~~ and ~~the abandoned course of the same river~~ across the Baraboo Range at Devils Lake, as well as the narrows of the Baraboo and of Narrows Creek at Ablemans, Wisconsin, found Doubtless more such cases would be ~~known~~ were the preglacial drainge of the area studied in detail. In the Adirondacks several valleys were formed by faulting of the Paleozoics down into grabens within the old rocks. Erosion trenched the peneplane to considerable depths. Around Wausau valleys were ~~trenched~~ to a depths of over 400 feet leaving ~~flat~~ hills whose flat tops display remnants of the former surface. Farther south post-peneplane erosion ~~becomes~~ is progressively less until at the contact with the younger rocks it is nil. In the Adirondacks broad mature valleys were formed because of belts of weak rock but erosion along fault zones left narrow ~~steep-sided~~ gorges. The basin of Lake Superior, a syncline ~~and~~ with associated graben filled with late Keweenawan shales and sandstones, ~~was~~ and later covered by Paleozoic limestones as shown at Limestone Mountain near Keweenaw Point, was much eroded and possibly deepened by earth movements along old lines of ~~movement~~ displacement.

insert 7a

History of glaciation. The earliest Pleistocene glaciation of which we can find a record in the Superior Highland was apparently the Kansan. Ice from the Kewatin center to the northwest crossed Lake Superior and carried copper and basaltic rocks from Keweenaw Point far to the southeast. The old drift around Wausau was probably deposied by such an ice sheet. During the younger Illinoian glaciation when ice came from the Labradorian center, and Green Bay lobe was formed which deposited the Arnott Moraine southeast of Stevens Point. This moraine retains its shape but is much weathered and has lost all kettles and knobs. Possibly there is some Illinoian drift elsewhere in the same region. Still later ice came from the Labradorian, Patrician, and Kewatin centers during the Wisconsin glaciation. This took place so short a time ago that the drift has been little altered by weathering and erosion. Lakes are found only in the area of this young drift. Its terminal moraines are still sharp

8 79

All trace of the peneplain ~~has~~ was obliterated within the basin. Some investigators have thought that the peneplanation of the Laurentian area is later in the exposed region than the plane which is buried below the Paleozoics and the presence of some Cretaceous outliers in Minnesota has made reasonable the suggestion of a Cretaceous peneplain which bevels the older one. ~~For~~ In Wisconsin such a suggestion has little to support it. The plateau on the west side of the Adirondacks, however, appears to have been formed by erosion to baselevel during the stripping of the later rocks which there may never have covered the higher parts of the mountains. ~~In the west the cover of glacial drift renders a decision hard to reach.~~

and well defined. This ice sheet overtopped the Adirondacks although the main currents of ice moved around them in the adjacent lowlands. ~~Contrary to popular ideas~~ ~~none of~~ the ice sheets seem not to have accomplished the vast amount of erosion ascribed to them by early investigators. Certainly they did not remove the normal hill and valley arrangement of the Apostle Islands which are soft sandstone and weathered rock. The ice did scrape off the loose soil in almost all places where it had a chance, but valleys which were transverse to the ice movement today look much like those along which the glaciers moved. Nor did the ice cap ~~did not~~ remove the pre-Cambrian mountains; they no longer existed at the time the land sank beneath the Cambrian ocean. During the retreat of the ice waters were ponded in the Lake Superior basin to a level of over 1100 feet where outflow was possible to the Mississippi via Brule and St. Croix Rivers. Another large lake (Lake Duluth) also existed in the valley of the St. Croix until drained by retreat of a lobe of Keewatin ice lower down the valley and the erosion of the deep gorge of the St. Croix Dalles which cut through the Paleozoics and uncovered some of the Keweenawan flows. ~~The northern lake was called Lake Duluth~~ is. Later retreat of the ice front gradually lowered this lake. In the Adirondacks several lakes were formed. The land also stood lower so that as the ice ~~xxxxxx~~ cleared the Hudson-Champlain and St. Lawrence valleys the sea came in and stood up to what is now elevation 500. Small valley glaciers formed on the higher peaks of the Adirondacks and eroded cirques before amelioration of the climate put an end to them. During late glacial time and since the ice went away entirely uplift of the land has occured as evinced by the ~~inclination~~ rise of the old beach lines toward the northeast and the level at which marine sediments occur. It is thought by some that such a movement is still going on and that for the west end of Lake Superior is being slowly submerged. ~~It is thought that~~ the most plasuible explanation of this uplift is rising of the land after having been weighted down by the ice sheet, that is isostacy. Glaciation left in the young drift area an immature drainage system superimposed over the more mature preglacial system which over wide areas

had little altered the pre-Cambrian system. The great depth of the Lake Superior basin is explained by many as due to glacial erosion. Reasons stated above seem to indicate that this view is extreme. Blocking of the outlet of the preglacial erosion valleys in northern Michigan may have been aided by downwarping of the bottom of the basin under the load of ice from which it has never recovered.

Relation of topography and natural resources to life of man. The Laurentian Upland can be classed as a rather inhospitable region on account of (a) its northerly latitude which makes the winters long and severe and (b) the very bowldery or else very sandy soils, and (c) the heavy growth of conifers. All these features tend to discourage agricultural settlement. In natural resources the forest and its products must rank first as it was the most widly distributed but ruthless lumberling has reduced this resource to a mere remnant of its former importance. Mining of iron is important in Minnesota and Michigan but not elsewhere and bids fair to last many years. The copper deposits of Keweenaw Point have seen their best days, and are no longer as important, as formerly. As long as lumbering lasted men could work in the woods in winter and farm during the summer but such an arrangement is much more difficult at present. This fact, added to the other handicaps, has made the Superior Highlands a country of has-beens: abandoned towns, farms, and mines interspersed through cut-over and burned-over wastes. The lakes attract tourists in the summer but this can hardly offset the losses. In the Adirondacks lumbering has not advanced quite so far and the scenery attracts tourists in both winter and summer.

INTERIOR LOWLANDS-SUMMARY

Definition. The Interior Lowlands Province is an area of slightly disturbed sediments, mainly of Paleozoic age, which in ~~few~~ no places rises ~~to as much as 1400~~ higher than 2000 feet above sea level and which forms the interior of the continent. It is sometimes called the Prairie Plains or Central Lowland.

Boundaries. The Interior Lowlands are bounded on the north by the Laurentian upland from central Minnesota eastward. On the east and southeast the province ~~adjoins~~ from the much higher Appalachian Plateau, ~~from which it~~ is separated by a marked escarpment. In western Tennessee and western Kentucky and southern Illinois the unconsolidated Sediments of the Coastal Plain mark the boundary. West of the Missisippi the line follows ~~along~~ to the Missouri River to the ~~mouth of the~~ vicinity of Jefferson City; thence it goes west of south at the eastern border of the Osage Plains next the higher Springfield Platform, Ozark Plateaus and folded ~~Ouichataws~~ Ouachita to meet the Coastal Plain in northern Texas. It follows the Coastal Plain, or Cretaceous boundary, southwest of Fort Worth and then turns west along the north side of the rough limestone country of the Callahan Divide to meet the edge of the ~~Tertiary~~ Texas High Plains. The eastern edge of these unconsolidated alluvial deposits is followed north leaving the Red Hills of Permian strata in the Lowland but not the rugged Smoky Hills ~~of~~ (Cretaceous) in Kansas. North of Kansas the line is less definite, especially in Nebraska. In the Dakotas it follows an escarpment, much altered by glaciation, which is called the Couteau des Prairie. The Interior Lowlands extend north into Canada from near the northwestern corner of North Dakota east to the point of begining.

Topography. The Interior Lowlands consist of plains and low plateaus with in few places a relief of as much as 1000 feet. Along the immediate shores of the Great Lakes and throughout large parts of Ohio, Indiana, Illinois, Iowa, and western Minnesota the surface is a plain so level that the eye cannnot distinguish any relief save along streams. A large portion of these plains were natural prairie with deep black soil. In such places the original timber was confined to the vicinity of the streams where natural drainage permitted, ~~the greater part of it. Throughout the plains region the bed rock is completely concealed over vast areas.~~ Outside of the plains region there are two distinct types of topography: (a) knob and sag ridges interspersed with pitted plains, and (b) cuestas and ~~plain~~ vales. The first type is characeristic of eastern Michigan and southeastern Wisconsin. In the region of the Great Lakes it is more or less mixed with the cuesta type for there the great Niagara Cuesta which extends from ~~its original locality~~ the Falls of that name northwest through Canada into northern Michigan, thence southwest and south into Wisconsin is the dominating topographic feature of the region. Another prominent feature is the Onondaga-Dundee cuesta which reaches from northern New York across the Ontario Peninsula to Lake Huron, through which it is traced by soundings, to the northern end of the Lower Peninsula of Michigan, southwest of which it is lost under Lake Michigan. In central and western Wisconsin, northeastern Iowa, and southeastern Minnesota cuestas are seen in great perfection although in many places the local dissection ~~into hills and valleys~~ prevents the eye from realizing the true nature of the larger topographic features. A series of cuestas, the ~~Dresbach~~, Franconia, Lower Magnesian, Black River, and Niagara form horseshoe-shaped escarpments which face in toward the dome of the Superior Highland ~~pre-Cambrian rocks of central Wisconsin~~. In the Osage Plains district of eastern Kansas, eastern Oklahoma, and northern Texas cuestas, mainly small and ~~six~~ discontinuous, rise from the prevailingly level surface. In central Kentucky, and central Tenessee large basins,

the Blue Grass and Nashville respectively, occur which are surrounded by cuesta rims. The hills around the southern basin are called the Highland Rim. This low plateau extends northwest into southern Illinois to fade out gradually into the plains to the north. The ~~basins~~ bottoms of the Great Lakes, with the exception of Erie, all extend below sea level.

Geology. Save for the Dakotas, a portion of western Minnesota, and western Iowa ~~the~~ where the bed rock is ~~of~~ Cretaceous ~~age~~, the Interior Lowlands are underlain by rocks of Paleozoic age. The rocks consist of shale, sandstone, limestone, and dolomite and range in age from Cambrian to Permian, ~~and~~ They vary greatly in resistance to weathering and erosion. The structure is simple, ~~for~~ and most of the region has very gentle dips. The strata dip away from the pre-Cambrian domes of the Superior Highlands and Adirondacks and from the Ozark uplift of Missouri. In the southwestern part of the province the dip is ~~irregularxand~~ to the west with many local irregularities. ~~An~~ broad gentle uplifted arch ~~whose sides dip very slightly~~ passes from the southeastern corner of Michigan west of south through Indiana, Kentucky, and Tennesee; this is called the Cincinnati Anticline. Deep basins occur (a) in southern Michigan, (b) Illinois, and (c) Iowa and northern Missouri; all of these contain Coal Measures and are called coal basins. There are a few places where local folding of a complex character occurs; these are in western Tennesee, Kentucky, Ohio, northwestern Indiana, and central Wisconsin. Such local structures have been ascribed by some to vulcanism which did not reach the surface. Faulting is not uncommon and southern Illinois and western Kentucky show very ~~complex~~ complicated movements associated with small igneous intrusions. All the Interior Lowlands from northeastern Kansas north, with the exception of southwestern Wisconsin, and small portions of adjoining states, have been glaciated. The ice invasions occured at widely separated times, ~~including the Nebraskan, Kansan, Illinoian, Iowan and Wisconsin stages of glaciation.~~ From the ~~present~~ topographic standpoint these can be divided into (a) the Old Drifts (Nebraskan, Kansan and Illinoian) which show profound alteration by postglacial weathering and erosion, and (b) the New Drifts (Iowan and Wisconsin) which display little subsequent alteration. The glacial drifts may also be divided into (a) stony drifts which occur in regions of relatively hard rocks like limestone ~~and which have much associated water-sorted material,~~ and (b) clay drifts which occur in shale regions,

The stony drifts, like those of the Laurentian area, ~~consist of~~ have rugged moraines and extensive outwash plains, ~~many~~ both of which are pitted and contain lakes. The clay drifts consist of much less accentuated features for the moraines have very gentle slopes; where thick enough to conceal the underlying rock hills clay drifts ~~consist of~~ make level plains. Such drift plains are characteristic of the great prairies of Indiana, Illinois, and Iowa. South of the terminal moraine of the Young Drift, a feature not everywhere well developed, the drift plains of the Old glaciation have suffered erosion. East of the Mississippi ~~this is~~ they are in the stage of early youth but farther west little of the original surface is left and instead there is a maze of dendritic valleys from 50 to over 100 feet deep. In some marginal ~~drift~~ districts the glacial drift consists merely of scattered stones whose character shows that they were transported for long distances. In Southwestern Wisconsin and extending into adjacent states a short distance, is the Driftless Area, ~~an area~~ region unglaciated but not ~~necessarily~~ probably ever completely surrounded by ice at any one time. Its eastern margin is made by the Young Drift and is therefore definite; the other borders are hard to follow for the glaciation was very long ago and the drift was long since eroded from the steep rock hills. The Great Lakes lie in vales between cuestas. Lakes Ontario, Erie, Georgian Bay ~~of~~ (Lake Huron), Green Bay ~~of~~ (Lake Michigan) and Lake Winnebago in Wisconsin all lie on the outcrop of the Ordovician shales. Lakes Erie, Huron, and Michigan are above Silurian and Devonian shales, salt, gypsum, and weak dolomite formations. Lake Superior is on Cambrian sandstone and lies north of the Lower Magnesian cuesta, ~~and~~ Its basin might with perfect propriety be considered an embayment of the Interior Lowlands ~~which extends back~~ into the Laurentian Upland ~~and yet~~ from which nearly all the Paleozoic strata have been removed. Outliers of the young rocks occur near Keweenaw Point.

History of the topography. So far as remnants of sediments ~~go for~~ Permian almost evidence the entire Interior lowland may have been above the sea since the close of the ~~Permian~~ Paleozoic. The Cretaceous sediments of its northwestern part represent a later marine incursion after extensive erosion of the ~~Paleozoic~~ older sediments. Vast ages of weathering and erosion worked on the outcrops of gently inclined beds of varying resistance. The domes were breached and the basins much less touched. The drainage outside the glaciated area is mature to old Each resistant bed came to cap a cuesta and each soft formation to underlie a vale. Where the soft formations were thick local peneplnes were formed at many different levels for erosion was in most places checked by the occurence of hard layers farther down ~~each~~ the main stream. The width of valleys, indeed the shapes of the hillsides, are all in conformity with the varying risistance of the different kinds of rock. For instance, the narrowing of the Mississippi Valley south from LaCrosse, Wisconsin, does not indicate a reversal of stream direction but simply the fact that the hard formations descend to the south at a rate greater than the grade of the river. The same phenomenon is present north of La Crosse and in the Wisconsin Valley. Karst topography is well developed in the driftless area Many students of the region have called the relatively even crests of the cuestas the remnants of uplifted and dissected penneplanes. Many of these ideas grew up before the country had been surveyed. From almost any eminence within the region the distant skyline looks level; it seems that if one ~~would~~ could travel far enough he would certainly come upon undissected remnants of an older flat topography where erosion since uplift has not yet reached. Many peneplnes were thus distinguished ~~simply by distant observation~~, were named, dated and put into the literature. Later study has raised much doubt of the sufficiency of proof for it. The minor details of the landscape are closely related to rock character and so should the larger one ~~seem to also~~ be. The work of Trowbridge in the Driftless Area ~~was~~ the most careful. He ~~urged~~ concluded that the crests of the several cuestas represent remnants

of ~~a~~ one dissected peneplain and that the vales and some of the lower summits of cuestas are remnants of a ~~lower~~ surface developed when the land stood about 200 feet higher than before. Arguments ~~for such an interpretation are~~ were! (a) presence of fairly level summits forming so-called "upland plains", (b) fact that the back slopes of the cuestas ~~slightly~~ bevel across the resistant formations which cap them so that the full thickness of the ~~resistant formation~~ hard rock is present only next to the margin of the higher weak layer, (c) supposed connecting ridges between different cuesta tops, (d) presence of gravels on some of the ridges and (e) entrenched meanders, ~~on some streams~~. Opposing facts are, (a) there are no remnants of a surface ~~in~~ which the present erosion cycle has not yet ~~trenched with some sort of valley~~ touched, (b) the ~~so-called level~~ ridge tops are not literally level and show no topographic undonformity to the valleys but instead can be regarded as the normal result of erosion and weathering on ~~the dolomite~~ alternate hard and soft rocks, (c) The uplands extend down the back slopes of cuestas to the supposed level plain and are the same all the way, (d) some of the uplands seem to be due to shale layers which act as roofs and protect soft underlying sandstones from decay by solution of the cement, ~~(e)~~ and for that matter the clay residium from dolomites probably acts in much the same way, (d) the bevel is easily explicable as the result of longer exposure of the cuesta crest than of the vale as a result of the retreat of the succeeding higher cuesta ~~and its associated weak formation~~, (f) ~~the~~ interconnecting ridges between cuestas are rare and explicable by irregularites in thickness of the Lower Magnesian dolomite, (g) the gravels are very like the Cretaceous gravels of Iowa and represent deposits by streams with fairly steep gradients ~~and therfore~~ which may have been left by normal shift of stream valleys ~~without assuming erosion to base level~~, (h) bends interpreted as intrenced meanders are rare and may simply be irregularites inherited from either broad valley floors or or from some other geological condition evidence of which (h) The same has now been destroyed by erosion. On the whole, the evidence for penplanation so far from the sea is ~~far from~~ not very convincing, although there is no evidence but what it might have occured.

The earlier two glacial invasions, ~~Nebraskan and Kansan~~ seem to have mainly come from the Keewatin center and therefore entered the U. S. through North Dakota and pressed southwest to approximately the present course of Missouri and Minnesota. ~~Ice~~ Glaciation extended farthest south ~~at these times~~. ~~Ice seems also to have crossed Lake Superior and have gone far to the southeast.~~

During the Illinoian the Labrador center had its maximum and ice covered almost all the country east of the Mississippi down to the Ohio. The courses of these two major streams seem largely to have been caused by glacial diversions early in the history of glaciation. In the interglacial intervals between and after the early glaciations ~~and after the Illinoan~~ extensive erosion took place. It has even been suggested that the ~~major portion~~ inner gorges of the Mississippi and its tributaries were eroded ~~before~~ between the Nebraskan and Kansan invasions, although this seems doubtful. It is often said that the Driftless Area is a sample of what the adjacent country looked like before glaciation but this must be amended to what it looked like before the last glaciation. The Iowan drift of northeastern Iowa, a gently rolling to almost flat tract, is classed ~~along~~ with the Wisconsin drift in topography and indeed it is now thought that it may really represent an very early part of the Wisconsin invasion. The Wisconsin ice deposited a somewhat more stony drift than did its predecessors largely because by then ~~large~~ much parts of the region to the north had been stripped of loose soil. The moraines, drumlins, and outwash plains of Wisconsin age are, therefore, prominent not only because of youth but also because they were originally ~~more~~ better developed. Drumlins are best ~~known~~ developed in (a) eastern Wisconsin, and (b) northern New York; They are not conspicuous in areas of clay drift. The Interior Lowlands were ~~doubtless~~ mainly altered by glacial deposition rather than by ice erosion. Many small isolated rock hills doubtless perished to make ~~up~~ the bowlders and pebbles of the drift, but wholesale removal of unaltered bed rock seems to be largely a myth. It is thought by many that the great depth of the basins of the Great Lakes tells of glacial erosion but there are rock islands in the lakes and indeed there are many

localities where the rock surface is almost as low which are not in the line of main glacial flow. For that matter not all the great lakes were ~~not traversed by the ice longitudinally~~ trunk channels for the ice. We must fall back on both (a) blocking of preglacial valleys, which doubtless discharged to the south, and (b) depression of the land throughout the entire Lakes district, although without doubt the glaciers did remove ~~vast~~ considerable amounts of soft rock from the preglacial lowlands in which the lakes lie. The salt and gypsum beneath some of the lakes may have had a part in promoting easy glacial erosion. During the retreat of the last contiental glacier marginal lakes were formed in the basins of the Great Lakes. Lake Chicago in the Michigan basin overflowed vis Des Palines and Illinois Rivers; Lake Maumee in the west end of the Erie depression discharged first via Wabash River, later to Lake Saginaw in Saganaw Bay, Michigan and thence across Michigan to Lake Chicago. Further recession formed Lake Algonquin, a confluence of Lakes Superior, Michigan, and Huron at a higher level than now which, because the land was lower at the north than it is now then, overflowed to the Ontario basin across lower Ontario(Kirkfield outlet). Lake Iroquois in that basin then had to reach the sea via Mohawk valley in northern New York. Still further recession of the ice freed a lower outlet via the Ottawa valley in Canada making the Nippissing Great Lakes which stood lower than the former stage. Continuted uplift of the land to the north has caused abandonment of this outlet in favor of the present conditions. The various widths of parts of the Niagara Falls gorge tells graphically of some of these variations for they affected the volume of the river and thus the width of the falls.

~~Lower Great Gorge= Early Lake Algonquin with outflow at Detroit via Lake Erie~~

Lower Narrow Gorge= Kirkfield outlet of Lake Algonquin

Lower Great Gorge= Early Lake Algonquin with outflow at Detroit via Lake Erie

Whirlpool Rapids Gorge= beginning of Lake Nipissing

Upper Great Gorge = present conditions

Lake Agassiz was formed in the valley of the Red River of the North. Its bed is an extensive plain in North Dakota and Minnesota

Late glacial, and apparently postglacial, earth movements have tilted the abandoned beach lines of the Great Lakes region. These movements ~~consist of progressive~~ resulted in elevation of the land townard the northeast and are generally ascribed to ~~rising due to~~ unloading from the weight of the ice sheet. Erosion has scarred the basins of the former lakes forming valleys locally over 100 feet in depth.

Subdivions of province. Based on the foregoing the following subdivisions of the Interior Lowlands may be proposed:

(a) Young Stony Drift region, Minnesota, Michigan, Eastern Wisconsin, Illinois north of Chicago

(b) Young claydrift region, Iowa, Illinois, Indiana, Ohio, same as above

(c) Beds of glacial lakes including bed of Lake Agassiz

(d) old drift region(mainly clay drift), Kansas, Nebraska, Missouri, southern Iowa, southern Illinois, southern Indiana, southern Ohio

(e) Driftless Area Plateau, southwestern Wisconsin, etc

(f) Nashville and Blue Grass Basins, Kentucky and Tennesee

(g) Highland Rim Plateau, parts of southern Ohio, eastern Kentucky, eastern and southern Tennessee.

(h) Shawnee Hills southern Illinois and western Kentucky north of the Highland Rim and rougher with much sandstone topography

(i) Osage Plains, Red Hills, Flint Hills, Kansas, Oklahoma, and Texas

Life of man. The Interior Lowlands are one of the garden spots of the world. Added to a good soil over most of the region the rainfall is adequate although not excessive. Some of the best soils are found on (a) young clay or limestone drifts, (b) residium from limestone, (c) loess. Much poorer soils occur on (a) sandstone, (b) shale on account of poor drainage, (c) sandy drift, (d) much weathered old drift (gumbotil) which has lost plant food and provides poor drainage. The Corn Belt and a large part of the wheat belt are situated in the province. Vast amounts of both coal and oil have been developed. Communication is easy both by land and by water so that many large cities have developed. On the whole the province is an area of progress although certain distiets of poor soil have suffered serious setbacks recently

OLDER APPALACHIANS-SUMMARY

Definition. The Older Appalachians consist of a ~~range~~ group of mountains composed of igneous and metamorphic rocks which extends from Carlisle, Pennsylvania southwest to northern Georgia.

Boundaries. The Older Appalchians are bounded on the ~~xx~~ northwest by a belt of slightly metamorphosed folded sediments, (mainly of younger age) the "ewer or Folded Appalachians. For nearly the entire southest (moderately) side as well as at their ~~south~~ end, the mountains give way abruptly to a region of similar rocks ~~but~~ of much less relief, the Piedmont Plateau. At the far northeast, however, the soft sandstones and shales of the Triassic Lowland form the border. The Older Appalachians are, therefore, sharply defined and are substantially without outliers.

Topography. For nearly half their length at the northeast the Older Appalachians consist of a single range, the Blue Ridge, which rises about 2000 feet above the lowlands to the east. This ridge has a narrow but fairly even crest. In Pennsylvania it is known as South Mountains. This portion of the Ridge is breached by the water gaps of the Potomac, Roanoke, and James Rivers and by a few small wind gaps. The name Blue Ridge is not confined to ~~the definite ridge of~~ the north but is ~~also~~ applied to the eastern border of the entire Province, which, because it can be seen from so great a distance, appears blue in color ~~due to~~ on account of atmospheric dispersion of the short light waves. This southern extent is not as straight wall but contains many reentrants or coves. There are no low passes but the streams , few of which head far back in the mountains, descend to the lowlands ~~in~~ through narrow canyons, many of them with falls and rapids. The southern mountains which comprise the Great Smoky ~~range~~, the Unakas, and other less well known groups of peaks, are wider and higher; In eastern Tennessee and western North Carolina the width is 75 miles and the highest peak, Mount Mitchell, attains the not inconsiderable elevation of 6711 feet. Almost wholly clothed with trees, and comparatively free from large cliffs, these mountains are beautiful without possessing the wildness and ruggedness of northern and western mountains. ~~Indeed~~, the many visitors ~~are is apt to~~ get an impression of size and ~~h~~eigth far beyound the real magnitude of the peaks. Most of the drainage is to the west, for instance the French Broad

rises within a few miles of the east side of the mountains and flowing mostly northwest in a few narrow gorges through the higher ranges. The heads of these west-flowing streams, as in the Asheville Basin, stand over 1000 feet higher than the Piedmont a short distance to the southeast. The drainage system is slightly modified dendritic.

Geology. The Older Appalachians are composed of granite, gneiss, schist, quartzite, and various other igneous and metamorphic rocks. The structure is complex with a prevailing northeast-southwest strike. The higher summits and ranges are dominantly composed of rocks which contain little feldspar such as quartzite and certain schists and gneisses. Many of the granites form relatively low lands. Mineral deposits are for the most part small. A considerable part of the rocks are of pre-Cambrian age but many are younger. No traces of glaciation have ever been found save a few striated pebbles along streams which may have been formed by floating ice. Soils are residual and many of the slopes are heavilly banked with decayed rock.

History of topography. The Older Appalachians seem to be residuals of a very ancient mountain range whose crest was closer to the continental border than theirs is. This fact is made known by (a) the prevailing westward drainage, and (b) the eastward derivation of the sedimentary rocks to the west. The last period of folding in these mountains, the ancient continent of Appalachia, occured in or shortly following the Permian. The vast ages of erosion and weathering which followed that time have reduced the mountains to a mere shadow of their former importance. Drainage to the Atlantic, to the southeast, whose border at the present level of the continent is far within the edge of the continental shelf, has a decided advantage in gradient over streams which flow the other way. Such drainage has long since destroyed the mountains back to the present position of the Blue Ridge and still the headwaters are pushing northwest. Many cases of abnormal drainage relations tell of comparatively recent stream captures and study of the maps indicates many places where the future will allow of other diversions to a more direct route to the ocean. This migration of the divide

is probably facilitated by a greater rainfall on the Piedmont than west of the mountains, although some claim that the precipitation on the west sides of the ranges themselves is greater than on the east slopes. Situated so near the sea the climate is humid and rock decay has been facilitated, although the great heat on the southern slopes promotes ~~very~~ rapid evaporation of the heavy rainfall. Erosion has doubtless not been at a constant rate nor always with the same baselevel. Considerable areas of peaks with sub-equal elevations, and broad basins whose bottoms ~~have been~~ are cut by narrow gorge-like valleys tell of either (a) changes in baselevel with consequent rejunvination of the streams or (b) of the cutting away of obstructions of hard rock in the stream beds. However, these indistinct evidences of former partial peneplanation are of little consequence to the present topography, whose dominant controll is rock character. The massive rocks form domes and the banded rocks ~~longer~~ ridges among some of which a trellis drainage system exists. Vegetation retains the rock waste making many fairly gentle slopes. Some of the valleys have alluvial terraces.

Life of man. The Older Appalachians are for the most part so rugged and inacessible that settlement is very sparse. Their inhabitants are of an old stock which retains the shiftless methods of the ~~first settlers~~ pioneers. Clearing of soil to develop new fields has in many places extended onto such steep slopes that soil erosion has become an important problem ~~for it~~ by overloading the streams with debris and causes them to aggrade their lower courses. The forest resources are most important but lack of transportation has thus far restrained extensive lumbering operations. The humid climate makes water power abundant but lack of natural lakes for reservoirs and the distance from markets combine to make development rather expensive. Mining is important only at Ducktown, Tennessee, where there is a copper deposit. The scenery and pleasent climate both summer and winter have led to the development of resorts for tourists particularly around Asheville.

PIEDMONT PLATEAU-SUMMARY

Definition. The Piedmont Plateau consists of an area of moderate relief underlain by crystalline rocks with a few patches of sedimentaries, which lies between the Older Appalachian mountains and the Coastal Plain.

Boundaries. On the northwest the Piedmont is bordered by the Blue Ridge escarpment save in east central Alabama and northwestern Georgia where the Older Appalachians are absent and the Folded Appalachians abut against the province. On the west, south and southeast, the unconsolidated sediments of the Coastal Plain thin out upon the basement rocks; this border is marked by rapids and falls in the streams and is therefore called the Fall Line. Many isolated patches of Coastal Plain sediments occur along this side. At the far northeast the Piedmont is separated from the Older Appalachians by a considerable tongue of soft Triassic sediments; this projection to the east is called the Trenton Prong.

Topography. The Piedmont Plateau has a western border at an elevation which varies from a few hundred feet above sea level in the north to over 1000 feet in the far south. The seaward edge rises from tidewater at Pliladelphia to nearly 500 feet at the southern end. Since the maximum width is over 100 miles the average slope is less than 5 feet per mile (erroniously given as 20 ft. by Bowman). The local relief of the Piedmont is in few places over 200 feet. The valleys are narrow with few flat floors, and the hill tops are smooth and rounded. Save in a few very restricted areas, no literally flat uplands exist. The valley sides are convex upward. Rising above the general level of the uplands are a few isolated hills and small mountains some of which are quite close to main drainage lines. These are more abundant near the Blue Ridge than elsewhere Among them may be mentioned Stone Mountain near Atlanta.

Geology. Unlike most plateaus the Piedmont is underlain for nearly its entire extent by ~~complex~~ crystalline rocks with complex structure; only a few small isolated areas, for the most part marked by smooth topography or wide valleys, are on soft ~~shales and sandstone~~ sedimentaries. The crystalline rocks are mainly of pre-Cambrian age, although many metamorphic sedimentaries of later ages occur. Schists, granites, trap rocks, and gneisses ~~occur~~ are present. The less altered sediments are of Triassic age and consits ~~mainly of~~ red sandstones and shales with some trap rocks. Very likely much of the trap rock seen elsewhere is of the same age. The Triassic areas show complex faulting and some folding. Near Richmond, Virginia, coal occurs ~~and~~ where locally was changed into natural coke by igneous intrusions. The prevailing strike of the structures is parallel to that of the mountains ~~to the west~~ northeast-southwest. The Piedmont is nowhere glaciated and the soils are residual. Most descriptions stress the great depth of soil but recent road grading shows that excessive weathering is confined to (a) feldspathic rocks and (b) schists. In such favorable localities excavations may be made with shovel or scraper to depths of over 50 feet below the natural surface. However, ~~hard~~ the other rocks are quite generally encountered at a depth of only a few feet. In spite of the depth of disintegration of some rocks decomposition or chemical weathering is for the most part relatively slight, and the surface soil is notably lacing in humus and clay. On granites comparatively fresh feldspar is present in road grades a depths of only a foot or two. In general the soils, which over wide areas are red on account of iron minerals in the rocks, resemble more those of arid districts rather than those commonly present in moist regions. This anomaly is doubtless due to (a) warm climate which evaporates much of the rainfall, and (b) easy percolation in the schists which permits water to pass rapidly to great depths. Contrary to general impression, the soils of the Piedmont are not rich; they are better than the sands of the coastal Plain and the land is smoother than the mountains to the west but nowhere does the soil begin to compare with that of the better parts of the Interior Lowlands. Soil erosion has made great inroads even on fairly gentle slopes.

Along the east side of the Piedmont there are abundant outliers of the Coastal Plains sediments some of them more miles from the main body of younger deposits. There are gravel terraces along some of the main streams which correspond to terrraces in the Coastal Plain. Mineral deposits are small and unimportant.

History of topography. The Piedmont is another remnat of the ancient Appalachia. Here all trace of the old mountains has been obliterated save where the rock is unusually hard and even these eminences are in few instances more than 500 feet in heigth. The erosional history of the area has not been simple. The narrow stream valleys and the broad hill tops tell definitely that the region had much less relief at some time in the not very remote geologic past than it posses today. The hill tops do not rise toward the mountains evenly but accurate surveys reveal that there are steps or terraces the borders between which are now deeply dissected. Some of these terraces carry gravels the origin of which is not definitely known. They may be either (a) marine, representing periods when the land stood lower than at present and the sea leveled the country back to a cliff line at the border of the next step, or (b) fluvial, that is remnants of old alluvial cones of material washed down from the mountains onto surfaces which had previously been eroded to peneplanes, while above the sea. Certain it is, that the terraces are approximately level and are all much younger that the inclined surface of low relief on which rest the Coastal Plain sediments. Some of the lower terraces in the valleys are not unlikely related to events of the Glacial Period, not yet worked out to a definite conclusion. The area has undoubtedly had its base level changed many times and not unlikely the climate has also changed and thus introduced further complexities into the erosional history.

Life of man. It was early found that the Piedmont both in soil and climate was better for settlement that the low, swampy, sandy Coastal Plain to the southeast. A chain of cites begining with Philadelphia at the northeast, grew up along the Fall Line, ~~for that~~ which offered both an obstical to navigation and water power. Water power development has been possible throughout the entire ~~district~~ region on account of the narrow valleys, ~~and~~ relatively steep gadients of the streams, ~~as well as~~ and the ~~xx~~ rather heavy rainfall. It is hindered by lack of natural reservoirs such as ~~are furnished by~~ the lakes of glaciated regions. Agriculture in the Piedmont is almost entirely confined to cotton raising for there is little grass for cattle ~~or market for other crops~~, and it has been fostered by the conservatism of the inhabitants who are largely ~~xxxxxx~~ of the "poor white" class. In recent time the district has been industrialized by establishment of cotton mills, mainly because of cheap labor rather than any direct geographic reason. Mining has never been of much importance although some gold and a few other minerals were once exploited. Soil erosion, soil exhaustion form constant one crop farming, the intense heat which nullifies much of the rainfall, the character of the inhabitants, the lack of coal, timber, and grass are all retarding features in the development of the Piedmont. Nevertheless, it is an important part of the country which is rapidly becoming more like the industrial North than the agricultural South

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES
LABORATORY

Central Lowland, East of Mississippi River
Edition of 1938-39.

Every student who takes this course for 5 credits is expected to put a minimum of four (4) hours a week on laboratory work. It is very important to keep this work up to date: DO NOT LET YOURSELF GET BEHIND. Dates must be adhered to for unexcused overdue reports will BE DENIED ANY CREDIT. Ordinarily all laboratory work will be done in Room 206. If you have to remove any maps PLEASE RETURN THEM AT ONCE. Maps should not be taken from the building or to offices without permission. Please pick up all maps on the tables when leaving the room and place in a neat pile. Maps will be furnished on which to show the boundaries of all provinces and the LOCATION OF ALL SMALL MAPS used. Maps of physiographic provinces, geology, and physiographic features are available in the laboratory. Consult references in library or models in hall whenever necessary. Keep rough notes in pencil which may be copied in ink or typewritten. Complete reports should be handed in on 8½" x 11" paper in a folder. A sheet or two of cross section paper may be used. Use of colored pencils adds to effectiveness of diagrams. Colored pencil may be made to look better by rubbing with a scrap of blotting paper or cloth. Wax crayons smear badly and should be avoided. General map should be kept up to date and handed in with each exercise. A ruler is needed or cross section paper may be used.

General: place on your general map not only the location of all small maps (number and place key in margin) but also (a) boundaries of all subdivisions of the province, (b) Niagara escarpment, (c) Magnesian escarpment, (d) Onondaga-Dundee escarpment, (e) Pottsville escarpment in southern Illinois and west Kentucky, (f) areas with name and outlet of Glacial Lakes Agassiz, Chicago, Maumee, (g) actual boundary of unglaciated part of Driftless Section.

Young Drift.

Urbana, Illinois and model of Illinois on 3rd floor.
Account for Yankee Ridge; for the surrounding flat areas. Describe the post-glacial valleys of the area.

St. Croix Dalles, Wis.-Minn. and model of Wisconsin south of library door.
What kinds of glacial features occur here? Which way did the ice move? Draw an E-W cross section (vertical scale not less than 800 feet to an inch) in north-central part of map to show relation of valley of St. Croix River to moraine and outwash plain. Lable features and comment on age of the St. Croix valley. Contrast with topography of Urbana, Ill., and explain.

South Haven, Michigan.
Compare with a very similar topography due to glaciation and suggest why sand dunes are more abundant here than in Wisconsin (on the west shore of the lake).

Calumet City, Illinois-Indiana.
Draw a cross section (vertical scale not less than 80 feet to an inch) from southwest to northeast and account for the topography shown. The beaches starting at southwest are Glenwood, Calumet, Toleston, Lable each.

Chart of Lake Huron.
Account for the ridges of (a) Saugoon Peninsula-Manitoulin Island and (b) Pt. Clark to North Point.

Niagara River and vicinity, New York; Folio 190 (consult in library or draw for laboratory period only).
Read legend on back of the map. Account for the falls and for the variations in width of the gorge below them (be brief).

Sun Prairie, Wis. (See map of Quaternary geology of southeastern Wisconsin). Account for and name the oval hills. What topographic features occur in the marginal moraine strip? Contrast with ground moraine areas.

Camp Custer, Michigan. Read legend on back.
How do the contours show the difference between pitted outwash and terminal moraine? What other name is given to a till plain? Draw a cross section from Gull Lake northeast to Dunn School near Fair Lake through Hickory Corners. Vertical scale not less than 400 feet to the inch.

Old Drift.

Areal geology, Breese, Ill. (Folio 195 and Ill. Geol. Survey Rept. Invest. 19, pt. 1).
List examples of Mac Clintock's types of topography present here. Account for the narrows in the valley crossed by the B. and O. R. R. east of Trenton. What has been the dominant process here in making the flat floors of the valleys, widening or filling? Explain how you know.

Driftless Area

Kendall, Wis.
Note the "two story" nature of the topography and illustrate by a cross section, (vertical scale 1 inch to 800 or more feet) from Meyers Hill northeast to the plains. Account for the level plain to north. Account (see 1932 edition of Bull. 36, pp. 4 and 37) for the double escarpment. Lable each.

Summary. When you have completed your notes, the summary can be finished elsewhere if you desire. However, do not cut your regular laboratory periods to do this, but start ahead with next province as soon as directions are ready. Make all answers explicit and not just "yes" or "no". Make it clear to everyone just what you are trying to say. After the answers to the foregoing questions, write a brief (LIMIT FOUR PAGES) summary of the province on following outline. You may, if desired, incorporate answers and diagrams called for above in body of report as "examples" instead of giving them separately.

Definition of province, first in terms of FACT, then, if necessary, in terms of INTERPRETATION. Give briefly any alternative names for the province and explain how derived.

Boundaries of the province and its main subdivisions not merely what it adjoins but the nature of the boundary, for instance as "escarpment," "change in geology," "edge of glacial drift," etc.

Geology, a very brief statement of the kinds of bed rocks, glacial drift etc., without much attention to geological age or details of origin.

Topography in terms of facts.

History of the topography, that is, the interpretation of the foregoing information on geology and topography. Explain fully all essential steps in origin of present surface. USE DIAGRAMS wherever this helps, but MAKE THEM A PART OF THE DISCUSSION.

Sometimes it is desirable to make a series of cross sections, each of which illustrates a step in development. Such are generally, but not always, given in class first. Make them carefully and make no line or mark unless it really means something.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

Laboratory questions, Superior Upland, Edition of 1938-39

Using the 1928 geological map of Wisconsin, the relief map of Wisconsin, and the black line map of the surface of the buried pre-Cambrian rocks, construct on a vertical scale of one inch to not less than 4000 feet a cross section of Wisconsin along a east-west line through Wausau. Make section 10 inches long. You may lump all the pre-Cambrian rocks in one color or pattern and all the Cambrian and later deposits in another. (See Bull. 36, 390-395).

Wausau, Wisconsin. See also geological maps and Wis. Bull. 16, 592-600; 36, 369-375. What evidences indicate that this area once had a higher relief than it now has? Where are remants of the peneplain still preserved? Reasoning from these areas, did or did not the area once have a lower relief than it does now? Reconcile these two results. If you went in the field, would you find it as easy to tell what part of this area had been glaciated as it is around Madison? Explain fully. Explain the flat floors of the large valleys.

Houghton and Calumet, Michigan. Make a small sketch without much exaggeration of vertical scale showing the geological structure of this ridge. See 1935 map of Lake Superior region or consult map of structure. Consult map from Professional Paper 154 and then describe the differences in topography above and below the highest beach line. Explain. Account for the great escarpment of southeast side of the Range. Why do these rocks from hogbacks? Locate a good example of a hogback.

Brainerd, Minn. and map of surface formations of Minnesota. Account for topography (a) S. E. of Brainerd including the oval hills, (b) W. of Brainerd, (c) along Long Lakes and in N. W. part of map, (d) N. E. of Woodrow.

Wealthwood, Minn. Account for (a) ridge on shore of Mille Laes L. E. and W. of Wealthwood, (b) Rocky Hill.

Superior and Duluth, Wisconsin-Minnesota. See map of Lake Superior structure and from them draw a sketch cross-section showing the relation of this valley to the main syncline to the southeast. Show only (a) old hard rocks, (b) Keweenawan lava flows, and (c) sandstones. Account for the escarpment south of the lake. Account for escarpment north of the lake. (See discussion in Monograph 52, or K. G. S. 226). Make a table showing physiographic significance of: (a) Minnesota Point, (b) irregular topography in extreme south of map, (c) Manitou Falls, (d) smooth topography at Superior, (e) V-shaped valley of Nomadji River, (f) shore ridge of Spirit Lake, (g) shoreline of St. Louis Bay, (h) curves in state boundary. (See Bull. 36, 447-452, also chart of harbor).

Map of bottom of Lake Superior - see also same map in guide book of Kansas Geological Society p. 226. (Faults incorrectly located on this map), and map of structure of Lake Superior basin. What explanations might account for the steep slopes of (a) northwest shore, (b) northeast shore, (c) north side of Keweenaw Point, (d) northwest side of Isle Royale. Account for the plateau of the Apostle Islands. Account for the enclosed depressions in eastern part of the lake. Account for the submerged ridge northeast from Keweenaw Point. Draw cross sections (vertical scale not less than 2000 feet to inch) (a) from Saw Teeth Mt. S E through outer Island to Porcupine Mts., (b) east from Stannards Rock to Theano Point. Indicate geology as far as showing (a) pre-Keweenawan, (b) flows, (c) sandstones.

On your general map show not only the corrected boundary of the province from geological map of Minnesota, but color in (a) areas of Lake Superior sandstone Aku (see 1935 map of Lake Superior region) (b) Middle Keweenawan lava flows Akmb, (c) border of young drift, and (d) old (pre-Wisconsin) drifts from map of Wisconsin. Contrast in summary the topography of these four divisions with that of the massive igneous and metamorphic rocks and explain why there is a difference. Explain why this difference is not equally shown at all places. Explain difficulty of locating the border of the province.

Summary on outline previously given. Limit to four pages.

Geology 130

PHYSIOGRAPHY OF THE UNITED STATES

Laboratory
Central Lowland, West of Mississippi River
Edition of 1938-39

General: Place on general map (a) limits of sections (see also Fig. 174, p. 617) (b) border of unglaciated areas. (c) pre-cambrian areas (d) Flint Hills (e) Niagara escarpment of Iowa (f) Lake Agassiz (g) maps as usual. Young drift and dissected till plains, sections.

Camp Dodge, Iowa: Read legend on back. Explain why there is so gradual a transition at edge of young drift. Why was valley of Des Moines river so deeply eroded? Contrast topography of old drift and young drifts where distant from the main streams. Use cross sections if desired.

Elk Point--see folio 156.
What two sections are shown? Compare their topography--See Fig. 3, p. 3. Was the rock valley of the Missouri River present before Wisconsin glaciation? See section on p. 7.

Wall map of outlet of Lake Agassiz. See map of glacial deposits of Minnesota. How are beaches indicated? Why are they at several levels? What is the origin of Traverse Lakes, of Cottonwood Slough?

Osage Section. Foraker, Oklahoma. See geological map of Oklahoma. Account for the escarpment and draw a cross section of it showing the hard layer which causes it.

Tishomingo, Indiana, Tennessee--Folio 98 (Library)
Read sections on topography, p.p. 1, 2; geologic structure, history of the Arbuckle mountain structures, p. 7. Account for the ridges near Nebo and Sylvan. Account for the levelness of the granite areas. When was most of the erosion of the folded rocks done? See also Geol. Soc. America, vol. 39, p. 1047, second section. Near the center of the mountains, remnants of Pontotoc lie nearly horizontal. See Plate 16, p. 56, Oklahoma Geol. Survey Bull. 46.

Wichitas. See above reference, first section, for structure. Copy sections in your report.

Summary as usual.

GEOLOGY 130

PHYSIOGRAPHY OF THE UNITED STATES
Laboratory, Coastal Plain, Edition 1938-39

Tsala Apopka, Florida.
Account for the moraine-like topography with lakes and for the comparatively level northeastern part of the map.

Vicksburg, Mississippi.
Describe in simple words the topography of the west half and then the east half of the map. Next account for these differences stating the age of each half of the map. Next account for these differences stating the age of each in terms of the cycle of erosion. Why does the Yazoo River join the main stream here? How did this affect the military importance of Vicksburg in the Civil War? (See Physiographic diagram of U. S.). What evidences do you find that the course of the Mississippi has changed during historic time? Explain fully. What name suggests the date of such a change? Explain why the Mississippi has large meanders and the Yazoo smaller ones. Explain why meanders on a flood plain are smaller than entrenched meanders of similar size streams.

Sandy Hook, New Jersey.
See also block diagram of N. J. and geologic map of N. J. Account for the row of hills which ends in the Highlands of Navesink. Account for the shape of Sandy Hook.

Choptank, Maryland, geological edition. See Folio 182.
State definitely in proper order the recent physiographic history which explains the topography of this area only.

Camp Mills, New York.
Read parts of the legend on the back which bear on the subject. See also Professional Paper 82, page 120 in the library. Draw a cross section of Long Island showing the Cretaceous cuesta, the terminal moraines, and the outwash plain. Omit names for suggested formations of older drift. (p. 20)

In the Summary attention should be directed to (a) the nature and origin of the Fall Line, (b) evidence of former extent of the Coastal Plain inland, (c) hypotheses to explain the marine terraces, (d) extension of Piedmont under the Coastal Plain (Geol. Soc. Am. 48, 753-812), (e) salt domes. Show in map (a) Black Belt, (b) terminal moraine, (c) edge of drift where different, (d) 100 ft. contour which divides the "low" and "high" parts of the area, (e) Mississippi floodplain, including Crowley's Ridge, (f) the major cuesta escarpments shown on the Lobeck diagram. Show quadrangles as usual.

GEOLOGY 130

M

PHYSIOGRAPHY OF THE UNITED STATES
Laboratory-Piedmont Plateau, Edition 1938-39

Gastonia, North Carolina - See Geological Map of U. S.
Locate on this map streams which have been influenced by structure of the rocks. Why do the main streams of the area apparently disregard geology? Outline your reasons for thinking that this region once had greater relief than it has today illustrating this by a sketch-section which shows the geology and its relation to original surface. Next outline your reasons for thinking that this area once had less relief than it has today and illustrate this with an actual profile from some part of the map on which the surface before uplift is restored with a dotted line.

Elkton-Wilmington Folio No. 211
Read the sections on Physiographic Divisions and Surface Features of the Piedmont, pp. 1-4 and on Geologic History of the Piedmont, pp. 15-16. Compare the slope in feet per mile of the top of the older rocks below the Coastal Plain with average slope of the exposed Piedmont using a ruler on Fig. 4, p. 15. (Note error on its legend.) What physiographic term is given to this surface under the Coastal Plain? See Text p. 126.

Passaic, New Jersey-New York; block diagram of New Jersey; geological map of N. M. or Folio No. 157.
Account for the straight border of the hills in the northwest corner of the map. Suggest reason for the hypothesis that this area once had a level topography. What significance has the name "Short Hills"? Account for the gaps in the trap ridges and for the fact that some now have no streams in them.

Talking Rock, Georgia

What physiographic provinces are shown? What is the significance of (a) entrenched meanders (b) steep slopes adjacent to main streams?

Write a summary on same outline as previous provinces. Discuss, in proper places, reasons for and against making the Piedmont crystallines and the Triassic of New Jersey-Virginia separate physiographic provinces; also two possible methods by which the relatively even surface of the Piedmont could have been produced from the ancient mountains and state evidence for the burial of Piedmont by coastal plain sediments either marine or alluvial. Put on your map (a) the areas of Triassic rocks, (b) Trenton Prong, (c) terminal moraine, (d) border of glaciated area, (e) three prominent monadnocks with names.

M

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

Laboratory, Blue Ridge, Edition 1938-39

For information on geology refer either to Geological map of United States or to maps of states where there are such. Folios may be consulted in the library or withdrawn for duration of laboratory period.

Pisgah, North Carolina-South Carolina. See Folio No. 147.
Account for the difference in average level of the French Broad and South Saluda river valleys. Locate examples of past and possible future drainage changes along the Blue Ridge and account for them. What is the drainage pattern? Explain.

Mt. Mitchell, North Carolina-Tenn. See Folio No. 124.
What determined the relative resistance to weathering of the different kinds of rocks? Describe the kinds of summit outlines which you find on the peaks. What is the significance (a) of entrenched meanders (b) of broad parts of the valleys within the mountains?

Antietam, Va.- Md. See geological maps of states.
What is the cause of the three prominent ridges?
What relation may the entrenched meanders have to these belts of hard rocks?

Fairfield, Pa. See Folio 225.
What are topographic results of faulting on the contact of Blue Ridge rocks with the Gettysburg Plain to the east? What kind of rocks makes up the tops of the highest ridges? What suggests that the ridges were once part of a lowland?

In your summary pay particular attention to the several hypotheses of the origin of the Blue Ridge. Diagrams will help to explain these. The problem of water gaps will be deferred to report on Ridge and Valley Province. Illustrate your history with a series of generalized cross sections, each of which shows a major step in development of the Blue Ridge and Piedmont. Label carefully and explain in text. Besides the quadrangles and boundary, show on map (a) Carlisle Prong (b) Mark with symbol)(water gaps of three large rivers which cross the province from west to east into names (c) gap of a stream which flows in reverse direction with name.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES
Laboratory questions, Ridge and Valley, Edition 1938-39

M

Refer to geological maps and to models in halls.

Chattanooga (Folio No. 6).
Why has so much interest been aroused in accounting for the course of the Tennessee River? Explain fully the two major hypotheses which have been advanced for this particular **gap but** reserve discussion of their merits to summary. (Text 276-277)

Delaware Watergap, edition of 1922.
First read the legend on the back. What evidence seen on this map has been used to demonstrate that the region was once almost level? That since then uplift has not been at the same rate all the time? Using one of the figures on the back as a guide and the data obtained from the cross section in the Elkton-Wilmington Folio make a section which shows how it has been attempted to attach geologic dates to the old land surfaces. (Section must include coastal Plain).

Greenland Gap; geological map of West Virginia.
Draw a cross section from near the NW corner southeast across the main ridges in NW part of the map. USE SAME VERTICAL AND HORIZONTAL SCALES. On this show the geological formations with names of ridge formers.

Natural Bridge special; geological map of Virginia. See Am. Jour. Sci. 19 (1930) 257-273. Discuss origin of the Natural Bridge. What physiographic provinces are shown on the map? Account for the valley of Cedar Creek in Short Hills.

Write summary on **regular** outline. In the section on Topography include a series of diagrams showing (a) monoclinal mountain, (b) synclinal mountain, (c) anticlinal mountain. Also explain the criteria by which you can read geologic structure from the contour map. In the section on History include discussion of (a) evidences for and against former regional and partial peneplains, (b) how these were dated **in the geologic time scale**, refer to cross section of Delaware water gap, and (c) origin of water gaps and wind gaps, the last including a comparison of the several hypotheses advanced. Show on map (a) watergaps with names of three rivers which cross from NW to **SW**, (b) gaps and name of two rivers from **SE** to **NW**, (c) terminal moraine and (d) border of unglaciated area (map of Pennsylvania).

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THE APPALACHIAN PLATEAUS AND THE NEWER APPALACHIANS

1. Read Section 7 of the Physiographic Diagram, dealing with the Appalachian Plateaus. See Article 542-3 in F&T, if need be. Why is hill country a more appropriate term than plateau, in naming this region? Outline the region on your Diagram.

2. Clarksburg quadrangle. This is a representative sample of most of the Appalachian Plateau. Note the contour interval. What proportion of the land is in slope? Is the country youthful, in early maturity, full maturity, or late maturity? How high are the ridge tops above the valley bottoms? (This figure is the relief.) What would be your experience if you were to walk in a straight line across the area (note degree and arrangement or pattern of the ridge tops and of the streams.) This pattern is called dendritic. Draw a sketch map to show the arrangement of the ridge crests in the middle section of the northern thrid of the Clarksburg quadrangle. This region was a smooth upland ages ago. How did the present topography develop?

3. The northern part of the Middlesboro area is in the same region as the Clarksburg. See one of the Middlesboro maps with green forest overprint. Suggest possible reasons for the large percentage of the area left in woods. Can you explain the location of the cleared areas? This is a region of serious soil erosion on most of the cleared land. Why? Account for the location of the roads. Ths southern part of this area is in the Folded Appalachians.

4. Read section 6 of the Physiographic Diagram, dealing with the Folded Appalachians. See Articles 546 and 548 in F&T, if need be. Outline this region on your map.

5. The Mt. Union quadrangle is an excellent sample of the Folded Appalachians.
   a. How is the bed rock of this region like that of the region immediately to the west? How unlike? (See F&T)
   b. Make a sketch map to show the arrangement of ridge crests in the southern third of the map.
   c. How does the bed rock underlying the ridges differ from that underlying the valleys?
   d. Describe the pattern of valleys. In which direction is travel easy? Difficult?
   e. Originally, this area was entirely wooded. Describe and explain the present woodland pattern.
   f. In what topographic position are the roads, rural homes, and towns?

6. Summary: Briefly compare the Allegheny-Cumberland hill country (Appalachian Plateau) and the Appalachian ridge-and-valley region (Folded Appalachians) in:

   (a) pattern of ridges and valleys
   (b) extent and distribution of woodland
   (c) distribution of roads, rural homes, and towns.

1. The Ozark Plateau is like the Allegheny-Cumberland Hill Country, and the Ouachita Mountains resemble the Appalachian Ridge-and-Valley Region. Draw a line on your Diagram to separate these two regions. (Ozarks and Ouachitas)

2. Why have these regions been of slight importance as barriers to trade. Answer all questions.

THE OLDER APPALACHIANS

1. Read Section 3 of the Physiographic Diagram, dealing with the Older Appalachians. Outline the Blue Ridge and the Piedmont on your diagram.

*2. The Gastonia sheet is taken as a sample of the Piedmont.
   a. What is the local relief (take the local relief of the middle section of the eastern third of the area)? Would you class this area as plains hill country or mountain (as defined in your text)? How does the relief compare with that of the Allegheny-Cumberland Hill Country(of which the Clarksburg area is a sample)? With the Appalachian Ridge-and-Valley Region (Mt. Union sheet)?

   b. How high above the surrounding country is the top of Pasour Mountain? Spencer Mountain? Account for the presence of these "mountains".

3. The Ashville quadrangle is taken as a sample of the Blue Ridge.
   *a. What is the maximum relief of the middle section of the southern third of the map? Is this area hill country or mountain, as defined in your text?
   *b. Taking the Ashville quadrangle as a whole, what arrangement has the ridge crests? Does the Blue Ridge most resemble the Appalachian Ridge-and-Valley Region or the Allegheny-Cumberland Hill Country in this regard?
   c. See the explanation in your text, (Article 552), of the origin of the lowland occupied in part by the city of Ashville.

*4. Summary.
   a. In what ways are the Piedmont and Blue Ridge alike? Different?
   b. How does the Piedmont resemble the inner Coastal Plain? How does the Blue Ridge resemble the Appalachian Ridge-and-Valley Region and the Allegheny-Cumberland Hill Country?

VII

NEW ENGLAND PROVINCE

1. Read Section 2 of the Physiographic Diagram, dealing with the New England Upland. Outline the region on your diagram.

*2. Much of the New England coast resembles that shown on the Boothbay sheet.
   a. What evidence of submergence does the Boothbay sheet present?
   b. What evidence of glaciation?
   c. What features help to make this area suitable for summer resorts? For fishing? How is the **location** of the area involved in each of these uses of the natural resources?

3. The Boston sheet (posted)also shows a submerged coast line.
   *a. Name several of the small estuaries which empty into Boston Bay or into its western extensions.
   b. What do you think was the origin of the islands shown on this map?

GEOLOGY 130

PHYSIOGRAPHY OF THE UNITED STATES

Laboratory-Appalachian Plateau, Edition 1938-39

Foxburg quadrangle, Pennsylvania, edition showing structure; (Folio No. 178). Study the map and see how geologic structure is shown. What relation is there between structural and topographic "highs"? Explain two theories of the bearing this has on the erosional history of the area. In what stage of the erosion cycle is the area now? what other evidence do you find of relatively recent uplift or of increase in stream volume? Last, list in order steps in the physiographic history of this area which are demonstrated by evidence of this map alone.

Watkins Glen, New York: Folio No. 169.
Locate examples of (a) mature preglacial surface, (b) post-Wisconsin gorge, (c) outwash filled valley, (d) stream diverted by glaciation, (e) hanging valley, (f) youthful glaciated valley containing lake, (g) youthful glaciated valley without lake and not parallel to direction of ice movement.

Elkland, Pennsylvania, glacial geology edition: structure sections, Folio 93. What dominates the topography, constructional features of glacial origin or erosional features of older age? Suggest two distinct explanations of the valley between Little Marsh and Phillips. Locate outliers of Pottsville formation and account for their preservation.

Katterskill, New York. See International Geological Congress Guidebook 9A. What physiographic provinces are shown. Explain with diagrams the drainage changes which have recently taken place on this area and tell why they took place.

In the summary include in proper places in your discussion, a statement as to the cause of perservation of the Plateau, summarize the problem of finding evidence of successive uplifts in this Province as compared to the Folded Appalachians, and the four hypothese of the peculiar glaciated youthful topography of western New York. Show on map (a) Finger Lakes, (b) Cumberland Plateau, (c) Catskill Mts., (d) Tughill Plateau, (e) Mohawk Valley, (f) Teays Valley, (g) Pine Mt., Ky., (h) terminal moraine, (i) border of glaciated area. (last two map of Pennsylvania.)

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES
Laboratory questions, New England, Edition 1938-39

not revised M

Eastport, Me. Geologic and structure maps. See Folio #192. How does the topography show the geologic structure? What relation exists between topography and the direction of glacial movement? How does this bear on the amount of glacial erosion? List in order the events which have occured since the ice retreated.

Housatonic, Mass.-N. Y. and geological map of Massachusetts. What relation has the topography to the structure of the bed rocks? To what kind of bed rock?

Hartford, Conn. and map of surface geology of Conn. Explain the two theories of the origin of the terraces. See Bull. 47 Conn. Geol. Survey, pp. 19-27.

Rochester, Vt.
What mountains are shown and what kinds of bed rock? Suggest two distinct factors which helped produce the rounded summits.

West Point, N. Y. See G. S. A. Bull. Vol. 47, 1831-1848. List possible reasons for the crossing of the Highlands by the Hudson River. By what name is the extension of crystalline rocks west of the Hudson known?

Boston and vicinity, Mass. See U.S.G.S. Bull. 839. Locate examples of drumlins. Account for the strip of land connecting Telegraph and Great Hills with the mainland. Account for the steep east face of Strawberry Hill. How can you tell rock islands from drift islands?

Passadomkeag, Me. See Monograph 34, plate 47. Draw a sketch outline of the quadrangle showing the eskers. What is the origin of such ridges?

Hawley, Mass.-Vt.
Is there evidence of rejuvenation of the streams of this area? Explain. What kind of topography was formerly present? (State average relief). Draw cross section to show uplift (Vert. x5).

Write summary on usual outline. Include discussion of (a) why N. E. is considered a separate province and (b) reasons for and against the existence of dissected peneplains in N. E. Discuss local glaciation and the hypothesis of stagnation of the continental ice sheet. On map show Mt. Monadnock, Green Mtns., White Mtns., Conn. valley Triassic area, Penn. of Boston and Naragansett Basins, Reading Prong, Manhattan Prong, Highlands of Hudson.

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PHYSIOGRAPHY OF THE UNITED STATES
Laboratory questions, New England, Edition 1937-38 38-39

Eastport, Maine, geological and structure maps. See Folio No. 192.
How does the topography show the geologic structure? What relation exists between topography and the direction of glacial movement? How does this bear upon the amount of glacial erosion? List in order the events which have occured since the ice retreated.

Housatonic, Mass-N.Y. and geological map of Massachusetts.
What relation has the topography to the structure of the bed rocks? To kind of bed rock?

Hartford, Ct. and wall map of surface geology of Connecticut.
Explain the two theories of the origin of the terraces using diagrams given in class. See Bull. 47 Ct. Geol. Survey, pp. 19-27.

Rochester, Vermont.
What mountains are shown and what kinds of bed rock? Suggest two distinct factors which helped produce the rounded summits.

West Point, N. Y. See G. S. Am. 47. 1831-1848.
List four possible reasons for the crossing of the Highlands by the Hudson River. By what name is the extension of crystalline rocks west of the Hudson known?

Boston and Vicinity, Mass.
See U. S. Bull. 839. Locate examples of drumlins. Account for the strip of land connecting Telegraph and Great Hills with the mainland. Account for the steep east face of Strawberry Hill. How can you tell rock islands from drift islands?

Passadomkeag, Maine See Monograph 34, plate 47.
Draw a sketch outline of the quadrangle showing the oskers. What is the origin of such ridges?

Hawley, Mass. Vt.
Is there evidence of rejuvination of the streams of this area? Explain. What kind of topography was present before (state average relief)? Draw a cross section with vertical scale not exaggerated over five times to show evidence of uplift.

Write summary on same outline as before. Include a discussion of (a) why New England is considered a separate province and (b) reasons for and against the existence of dissected peneplains in New England. Under glacial history discuss both local glaciation and the hypothesis of stagnation of the continental ice sheet. Show on map (a) Mt. Monadnock, (b) Green Mountains, (c) White Mountains, (d) Connecticut valley Triassic area, (e) ~~Pennsylvanian of Boston and Naragansett Basins~~, (f) Reading Prong, (g) Manhattan Prong, (h) Highlands of Hudson.

GEOLOGY 130

Physiography Of the United States

Laboratory questions, Adirondacks, Edition 1938-39.

Lake Placid, New York.

See New York State Museum Bull. 193. Account for the rounded mountains (two causes). What effect did glaciation have on the drainage pattern? On topography? (Locate examples).

Elizabethtown, New York. 393-394

How does this map show the effect on topography of faults? What evidence of local glaciation can you find? pp 408-409

Lowville, New York. 325-326 pp 395-396 406-407

Account for the level areas with kettles in eastern part of map. Where did the glacier last longest during its melting? Compare the shapes of the "hard rock" hills with those of the "soft rock" plateau hills west of Black River.

On map show (a) area of intrusive igneous rock, (b) of gneiss.

GEOLOGY 130

PHYSIOGRAPHY OF THE UNITED STATES

Laboratory questions, Interior Low Plateau, Edition 1938-39

Greenbrier, Tenn. see geological map of Tennessee
What name is given to the escarpment north of Nashville? Account for it.

Georgetown, Kentucky
What name is given to the kind of topography found on tops of the ridges? Account for it. What suggests that relief was once less than now?

Lockport, Kentucky
Account for the formation of the abandoned valley near Bethel Church in SE part. Locate other examples of same process.

Hollow Springs, Tennessee
Account for the Plateau of the Barrons. (see geological map of Ky.)

Vienna, Illinois
What is cause of the high bluffs in north part?
Draw a cross section with a reasonable vertical scale from Mermet through Ganntown N.E. to Johnson Creek to edge of map and account for features shown.
What is origin of the wide valley from Karnak east through Mermet?

Summary as usual. Show on the E. W. cross section of Kentucky the probable position of Highland Rim peneplain. Why is this surface not preserved in the Nashville Basin? On map show (a) limits of Blue grass and Nashville Basins (b) Dripping Springs escarpment (edge of Chester) (c) Pottsville escarpment. (d) Mammoth Cave. (e) Knobstone escarpment in Indiana (fig. 116).

GEOLOGY 130

PHYSIOGRAPHY OF THE UNITED STATES

Laboratory, Ozark Plateau, Edition 1938-39

Eureka-Harrison Folio No. 202.

Read sections on Geology and Geography of Ozark region, Topography, and Geologic History of Mesozoic and Cenozoic. Show by a cross section (structure section sheet) the three benches. Indicate the resistant rocks causing them and the names used in Missouri.

Coldwater, Mo. See geoglogical Map of Missouri.

Account for the mountains and compare with a similar area in Wisconsin. Refer to Mo. Geol. Survey vol. 10, pp. 94-109 for discussion of entrench meanders. What explainations may apply here?

Summary:

Show on map (a) St. Francis Mts, (b) Mississippian escarpment, (c) Boston Mts, (d) Springfield Platform, (e) Salem Platform, (f) Escarpment at top of Cambrian ss. (g) Escarpment at top of St. Peter ss. Discuss evidence of more than one cycle of erosion.

GEOLOGY 130

Physiography Of The United States

Laboratory, Ouachita Mountain Edition 1938-39

Caddo Gap, Ark.

What physiographic provinces shown on this map? Describe what surface features show this boundary on the map. Refer to Bull. 808, pl. I. What evidence indicates two cycles of erosion (fig. 7, Bull. 808)? Study structure sections in above and account for the bends in Caddo Mt. and for the structure of Nelson Mt.

Hot Springs and vicinity, top. and geological maps.

Refer to Folio 215. What is the most resistant kind of rock here and how does this fact show in the topography? Gaps across ridges narrow in the direction of dip. Apply all criteria to Trap Mt., West Mt., Sugarloaf Mt., and Indian Mt. What causes the difficulty? Does the rule that an anticline has a long gentle nose and a suncline a short nose apply here?

Winding Stair, Okla.

Account for the topography near Heavener by using the geological map.

Little Rock, Ark.

Read the legend on back. Find the border of the Coastal Plain. Account for differences in course of Arkansas River above and below Little Rock. What evidence suggests that the Coastal Plain sediments were deposited on a surface of very low relief? That the Coastal Plain once extended farther?

Symmary.

Locate on map (a) Athens Plateau, (b) Arkansas valley section. Compare physiographic history of the province with that of Ridge and Valley province.

All reports must be in long enough before the examination to permit of grading. NO reports received later than that will be accepted.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

Sept. 30, 1929

For entire class:
(1) Every student should have a copy of Bowman's Forest Physiography. These have been ordered at Brown's book store, corner of Lake and State

(2) Every student should have a copy of the Physiographic Diagram of the U. S. by Lobeck, large scale edition, printed on both sides. These will be on sale at Brown's book store, corner Lake and State

(3) Read Bowman, pp. 107-126, 554-557, 572-584. If possible also references 15 or 16. Reference assigned to each student. On the latter be prepared to hand in a written summary not to exceed one page in length. While reading refer constantly to the Physiographic diagram which was made for this purpose.

For 5 credit students:
(1) Every student should have (a) paper 8½ x 11 inches. If any notes or sketches are made on smaller sheets paste them on to one of these. Notes taken in the laboratory may be typed at home. (b) manilla folders for above in which to hand in all notes on each physiographic province when finished. (c) colored pencils not wax crayons (d) ordinary pencil and eraser (e) several sheets of cross section paper which may if desired be cut into strips for profiles (f) India ink, pen and penwiper are also desirable for marking on your diagram etc.

(2) Bring the Physiographic diagram to the laboratory. On it mark with colored pencil the boundaries of each province as studied and mark in ink the boundaries of every small map studied except state maps. Also color other features as directed and add an explanation.

(3) Keep your notes etc between periods which are Monday and Wednesday 2;30-4;20 The instructor will not be responsible for anything left in the laboratory

(4) Students will please not touch materials left in the laboratory for other classes.

LAURENTIAN UPLANDS-SUPERIOR HIGHLAND
(1) On the Physiographic Diagram mark the boundary of the Superior Highland using the 1928 geological map of Wisconsin and the Lake Superior model.

(2) On the same color (a) areas of massive rocks, (b) areas of banded rocks. (c) Lable Isle Royal, Apostle Islands, (d) color area underlain by sandstone west of Huron Mts.

(3) Questions
(a) What geologic names are applied to the different groups of rocks colored above? (b) what kinds of rock does each consist of? (c) explain the reason that each group makes a different kind of topography. (d) State why we know that the Superior highland was once part of a mountain range (e) State how we know that the present area of the highland is not as large as its original extent. (f) How do we know that the mountains disappeared long before the coming of the glaciers? (g) What do we call such an area as the Superior highland is at present? (h) What term is applied to the isolated hills and ridges; name several and mark them on the map when not shown (see map of Wisconsin) (i) Account for the lakes and suggest reasons for the fact that they occur only in certain portions of the area (j) Mark on the map the border of the young drift (k) What geological name is applied to this drift? (l) How do we know that glaciation occured at different times? (m) Suggest reason for the conclusion which was once reached that the region around Wausau had never been glaciated. (n) Account for the level area near the terminal moraine

northeast of Wausau (c) Account for the terms Laurentian upland, archean shield, pre-Cambrian shield. (p) Why is bed rock geology of large areas so poorly known?

(4) Map and model of Lake Superior region-map of Wisconsin, 1928

(a) Draw an East-West sketch or diagramatic section through Wisconsin at latitude of Rib Hill. Do not subdivide the rocks which are younger than Cambrian. What name is applied to this group of rocks? Use horizontal scale about half that of map of Wisconsin, vertical scale not over 1 inch = 5000 ft. Compute amount of exaggeration. Granite is found at Hudson at 375 feet, at Monomonie at 350 ft, at Marinette at 900 ft.

(b) From conclusion that Superior upland was made a peneplain before Cambrian time suggest reason for present slope of surface of the hard rocks.

(c) Draw a sketch cross section across the basin of Lake Superior northwest-southeast through Porcupine Mts. Use horizontal scale same as map of Lake Superior region, vertical scale 1 inch = 5000 ft. Compute exaggeration.

(d) Suggest possible explanations for the great depth of the Lake Superior basin. Discuss the difference between the fold and the actual basin. The origin of Lake Superior will be considered in connection with the Interior Lowland.

Marathon quadrangle, [illegible] and Wausau quadrangle, Wisconsin

This area is typical of the southern part of the Superior highland in Wisconsin. What evidence do you see that this area once had lower relief than it does today? Examine the map of Wisconsin and find what kinds of bed rocks occur here. How do they affect the topography? What kind of drainage pattern is present? Illustrate your conclusion with an accurate profile from near the southwest side of Rib Hill northeast to near northeast corner of Town of Hewitt. Vertical scale 1 inch = 2000 ft. What exaggeration? What part of these maps has been covered with Young Drift? with Old Drift? Account for scarcity of drift material in the valley of the Wisconsin above the flat valley floor. Account for this level floor. Account for difference in topography of the old and young drifts. On cross section show only massive rocks and banded rocks. Was this area once covered by rocks like those of southern Wisconsin? How was age of peneplain fixed?

Superior quadrangle, Duluth quadrangle, Wisconsin and Minnesota

Draw an accurate profile from Proctor to Southeast corner of Superior quadrangle. Make in two parts and use vertical scale 1 inch = 1000 ft. Add geology from map of Wisconsin showing (a) lava flows, (b) sandstone and shale, (c) faults. What relation has the sandstone to the peneplain? Locate specifically (a) unaltered glacial topography like terminal moraines, (b) abandoned lake bed, (c) postglacial erosion valley, (d) drowned river valley, (e) ridge due to tilted lava flow, (f) supposed hangling valley

Give reasons for supposing that the bluffs at Duluth are a fault scarp. See Ref. no. 15. The location of the boundary between Minnesota and Wisconsin was disputed. Suggest cause for the location of this line shown on the map cutting through the ends of docks on the Minnesota side. In the suit over taxes on these docks the question came up as to whether St. Louis Bay is a river or a lake. How would you argue this question? Suggest origin of Minnesota and Wisconsin Points. Find other similar features. Why is the level of Lake Superior now rising?

St. Croix Dalles quadrangle, Minnesota and Wisconsin

Locate definitely (a) an area of terminal moraine with lakes, (b) a pitted outwash plain with lakes and kettles, (c) valley eroded by drainage from the glacier at time of lakes to the north, (d) ridge due to tilted lava flows (such ridges trend northeast-southwest because of faults which locally depress the hard rocks. Note narrows in St. Croix valley due to such ridges. Note difference in valley where excavated in rock south of the Dalles and where in drift farther north.

Adirondacks
Lake Placid quadrangle, New York
This is a typical portion of the East Central Adirondacks. What evidence do you see of fault control of valley directions? What kinds of rocks are present (map on board)? Locate examples of glacial diversion of streams. Account for the rounded outlines of the mountains. Do you find evidence of local or Alpine as well as continental glaciation?

Bolton quadrangle, New York
What kinds of rocks are present? Account for the straight valleys. In what directions do the faults run? Explain the difference between fault valleys and fault line valleys. Locate some cirques. Explain their origin. Account for the larger lakes.

Lowville quadrangle, New York
This map shows the western border of the Adirondacks which follows the valley of Black River. Suggest possible cause for the river valley in this location. What is the ridge from Croghan south? See reference No. 77. Account for its direction with ice coming from the west of north. Account for flat-topped areas with kettles and lakes in eastern part of the map. The rounded hills in the eastern part of the map are composed of the old hard rocks. Compare their shape with the hills of sedimentary rocks west of Black River.

Elizabthtown quadrangle, New York
This map illustrates the effect of faults on valleys. Look for evidence of mountain or local glaciation. Is there a large amount of drift in this region. Explain.

Summary.
Write out a brief summary of the Laurentian Upland in the U. S. using the following outline.
Definition
Boundaries
Topography, description in terms of fact without explanation of history.
Geology
History of the topography
Relation of the topography and natural resources to life of man.
This summary MUST NOT EXCEED FOUR (4) PAGES

Bind up both answers and directions in a folder to hand in.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

2nd edition

Laboratory, Laurentian Upland

General Directions

Every student taking 5 credits is expected to put in a minimum of 4 hours per week on laboratory work if possible at the regular assigned hours. Special cases will be allowed to deviate from this program. The text book is "Forest Physiography" by Bowman. Every student including those taking 3 credits should have a copy of the large scale physiographic diagram of the United States by Lobeck. ~~These are on sale at Browns book store, corner State and Lake.~~ Those intending to teach are urged to buy the edition which is printed on only one side of the paper and to have this sectioned and mounted on cloth. This diagram should be at hand while reading the text as it locates nearly all the places there mentioned. It is a good idea to bring it to all meetings of the class. Students taking laboratory work should also have typwriter size paper, covers for handing in notes on such paper, clips for fastening together notes, ordinary pencil and eraser, colored pencils preferably not wax crayons, some cross section paper, red ink for marking on physiographic diagram.

F r every province studied mark the boundaries on your diagram in ink; also locate the limits of every small map (not state maps) used in the laboratory. Keep notes etc until ready to hand them in for there is no chance to leave anything in the laboratory. STUDENTS ARE REQUESTED NOT TO HANDLE SPECIMENS ETC. left for use of other classes and to NOT LEAVE ANY MAPS ON THE TABLES when through with them. Please return all maps to small room adjacent to the laboratory. DO NOT LEAVE ANY MAP HANGING OVER THE BLACKBOARD

In marking the boundaries of the Superior Highland use the 1928 map of Wisconsin. Explain why it does not agree with the line shown on the physiographic diagram. Study the geological model of the Lake Superior region in hall and locate typical areas of (a) massive rocks and (b) banded rocks or layers of rock of varying hardness. What ages of rock are common in each of these two groups? Explain the reasons for the different kind of topography made by the two groups. Locate typical examples of each and illustrate with sketches showing rough crosssections. Why do we know that the Superior Highland was once part of a mountain range? How do we know that the present area of the highland is not as large as the original extent of the mountains? How is the geological date of the removal of the mountains determined? How do we know that this took place long before the coming of the glaciers? What physiographic term is applied to the topography of the Superior Highland? What term is applied to the isolated hills and ridges or ranges? Locate some of these giving their names. What kinds of rock are most common in them and why? Note that lakes are not uniformly distributed. Give the three general classes of lakes on the basis of origin. How do we know that all the area of the Superior Highland was not glaciated at the same time? Using the 1928 map of Wisconsin mark the boundary of the Young or Wisconsin Drift. Why is there difference of opinion as to whether or not the area around Wausau was ever glaciated? Account for the terms Laurentian Upland, Archean shield, Pre-Cambrian shield. Why is bed rock geology not shown over large areas? Illustrate the relation of the Superior Highland to the adjacent province by means of a rough cross section through Wisconsin at the latitude of Wausau. In drawing cross sections or profiles remember that the vertical scale must not be exaggereated too much. Do not represent rocks which dip less than 1 degree (92 feet per mile) as having high angles of inclination. For such a section make it about the length of a page and use a vertical scale of not less than 5000 feet per inch. Remember that the highest altitude of the general upland is about 1500, the top of Rib Hill (recent determination) is 1927, Lake Michigan 581. Granite or other hard rock was struck at Marinette at 900 feet below surface, at Menomie, Dunn Co., at 350 and at Hudson at 375.

Marathon and Wausau quadrangles, Wisconsin; 1928 geological map of Wisconsin
This area is typical of the southern part of the Superior Highland in Wisconsin. What evidence can you find on this map which indicates that this area once had lower relief than it does today? What kinds of bed rocks occur in this area? How do they affect the topography? What is the drainage pattern? What relation has part of it to the structure of the rocks? Explain fully. Was this area all glaciated? Explain difficulties of telling in field and on map. Account for the topography of the eastern part of the Wausau quadrangle. Account for the flat floor of the larger valleys. Is there reason to think that this area was once buried by the younger sedimentary rocks which are now confined to lower areas to west, south, and east? Explain fully.

Superior and Duluth quadrangles, Wisconsin-Minnesota; gelogical map of west end of Lake Superior
These maps show the west end of the trough in which Lake Superior is situated. This trough is lower than the peneplain remnants to south and north and differs from them in being underlain by sandstone and shale instead of hard rock. Suggest three distinct and possible explanations of the trough and two distinct explanations of orosion within it. Is there any reason to think that another fault occurs along the north shore? Locate definitely (a) unaltered glacial depositional topography, (b) lake bottom topography formed when ice occupied the east end of Lake Superior, (c) postglacial erosion valley, (d) drowned postglacial valley, (e) spit enclosing bay, (f) drowned natural levee, (g) submerged meander as shown by boundary line between states as here given, (h) ridge due to tilted lava flow, (i) ridge due to intrusive igneous rock. Notice the Minnesota docks which cross the State Line. This led to an effort by the city of Superior to tax these docks. In the resulting suit before the U. S. Supreme Court it was brought out that the boundary should follow the "main channel" of St. Louis Bay. Physiographers testified that this ment the river channel before the water rose, but the court dodged the question of "when does a river become a lake" by saying that boats always went the shortest way anyhow, the line now dredged straight through the Bay, and decided in favor of Minnesota. Why is the water level rising? Does it look as though this is a comparatively rapid process? Explain.

Houghton and Calumet Special quadrangles, Michigan; geological map of L. Sup. re
What topographic feature is shown in part by these maps? Account for the escarpment on west side of Portage Lake. Account for the difference between the topography of South Range and the rest of the area. Suggest possible origin of the valley which crosses the peninsula at Houghton. Why was a canal needed to complete the route? How can the direction of dip and strike of rocks be told from the map. Account for the alternating valleys and ridges. Can you locate any beaches of higher levels of Lake Superior? Account for the complex area northeast of the Portage Lake Ship Canal close to the beach of the present lake. Account for the deltas near Houghton which are covered with brown dots. What does this indicate? Locate other deltas. Why are there none in Lake Superior?

Wealthwood quadrangle, Minnesota and map of glacial geology of Minnesota
Account fot the lake basins. Are they all the same kind? Explain possible origin of the ridge on the the north beach of Mille Lacs Lake.

Denzer quadrangle, Wisconsin and geological map of Wisconsin
This map, which is old and very poorly surveyed, shows part of the Baraboo Range. Note the large flat uplands in the central part of the map. The quartzite here dips at least 15 degrees to the north. Suggest two distinct and possible modes of origin of these uplands. Note the isolated hills of quartzite which rise through the uplands of sedimentary rocks farther west. Account for the narrows of Narrows Creek and Baraboo River. Locate the terminal moraine of the

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Young Drift and account for the flat areas west of it. What was the condition in the valley of the Baraboo when the ice was at the moraine?

Lake Placid quadrangle, New York; geological map of New York
What evidence do you see of fault control of valley directions? Explain the difference between "fault valleys" and "fault line valleys. What kinds of bed rock are present? Locate examples of diversion of streams due to glacial deposition. Account for the rounded outlines of the mountains. Do you find evidence of local or Alpine glaciation as well as of continental glaciation? Explain.

Bolton quadrangle, New York
What kinds of bed rock are present? Account for the straight valleys. In what directions did faulting occur? Locate several cirques and explain their origin. Account for the larger lakes.

Elizabethtown quadrangle, New York
This map illustrates the effect of faulting on the drainage pattern. Is there evidence of local glaciation and where? Is there a large amount of continental glacial drift here. Explain.

Summary
A written summary of the features of each province is to accompany the notes on the foregoing questions. In general the shorter the summary the better provided it is adequate and clear. Notes and summaries may be typewritten if desired. Last date for handing in is given at end of each exercise. The physiographic diagram need not be handed in with each set of notes. The following outline is satisfactory but need not be followed in exact order if it seems best to alter it somewhat.
Definition of province.
Boundaries of the province and its main subdivisions.
Topography, a description in terms of fact without any explanation of history
Geology, a brief statement of the kinds of rocks present and their structure without details of origin and history of the rocks.
History of the present topography
Brief summary of the effect of the topography and principal natural resources on the life of man in the province. This can be based on information picked up from maps, field trips, and the text and need not be exhaustive.

LAST DATE FOR THIS EXERCISE OCT. 13

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

3rd edition

Laboratory, Laurentian Upland

Every student taking this course for 5 credits is expected to put in a minimum of 4 hours per week in the laboratory. As far as possible it is expected that this will be done at the regular periods. When Room 206 is occupied by other classes maps may be taken to Room 212. PLEASE RETURN THESE AFTER USING. Special permission should be secured before removing any map to any other place. When finished with maps the last person using them will please park them on top of the map case in the small room opening off 206. Every five credit student must have a copy of the LARGE SCALE Physiographic Diagram of the United States by Lobeck. The edition printed on only one side of the paper is best and it is strongly advised that the map be cut into sections each about the size of this sheet and mounted on unbleached muslin leaving at least ½ inch between adjacent sheets. Bring this map to class as it helps to see what is being pointed out on the wall map. Use it also for studying as it locates almost all places mentioned in the text. All notes must be handed in on paper the size of this sheet (8½ X 11 inches). Use a cover fastening loose sheets in any desired way. Cross section paper, preferably 10 or 20 divisions to the inch, will be used for sections. This can be cut up into narrow strips but if so each should be pasted to a regular size sheet of plain paper before handing in. Inking in of the Physiographic Diagram can be done at home; red is best. Colored pencils, NOT wax crayons, are desirable. All that is needed in the laboratory is ordinary pencil and eraser. There are no facilities for leaving supplies from one period to the next. Notes may be taken home for typing. PLEASE DO NOT HANDLE specimens left in 206 for other classes and please see that no wall maps are left hanging over the blackboard. PLEASE SEE THAT TABLES ARE CLEARED WHEN THROUGH!

The Physiographic Diagram is used to show the boundaries of every province studies and of such subdivisions and other features as may be indicated in the directions. The boundaries and name of every quadrangle studied are also to be indicated. Use large wall map of U. S. to get these. Physiographic boundaries may be obtained from copy of Fenneman map of U. S. on map rack.

Mark the boundaries of the Laurentian highland on the Physiographic diagram. Use 1928 map of Wisconsin and map of Lake Superior region to supplement and correct the Fenneman map. In your summary explain (a) why some of this boundary is not well known, (b) why recent changes have been made in it. Do not show the smaller isolated areas of old rocks as these should properly be treated with the Interior Lowlands.

1928 geological map of Wisconsin, map of Lake Superior Region, model of same in ha
What general name is applied to the age of the bed rocks of the Laurnotian Upland? What kinds of rocks occur? Use the legend for the Lake Superior model and map to list the age subdivisions of the Laurentian Upland rocks. Divide these rocks into two general classes based on their effect on topography. Under each list the kinds of rock and the age names. Be sure you understand the difference between these two things as well as the different effect on erosion. Illustrate each general class by a diagramatic section. State where an example of each may be found. On your Diagram color in the Keweenawan, also the area underlain by sandstone close to Lake Superior, west of Marquette, Michigan. In your summary remember to account fro the terms Laurentian Upland, Archean Shield, pre-Cambrian Shield and explain fully how we know that this area was (a) once mountainous and (b) much larger than it is now.

1928 map of Wisconsin (corrected) and map of concealed pre-Cambrian.
Using these two maps construct a cross section north-south through Wisconsin using same horizontal scale as the maps. Vertical scale must not exceed 5000 feet per inch. As help follow cross section 2, 1911 map of Wisconsin

These sections show something about like what is expected in relation of vertical to horizontal. Remember that you should never indicate rocks which dip less than 1 degree or 92 feet per mile as having a steep dip. Do not attempt to show details of the surface outside the Laurentian or Superior Upland at present. The section should include the Baraboo Bluffs to show why isolated areas of pre-Cambrian occur out in the Interior Lowland. Do not attempt to show details of the pre-Cambrian [illegible] rock structure. Rib Hill, the highest known point in Wisconsin, elevation 1927 feet, should be included in the section. To help with elevations (a) see sections on 1911 map, (b) see list of elevations in Wisconsin, back of Bulletin 36, Wisconsin Geol. and Nat. Hist. Survey, in library, (c) use other maps in laboratory. Get pre-Cambrian elevations from map in laboratory.

Marathon and Wausau quadrangles, Wisconsin; 1928 geological map of Wisconsin. How do you know that this area once had higher relief than it does now? What on the topographic map suggests that it once had LOWER relief than now? What kinds of bed rocks occur here? What ages? What is the drainage pattern? What relation has it to rock structure? Do you find evidence that any part of these maps was affected by the Young glaciation, by the Old glaciations? Why is no effect of the Old glaciations found? Explain the difficulties of telling whether or not such an area was glaciated which you would meet with in the field. Account for the flat floors of the larger valleys. Is there reason to think that this region was once covered by the rocks now found in the Interior Lowland? Explain fully including what has happened since such cover was removed.

Houghton and Calumet quadrangles, Michigan; geological map of Lake Superior Region How do these maps indicate the structure and nature of the bed rocks? Explain by drawing a cross section with horizontal scale same as map and vertical scale exaggerated not more than 5 times. Show your computations in notes. Account for the great escarpment along the southeast side of the Copper Range. Account for the difference between the topography of South Range and the rest of the area. Can you locate any of the abandoned beach lines? If not study map from Prof. Paper 154 A on map rack. What process closed the erosional (preglacial) gap near Houghton so that a ship canal was needed? What relation have the highest rock ridges to the Lake Superior peneplain?

Superior and Duluth quadrangles, Wisconsin-Minnesota; geological map of west end of Lake Superior.

These maps show the west end of the Lake Superior trough. Note relation of this part to the Lake Superior syncline. Note the absence of any remnant of the Lake Superior peneplain in the trough. Discuss possible explanations of this fact and different possible agents of erosion. Postpone discussion of origin of Lake Superior basin until summary of province. Locate definitely with reference to either other features or by section, town, and range: (a) unaltered glacial depositional topography of the Young glaciation, (b) glacial lake bottom topography including explanation of the lake, (c) postglacial erosion valley, (d) drowned postglacial erosion valley including explanation, (e) lake spit, (f) drowned natural levee, (g) submerged meander as shown by state boundary, (h) ridge due to inclined lava flow, (i) ridge of intrusive igneous rock. Note the docks which cross the Minnesota-Wisconsin line as here mapped. Their building led to a boundary controversy in which physiography [illegible] was important. [illegible]. The boundary was defined as the "main channel." Knowing the recent physiographic history of the Bay prepare a case for both the rival states which desired to tax these docks. It must be recalled that boats never followed the old submerged meander but cut [illegible] across the bay along a straight line now dredged. Actual decision of the Supreme Court will be given in class. Do you think that the water level may still be rising and why?

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Wealthwood quadrangle, Minnesota; map of glacial geology of Minnesota
Account for several types of lake basins on the quadrangle. Suggest origin of low ridge on north beach of Mille Lacs Lake.

Lake Placid quadrangle, New York: geological map of New York
What is the bed rock of the quadrangle? Account for the rounded outlines of the mountains giving two contributing causes. What effect did glaciation have on the streams of the area? Was glaciation all of same kind? Explain fully how you know this. Explain the difference between a "fault valley" and a f . "fault line valley". Which kind is present here and how known?

Bolton quadrangle, New York
Same questions so far as they apply as for Lake Placid. Do not repeat needlessly.

Summary
When you complete your notes and diagrams they may be typed if you desire. Answers handed in should always be explicit and make clear just what they are about. For instance to just say "Yes" or "No" to a question is not enough. Make it clear to anyone just what it is all about.
After your answers to questions add a VERY BRIEF SUMMARY of the physiographic province. This summary should so far as possible avoid the style of treatment given in your text book. LENGTH LIMIT FOUR(4) pages will be strictly enforced in order to insure condensation to absolute essentials. The following outline seems to be satisfactory for most provinces although it may be altered if found necessary.

Definition of province. Make this first in TERMS OF FACT although an explantion in terms of INTERPRETATION MAY BE ADDED. For instance if you say"a region of crystalline rocks with low relief" it is a statement of observable facts but if you say " a peneplained mountain range" that is interpretation. Remember that many interpretations are subject to revision as science advances but facts are not changed, only added to.
Boundaries of the province and its main subdivisions
Geology. Make a very brief statement of the kinds of rocks and their structure without much stress on age, details of origin or history of formation of the rocks except insofar as it affects present conditions of the surface.
Topography. Make this so far as possible a description in terms of fact and defer the interpretation of history to the next section.
History of the topography.

Illustrate your summary with cross sections or diagrams which have been given in class or you have adapted from the text book to suit your needs. Do not copy without change.

THIS EXERCISE IS DUE OCT. . 14. No extension of time without good cause explained in advance.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

fourth

Laboratory questions, Laurential Upland, edition of 1934

Every student who takes this course for 5 credits is expected to put in a minimum of four (4) hours a week on laboratory work. It is very important to keep this work up to date: DO NOT LET YOURSELF GET BEHIND. Unless otherwise stated in class all reports are due the day the NEXT province is begun in class. Overdue reports hold up the return of those which have been handed in. Unexcused overdue reports MAY BE DENIED ANY CREDIT. Ordinarily all laboratory work will be done in Room 206. If you have to remove any maps PLEASE RETURN THEM AT ONCE. Maps should not be taken from the building or to offices without permission. Please pick up all maps on the tables when leaving the room and place them on top of one of the map cases. Please do not leave any wall maps hung on either the blackboard or the map rack. Maps will be furnished on which to show the boundaries of all provinces and the LOCATION OF ALL SMALL MAPS used. Maps of physiographic provinces, geology, and physiographic features are available in the laboratory. Consult references in library or models in hall whenever necessary. Keep rough notes in pencil which may be inked in if drawings, copied in ink or typewriting if written. Complete reports should be handed in on 8¼" X 11" paper in a folder. A sheet or two of cross section paper may be used. Use of colored pencils adds to effectiveness of diagrams. DO NOT USE WAX CRAYONS. Colored pencil may be made to look better by rubbing with a scrap of blotting paper or with cloth dipped in pure gasoline or benzine.

On your general map show not only the corrected boundary of the province but color in (a) areas of Lake Superior sandstone (see model in hall), (b) Middle and Lower Keweenawan lava flows, (c) Huronian rocks. Contrast (in notes) the topography of these three divisions with that of the massive igneous and metamorphic rocks and explain why there is a difference. Explain why this difference is not shown at all places.

Using the 1928 (small) geological map of Wisconsin, the map of the surface of the buried pre-Cambrian rocks, and the large scale geological map of Wisconsin construct on same horizontal scale as the small map and a vertical scale of one inch to 5000 feet a cross-section of Wisconsin along an east-west line through Rib Hill near Wausau. You may lump all the pre-Cambrian rocks in one color or pattern and all the Cambrian and later deposits in another.

Marathon and Wausau, Wisconsin. See also geological maps. What evidences can you discover which indicate that this area once had a higher relief than it now has? Draw a cross section across the valley of the Wisconsin some distance north of Wausau. Make it several miles long so as to include some of the rolling uplands. Vertical scale not over one inch to 2000 feet. Horizontal scale same as map. Reasoning from this section did or did not the area once have a lower relief than it does now? Reconcile these two results. Make a small outline of the two quadrangles and show on it (a) area covered by Young (Wisconsin) drift, (b) area covered by Old drift, and (c) area which may not have been glaciated. Study original map and then tell how these three areas differ in topography. If you went in the field would you find it as easy to tell what part of the area had been glaciated as it is around Madison? Explain fully. What if any relation do the stream valleys of this area have to the rocks? Explain. Explain the flat floors of the large valleys.

fourth

Houghton and Calumet, Michigan. Make a small sketch without much exaggeration of vertical scale showing the geological structure of this ridge. Consult geological map of Lake Superior region but recall what has been explained in class about the kind of fault which occurs. Consult map from Proffessional Paper 154 and then describe the differences in topography above and below the highest beach line. What is probable origin of the gap through the ridge? Was the lake present then? How could a stream come to disregard rock structure? Explain. Account for the great escarpment of southeast side of the Range.

Superior and Duluth quadrangles, Wisconsin-Minnesota. See map from Wisconsin Bull. 35 and from it construct a sketch cross-section showing the relation of this valley to the main syncline to the southeast. See also map of Lake Superior region. In making such a section remember that NEATNESS AND DEFINITENESS count. Don not draw any line unless you are sure it is going to mean something. Do not exaggerate vertical scale too much especially in folded rock areas. Show only (a) Keweenawan lava flows and (b) sandstones. Account for the escarpment south of the lake. Account for escarpment north of the lake (See discussion in Monograph 52). Make a table showing physiographic significance of: (a) Minnesota Point, (b) irregular topography in extreme south of map, (c) Manitou Falls, (d) smooth topography at Superior, (e) V-shaped valley of Nemadji River, (f) shore ridge of Spirit Lake, (g) shoreline of St. Louis Bay, (h) curves in state boundary. For the last see pp. 446-452 new edition of Wisconsin Bull. 36. Write a brief summary of how physiography entered into this boundary dispute.

Lake Placid, New York See geological map of New York state. What is the bed rocks of this area. Account for the rounded outlines of the mountains giving two contributing causes. What effects of glaciation on stream pattern can you distinguish. Be specific. Do you find definite evidence of two different kinds of glaciation? Where? Explain what is ment by the term "fault valley" and "fault line valley". Can you locate an example of either on this map? Explain fully.

Summary. When you have completed your notes the summary can be finished elsewhere if you desire. However, do not cut your regular laboratory periods to do this but start ahead with next province as soon as directions are ready. Make all answers explicit and not just "yes" or "no". Make it clear to everyone just what you are trying to say. After the answers to the foregoing questions write a brief (LIMIT FOUR PAGES) summary of the province on following outline.

Definition of province, first in terms of FACT then if necessary in terms of INTERPRETAION. Give briefly any alternative names for the province and explain how derived.

Boundaries of the province and its main subdivisions not merely what it adjoins but the nature of the boundary as escarpment, change in geology, edge of glacial drift, etc. In this province explain the difficulty of exact location of some of the boundary.

Geology, a very brief statment of the kinds of bed rocks, glacial drift, etc. without much attention to geological age or details of origin.

Topography in terms of facts.

History of the topography, that is the interpretaion of the foregoing information on geology and topgraphy. In this province do not forget to explain fully all essential steps in origin of present surface. USE DIAGRAMS wherever this helps but MAKE THEM A PART OF THE DISCUSSION. Do not forget the discussion of the origin of the basin of Lake Superior.

GEOLOGY 130

PHYSIOGRAPHY OF THE UNITED STATES

Laboratory questions, Laurentian Upland, edition of 1936

Every student who takes this course for 5 credits is expected to put in a minimum of four (4) hours a week on laboratory work. It is very important to keep this work up to date: DO NOT LET YOURSELF GET BEHIND. Unless otherwise stated in class all reports are due the day the NEXT province is begun in class. Overdue reports hold up the return of those which have been handed in. Unexcused overdue reports MAY BE DENIED ANY CREDIT. Ordinarily all laboratory work will be done in Room 212. If you have to remove any maps PLEASE RETURN THEM AT ONCE. Maps should not be taken from the building or to offices without permission. Please pick up all maps on the tables when leaving the room and place in a net pile on small table. Maps will be furnished on which to show the boundaries of all provinces and the LOCATION OF ALL SMALL MAPS used . Maps of physiographic provinces, geology, and physiographic features are available in the laboratory. Consult references in library or models in hall whenever necessary. Keep rough notes in pencil which may be copied in ink or typewritten. Complete reports should be handed in on 8½"x 11" paper in a folder. A sheet or two of cross section paper may be used. Use of colored pencils adds to effectiveness of diagrams. Colored pencil may be made to look better by rubbing with a scrap of blotting paper or cloth. Wax crayons smear badly and should be avoided.

On your general map show not only the corrected boundary of the province but color in (a) areas of Lake Superior sandstone AKU (see 1935 map of Lake Superior region), (b) Middle Keweenawan lava flows Akmb, (c) Mesabi and Gogebic range (see model), (d)borders of young and old (pre-Wisconsin) drifts. Contrast (in notes) the topography of these three divisions with that of the massive igneous and metamorphic rocks and explain why there is a difference. Explain why this difference is not shown at all places.

Using the large geological map of Wisconsin, the black line map of the surface of the buried pre-Cambrian rocks, construct on a vertical scale of one inch to 5000 feet a cross-section of Wisconsin along a north-south line through Rib Hill near Wausau. Mold section 10 inches long. You may lump all the pre-Cambrian rocks in one color or pattern and all the Cambrian and later deposits in another.

Marathon and Wausau, Wisconsin. See also geological maps.
What evidences can you discover which indicate that this area once had a higher relief than it now has? Draw a cross section across the valley of the Wisconsin some distance north of Wausau several miles long so as to include some of the rolling uplands. Vertical scale not over one inch to 2000 feet. Horizontal scale same as map. Reasoning from this section did or did not the area once have a lower relief than it does now? Reconcile these two results. If you went in the field would you find it as easy to tell what part of this area had been glaciated as it is around Madison? Explain fully. What if any relation do the stream valleys of this area have to the rocks? Explain. Explain the flat floors of the large valleys.
Houghton and Calumet, Michigan. Make a small sketch without much exaggeration of vertical scale showing the geological structure of this ridge. See 1935 map of Lake Superior region. Consult map from Professional Paper 154 and then describe the differences in topography above and below the highest beach line. Explain Account for the great escarpment of southeast side of the Range.

Superior and Duluth quadrangles, Wisconsin-Minnesota. See maps from Wisconsin Bull. 25 and blue print map of Superior structure and from them construct a sketch cross-section showing the relation of this valley to the main syncline to the southeast. In making such a section remember that NEATNESS AND DEFINITENESS count. Do not draw any line unless you are sure it is going to mean something. Do not exaggerate vertical scale too much especially in folded rock areas. Show only

(c) Keweenawan lava flows and (d) sandstones. Account for the escarpment south of the lake. Account for escarpment north of the lake (See discussion in Monograph 52). Make a table showing physiographic significance of: (a) Minnesota Point, (b) irregular topography in extreme south of map, (c) Manitou Falls, (d) smooth topography at Superior, (e) V-shaped valley of Nemadji River, (f) shore ridge of Spirit Lake, (g) shoreline of St. Louis Bay, (h) curves in state boundary.

Lake Placid, New York. See geological map of New York state. What is the bed rock of this area? Account for the rounded outlines of the mountains giving two contributing causes. What effects of glaciation on stream pattern can you distinguish. Be specific. Do you find definite evidence of two different kinds of glaciation? Where?

Map of bottom of Lake Superior-see also same map in guide book of Kansas Geological Society p. 226. (Faults incorrectly located on this map.)

What explanations might account for the steep slopes of (a) northwest shore, (b) northeast shore, (c) north side of Keweenaw Point, (d) northwest side of Isle Royale. Account for the plateau of the Apostle Islands. Account for the enclosed depressions in eastern part of the lake. Account for the submerged ridge northeast from Keweenaw Point.

Summary. When you have completed your notes the summary can be finished elsewhere if you desire. However, do not cut your regular laboratory periods to do this but start ahead with next province as soon as directions are ready. Make all answers explicit and not just "yes" or "no". Make it clear to everyone just what you are tryping to say. After the answers to the foregoing questions write a brief (LIMIT FOUR PAGES) summary of the province on following outline.

Definition of province, first in terms of FACT then if necessary in terms of INTERPRETATION. Give briefly any alternative names for the province and explain how derived.

Boundaries of the province and its main subdivisions not merely what it adjoins but the nature of the boundary for instance as "escarpment", "change in geology", "edge of glacial drift", etc. In this province explain the difficulty of exact location of some of the boundary.

Geology, a very brief statement of the kinds of bed rocks, glacial drift, etc. without much attention to geological age or details of origin.

Topography in terms of facts.

History of the topography, that is the interpretation of the foregoing information on geology and topography. In this province do not forget to explain fully all essential steps in origin of present surface. USE DIAGRAMS wherever this helps but MAKE THEM A PART OF THE DISCUSSION. Do not forget the discussion of the origin of the basin of Lake Superior.

GEOLOGY 130
PHYSIOGRAPHY OF THE UNITED STATES

Laboratory questions, Laurentian Upland, 1937-38

Every student who takes this course for 5 credits is expected to put in a minimum of four (4) hours a week on laboratory work. It is very important to keep this work up to date: DO NOT LET YOURSELF GET BEHIND. Dates will be given in class. Overdue reports hold up the return of those which have been handed in. Unexcused overdue reports MAY BE DENIED ANY CREDIT. Ordinarily all laboratory work will be done in Room 212. If you have to remove any maps PLEASE RETURN THEM AT ONCE. Maps should not be taken from the building or to offices without permission. Please pick up all maps on the tables when leaving the room and place in a neat pile. Maps will be furnished later on which to show the boundaries of all provinces and the LOCATION OF ALL SMALL MAPS used. Maps of physiographic provinces, geology, and physiographic features are available in the laboratory. Consult references in library or models in hall whenever necessary. Keep rough notes in pencil which may be copied in ink or typewritten. Complete reports should be handed in on 8½"x11" paper in a folder. A sheet or two of cross section paper may be used. Use of colored pencils adds to effectiveness of diagrams. Colored pencil may be made to look better by rubbing with a scrap of blotting paper or cloth. Wax crayons smear badly and should be avoided. General map should be kept up to date and handed in whenever called for.

Using the large geological map of Wisconsin and the black line map of the surface of the buried pre-Cambrian rocks, construct on a vertical scale of one inch to 5000 feet a cross-section of Wisconsin along a east-west line through Stevens Point. Make section 10 inches long. You may lump all the pre-Cambrian rocks in one color or pattern and all the Cambrian and later deposits in another. (See Bull. 36, 390-395).

Marathon and Wausau, Wisconsin. See also geological maps and Wis. Bull. 16, 592-600; 36, 369-375. What evidences can you discover which indicate that this area once had a higher relief than it now has? Where are remants of the peneplain still preserved? Reasoning from these areas did or did not the area once have a lower relief than it does now? Reconcile these two results. If you went in the field would you find it as easy to tell what part of this area had been glaciated as it is around Madison? Explain fully. What if any relation do the stream valleys of this area have to the rocks? Explain. Explain the flat floors of the large valleys.

Houghton and Calumet, Michigan. Make a small sketch without much exaggeration of vertical scale showing the geological structure of this ridge. See 1935 map of Lake Superior region or consult map of structure. Consult map from Professional Paper 154 and then describe the differences in topography above and below the highest beach line. Explain. Account for the great escarpment of southeast side of the Range.

Superior and Duluth quadrangles, Wisconsin-Minnesota. See maps from Wisconsin Bull. 25 and map of Superior structure and from them construct a sketch cross-section showing the relation of this valley to the main syncline to the southeast. In making such a section remember that NEATNESS AND DEFINITENESS count. Do not draw any line unless you are sure it is going to mean something. Do not exaggerate vertical scale too much especially in folded rock areas. Show only (a) old hard rocks, (b) Keweenawan lava flows, and (c) sandstones. Account for the escarpment south of the lake. Account for escarpment north of the lake (See discussion in Monograph 52). Make a table showing physiographic significance of:. (a) Minnesota Point, (b) irregular topography in extreme south of map, (c) Manitou Falls, (d) smooth topography at Superior, (e) V-shaped valley of Nomadji River, (f) shore ridge of Spirit Lake, (g) shoreline of St. Louis Bay, (h) curves in state boundary. (See Bull. 36, 447-452.)

Lake Placid, New York. See geological map of New York state. What is the bed rock of this area? Account for the rounded outlines of the mountains giving two contributing causes. What effects of glaciation on stream pattern can you distinguish? Be specific. Do you find definite evidence of two different kinds of glaciation? Where? (See also New York State Mus. Bull. 193).

Map of bottom of Lake Superior-see also same map in guide book of Kansas Geological Society p. 226. (Faults incorrectly located on this map and map of structure of Lake Superior basin. What explanations might account for the steep slopes of (a) northwest shore, (b) northeast shore, (c) north side of Keweenaw Point, (d) northwest side of Isle Royale, Account for the plateau of the Apostle Islands. Account for the enclosed depressions in eastern part of the lake. Account for the submerged ridge northeast from Keweenaw Point. Draw cross sections (vertical scale not less than 2000 feet to inch) (a) from Saw Teeth Mt. S E through outer Island to Porcupine Mts., (b) east from Stannards Rock to Theano Point.

On your general map show not only the corrected boundary of the province but color in (a) areas of Lake Superior sandstone Aku (see 1935 map of Lake Superior region, (b) Middle Keweenawan lava flows Akmb, (c) border of young drift, and (d) old (pre-Wisconsin) drifts. Contrast (in notes) the topography of these four divisions with that of the massive igneous and metamorphic rocks and explain why there is a difference. Explain why this difference is not equally shown at all places. Defer this work until you receive your map.

Summary. When you have completed your notes the summary can be finished elsewhere if you desire. However, do not cut your regular laboratory periods to do this but start ahead with next province as soon as directions are ready. Make all answers explicit and not just "yes"or"no". Make it clear to everyone just what you are trying to say. After the answers to the foregoing questions write a brief (LIMIT FOUR PAGES) summary of the province on following outline. You may if desired incorporate answers and

diagram called for above in body of report instead of giving them separately.

Definition of province, first in terms of FACT then, if necessary, in terms of INTERPRETATION. Give briefly any alternative names for the province and explain how derived.

Boundaries of the province and its main subdivisions not merely what it adjoins but the nature of the boundary for instance as "escarpment," "change in geology," "edge of glacial drift," etc. In this province explain the difficulty of exact location of some of the boundary.

Geology, a very brief statement of the kinds of bed rocks, glacial drift, etc. without much attention to geological age or details or origin.

Topography in terms of facts.

History of the topography, that is the interpretation of the foregoing information on geology and topography. In this province do not forget to explain fully all essential steps in origin of present surface. USE DIAGRAMS wherever this helps but MAKE THEM A PART OF THE DISCUSSION. Do not forget the discussion of the origin of the basin of Lake Superior. Give a series view of diagram each of which illustrates a major step in development of pre-topography.