# Material from Glacial geology course - Geology 143 - 1. 1920-1921

Thwaites, F. T. (Fredrik Turville), 1883-1961
[s.l.]: [s.n.], 1920-1921

GEOLOGY 143.

Calendar, 1922.

Feb. 6. Organization; value and status of glacial geology.

Feb. 8. Modern glaciers, especially Greenland; Shaler and Davis, pp. 32-37; Hobbs, pp. 97-101, 119-176 or Russell, pp. 133-145.

Feb. 10. Glaciers of Antartica; Hobbs, pp. 186-289 or Tillman, thesis, 1917, pp. 23-61.

Feb. 13. Theory of glacial motion; Shaler and Davis, pp. 139-161; Russell, Chap. IX; Chamberlin and Salisbury, vol. 1, pp. ~~[illegible]~~, 294-308.

Feb. 15. Evidence of Pleistocene glaciation; Fairchild, Am. Geologist, 22, pp. 154-165; ~~Shaler and Davis pp. 38-48~~; G. F. Wright, pp. 122-133. Salisbury, Jour. Geol., 2, pp. 708-724, 837-851.

Feb. 17. Centers of glaciation; Chamberlin map; Tyrell, Jour. Geol. 6, pp. 147-160; Upham, Int. Geol. Cong XII, pp. 513-522; Tyrell, Ibid., pp. 523-535 (parts); Fairchild, Am. Geol., 22, pp. 165-167.

Feb. 20. Striae. Chamberlin ~~and Salisbury~~, 7th Ann. Rept., U.S.G.S., pp. 158-248; Shaler and Davis, plates XX, XXI.

Feb. 24. Glacial erosion; Shaler and Davis, pp. 49-60; Tarr, Bull. G. S. A., 5, pp. 339-356 or Folio 169, p. 16. Russell, Ann. Rept., Mich. Geol. Survey, 1906, pp. 29-40; Fairchild, Bull. G. S. A., 16, pp. 13-74.

Feb. 27. Origin of basins of Great Lakes; Taylor, U. S. G. S. Mon. 53, pp. 316-318, map. plate II; Chamberlin, Geol. of Wis., 1, pp. 252-259; Martin, Wis. Bull. 36, pp. 222-239; Grabau, N. Y. State Museum Bull. 45, pp. 37-54.

March 1. Bowlder trains, etc.; Buell, Wis. Acad. Trans., 10, pp. 485-509; Salisbury, Ibid., 6, pp. 42-50; Crosby, Am. Geol., 17, pp. 203-234.

March 3. Glacial till, etc., Crosby, Boston Soc. Nat. Hist., Proc., 25, pp. 115-140; Salisbury, Journ. Geol. 8, pp. 426-432; Alden, U. S. G. S., Prof. Paper 34, pp. 72-100.

March 6. Preglacial topography; G. F. Wright, pp. 298-312; Alden, U. S. G. S. Prof. Paper 34, pp. 14-18; Map problem.

Mar. 8. Terminal moraines, general; Chamberlin, Geol. of Wis., 1, pp. 275-282; 3d Ann. Rept., U. S. G. S., pp. 310-314; Map exercise.

Mar. 10. Moraine in eastern States; ~~Taylor, Journ Geol. 5, pp. 421-466~~; Fuller, U. S. G. S. Prof. Paper 82; Salisbury, N. J. State Survey 5; G. F. Wright, pp. 203-225 or U. S. G. S. Bull. 58; map work.

Mar. 13. Terminal moraines in Wis.; Alden, U. S. G. S. Prof. Paper 34, pp. 30-38, 53-55, 63-66; Prof. Paper 106, pp. 209-220, 230-237; map work.

Mar. 15. Drumlins; Alden, U. S. G. S. Bull. 273; Fairchild, N. Y. State Museum Bull. 111; Tarr, Am. Geol., 13, pp. 393-407; Shaler and Davis, plate XXIV; map exercise.

Mar. 17. Outwash plains and terraces; Tarr and Martin, Alaskan glacier studies, illustrations of modern outwash plains; Salisbury, N. J. State Survey, 5, pp. 124-130; Carman, Iowa Survey, 26, pp. 357-414; map exercise.

Mar. 20. Outwash in Wisconsin; Martin, Wis. Bull. 36, pp. 138-167; Alden, U.S.G.S. Prof. Paper 34, pp. 25-62; Prof. Paper 106, pp. ~~186-194~~, 238-245, 263-269.

Mar. 22. Kames and pitted plains. Salisbury, N. J. State Survey, 5, pp. 115-124; Jour. Geol., 4, pp. 948-970; Fairchild, Jour. Geol., 6, pp. 589-596; map exercise.

Mar. 24. Deltas and nonglacial terraces; Fuller, Jour. Geol. 7, pp. 452-462; Davis, Bull. G. S. A., 1, pp. 195-202; Shaw, Jour. Geol., 19, pp. 140-156; Martin, Wis. Bull. 36, pp. 119-122.

Mar. 27. Eskers; Crosby, Am. Geol., 30, pp. 1-38; Davis, Boston Soc. Nat. Hist. Proc., 25, pp. 477-499; Trowbridge, Iowa Acad. Sci., 21, pp. 211-214; ~~Stone, U. S. G. S. Mon. 34, pp. 369-468~~ or Jour. Geol., 1, pp. 246-254; ~~map exercises~~.

Mar. 29. Marginal lakes; W. B. Wright, pp. 338-343; Leverett, Mich. Acad. Sci., 12, pp. 19-42; Leverett and Taylor, U. S. G. S. Mon. 53 (summary).

Mar. 31. Lake Agassiz, etc; Johnston, Jour. Geol., 24, pp. 625-638; W. B. Wright, pp. 174-196; ~~Shaw, Jour. Geol., 20, pp. 481-491 or Ill. State Survey, 20, pp. 139-157~~.

April 3. Deformation of shorelines; W. B. Wright, pp. 387-405; Leverett and Taylor, U. S. G. S. Mon. 53, chap. 25.

April 5. Midsemester Exam.

April 7. Loess; W. B. Wright, Chap. X, parts referring to U. S.; Shimek, Jour. Geol., 7, pp. 122-140; Iowa Acad. Sci., 15, ~~117-135~~; Udden, Bull. G. S. A., 9, pp. 6-9.

April 10. Loess, cont.; Alden and Leighton, Iowa Survey, 26, pp. 149-164; Carman, Iowa Survey, 26, pp. 339-356; Leverett, U. S. G. S. Mon. 38, pp. 153-184; ~~(work with soils maps.)~~

April 19. Drift sheets, introduction; Salisbury, Jour. Geol., 1, pp. 61-84; Chamberlin, Jour. Geol., 4, pp. 872-876; Chamberlin and Salisbury, 3, pp. 382-394.

April 21. Erosion as a time measure; Leverett, Am. Jour. Sci., ~~28~~ (1909), pp. 349-368; Bain, Iowa Geol. Surv., 6, pp. 433-476; Hershey, Am. Geol. 12, pp. 314-326.

April 24. Weathering as a time measure; Leverett, cont.; Udden, Jour. Geol., 21, pp. 564-567; Alden, Jour. Geol., 17, pp. 694-709; Kay, Jour. Geol. 28, pp. 89-125.

April 26. Nebraskan, Jersian and Aftonian; McGee, 11th Ann. Rept., U.S.G.S., pp. 472-510, ~~540-542~~; Salisbury, N. J. State Survey, 5, pp. 187-189, 751-782; Shimek, Bull. G. S. A., 21, pp. 119-140; Bain, Iowa Acad. Sci., 5, pp. 86-101; Carman, Iowa Survey, 26, pp. 414-429.

April 28. Kansan, Yarmouth; Hershey, Am. Geol., 28, pp. 20-25; Calvin, Am. Geol., 17, pp. 195-203; Leverett, U. S. G. S. Mon. 38, pp. 105-124; Carman, Iowa Survey, 26, pp. 320-338.

May 1. Illinoian, Sangamon. Leverett, U. S. G. S. Mon. 38, pp. 24-47, 89-97, 125-130; Leverett, Mon. 53, pp. 63-72.

May 3. Iowan. ~~Leverett, Mon. 38, pp. 131-153;~~ Calvin, Jour. Geol., 19, pp. 577-602. Alden and Leighton, Iowa Survey, 26, pp. 55-181.

May 5. Toronto. Coleman, Jour. Geol., 9, pp. 285-310; Am. Geol., 29, pp. 71-80; Bull. G. S. A., 26, pp. 243-254.

May 8. Early Wisconsin, Peorian, Late Wisconsin; Leverett, U. S. G. S. Mon. 38, pp. 185-190, 317-318; Leverett, Mon. 53, pp. 28-29; Carman, Iowa Survey, 26, pp. 251-293; Alden, Prof. Paper 106, pp. 310-323;

May 10. Summary; Calvin, Bull. G. S. A., 20, pp. 133-152; Wright, G. F., pp. 575-615; Wright, W. B., pp. 161-173; ~~Wright, G. F., Int. Geol. Cong. XII, pp. 451-453.~~

May 12. Cause of the Glacial period; Shaler and Davis, pp. 60-91; Wright, W. B. Chaps. XIII, XIV; Huntington, Bull. G. S. A., 25, pp. 477-590.

May 15. Glacial climate. Shaler and Davis, pp. 105-111; Wright, W. B., Chap. XIX, parts; Brooks, Quart. Jour. Royal Met. Soc., 40, pp. 53-71.

May 17. Life in glacial period. Shaler and Davis, pp. 117-138; Wright, W. B., pp. 221-250; Wright, G. F., pp. 423-444; Hay, Iowa Survey, 23.

May 19. Post-glacial time. Bannister, Jour. Geol., 5, pp. 739-743; Wright, G. F., pp. 532-575; Hotchkiss, Bull. G. S. A., 28, pp. 138-141; Kindle and Taylor, Folio 190, pp. 20-25; Sardeson, Bull. G. S. A., 19, pp. 29-52.

May 22. The Driftless Area; Chamberlin and Salisbury, 6th Ann. Rept., U. S. G. S. pp. 212-327; Martin, Wis. Bull. 36, pp. 71-106.

May 24. Soils. Lecture.

May 26. Economic problems; Lecture.

May 29. Field methods; Lecture.

~~May 31. Open.~~

June 6 Final Examination.

"Thirty"

1924. Feb 11 begin
Recess April 9-15 incl
Exams begin June 9
Last class June 7
Exam 23? Mon June 16

Glacial Geology, Geology 143 Calendar, 1923.

Glacial Geology, Geology 143 Calendar, 1923.

Feb.5 Preliminary

Feb. 7 No class

Feb.9 Greenland: Hobbs, 97-176 or Russell, 133-145

Feb.12 Antarctica: Hobbs, 186-289 or Tillman, 23-61

Feb.14 Glacial motion: Russell, Chap.IX or Shaler and Davis, 139-161; Chamberlin and Salisbury, 1, 308-323.

Feb.16 Evidence of glaciation: G.F.Wright, 122-133; Salisbury, Jour. Geol. 2, 708-724, 837-851; Fairchild, Amer.Geol. 22, 154-165.

Feb. 19 Glacial centers: Copy Chamberlin map of N.A.; Fairchild, Amer. Geol. 22 165-167; Upham, Int. Geol. Cong.XII, 515-522.

Feb.21 Striae: Chamberlin, 7th Ann. Rept.U.S.G.S., 158-248; map given out for

Feb.23 Glacial erosion: Tarr, Bull.G.S.A.5, 339-356 or U.S.G.S.Folio 169, 16; Gilbert, Bull.G.S.A. 10, 121-130 or Fairchild, Bull. G.S.A. 16, 13-74.

Feb.26 Basins of Great Lakes: Leverett and Taylor, U.S.G.S. Mon. 53, 316-318, plate II; Martin, Wis. G.S. Bull. 36, 222-239; Alden, U.S.G.S.Prof. Paper 106, 126.

Feb. 28 Bowlder trains etc.: Buell, Wis. Acad. Trans 10, 485-509; Crosby, Amer. Geol.17, 203-234.

Mar. 2 Glacial till: Crosby, Boston Soc. Nat.Hist Proc. 25, 115-140; Salisbury, Jour. Geol. 8, 426-432.

Mar.5 Preglacial topography: Alden, Prof. Paper 34, 14-18; map problem due.

Mar. 7 Terminal moraines: map exercise; Chamberlin, Geol. of Wis.,1, 275-282 or 3rd. Ann. Rept. U.S.G.S., 310-314.

Mar.9 ~~Make copy of map of moraines of central U.S.~~

Mar. 12 Drumlins: map exercise; Alden, U.S.G.S.Bull. 273 or Fairchild, N.Y.State Museum Bull. 111.

Mar. 14 Outwash: map exercise; Salisbury N.J.G.S. 5, 124-130.

Mar. 16 Outwash, cont.: Carman, Iowa G.S.26, 357-414; Shaw, Jour. Geol. 19, 140-156.

Mar. 19 Pitted outwash etc.: map exercise; Salisbury, Jour. Geol. 4, 948-970.

Mar.21 Deltas: Fuller, Jour. Geol 7, 452-462 or Davis, Bull. G.S.A. 1, 195-202; Fairchild, Jour. Geol. 6, 589-596.

Mar. 23 Eskers: Crosby, Amer. Geol. 30, 1-38; Davis, Boston Soc. Nat. Hist. Proc. 25, 477-499.

Mar. 26 Glacial Great Lakes: W.B.Wright, 338-343 or Leverett and Taylor, Mon. 53, summary or Alden, Prof. Paper 106, maps or Leverett, Mich. Acad. Sci. 12, 19-42.

Mar. 28 Pleistocene lakes: W.B.Wright, 174-196; Johnston, Jour. Geol. 24, 625-638.

Mar. 30 Deformation of shorelines: W.B.Wright, 387-405 or Leverett and Taylor, Mon.53, chap. 25.

Arp.2 Midsemester exam. April 4-10 Easter recess.

Apr. 11 Loess: Shimek, Jour. Geol 7, 122-140; Shimek, Iowa Acad. Sci. 15, 57-75; Udden, Bull. G.S.A. 9, 6-9.

Apr. 13 Loess, cont.: W.B.Wright, chap.X; Alden and Leighton, Iowa G.S. 26, 144-164 or Carman, Iowa G.S. 26, 339-356.

1923 calendar cont.

Apr. 16 Drift sheets, general: Salisbury, Jour. Geol 1, ~~xxxxxx~~ 61-84; Chamberlin Jour. Geol. 4, 872-876 or Chamberlin and Salisbury, 3, 382-394.

Apr. 18 Erosion as a time measure: Leverett, Amer. Jour. Sci. 177, 349-368; Bain, Iowa G.S. 6, 433-476; map exercise. get

Apr. 20 Weathering as a time measure: Alden, Jour. Geol 17, 694-709 or Prof. Paper 106, 151-155, 159-160; Bain, Amer.Geol 23, 166-176.

Apr. 23 Weathering, cont.: Kay and Pearce, Jour. Geol. 28, 89-125 123-132; ~~Wilder, Iowa G.S. 10, 89-157~~; Leighton, Iowa Acad. Sci. 22, 19-20.

Apr. 25 Nebraskan: Mc.Gee, 11th. Ann. Rept. , 472-510, 540-542; Salisbury, N.J.G.S. 5, 187-189, 751-782.

Apr. 27 Aftonian: Shimek, Bull. G.S.A. 21, 119-140 or Bain, Iowa Acad. Sci. 5, 86-101 or Amer. Geol. 21, 255-262; Calvin, Iowa Acad. Sci. 17, 177-180. get

Apr. 30 Kansan and Yarmouth: Hershey, Amer. Geol. 28, 20-25 or Leverett, Mon. 38, 105-124; Carman, Iowa G.S. 26, 320-338.

May 2. Illinoian and Sangamon: Leverett, Mon. 38, 24-47, 89-97, 125-130; Leverett and Taylor, Mon. 53, 63-72.

May 4 Iowan: Calvin, Jour. Geol. 19, 577-602; Alden and Leighton, Iowa G.S. 26, 55-181.

(Margin notes: better Bain I 6 59, 17 75-97 of Amer. Geol 23 168-176 (Kay?)

May 7 Toronto: Coleman, Jour. Geol. 9, 285-310 or Amer. Geol. 29, 71-80 or Bull. G.S.A. 26, 243-254.

May 9. Peorian, Wisconsin: Leverett, Mon. 38, 185-190, 317-318; Leverett and Taylor, Mon. 53, 28-29; Carman, Iowa G.S. 26, 251-293; Alden, Prof. Paper 106, 310-323.

May 11, 12, 13 Long field trip date subject to weather.

May. 14 Review of trip.

May 16 Summay of drift sheets: Calvin, Bull G.S.A. 20, 135-152; G.F.Wright, 575-615; W.B.Wright, 161-173.

May 18 Cause of glaciation: Shaler and Davis, 69-91; W.B.Wright, chaps XIII, XIV.

May 21 Cause, cont.: Brooke, Quart. Jour. Royal Met. Soc. 40, 55-71.
Quaternary life: Chamberlin and Salisbury 3, 483-498; Hay, Iowa G.S. 23

May 23 Postglacial time: Kindle and Taylor, Folio 190, 20-25; Bannister, Jour. Geol. 5, 730-743.

May 25 Economic problems.

May 25-30 Possible voluntary trip to Iowa.

June 1. Last meeting of class. Field reports due.

June? Final exam.

"Thirty"

GLACIAL GEOLOGY Geology 143
Preglacial topography problem, 1923
New well data furnished by J.J.Faust & Sons, Kaukauna.

N 20, R. 19 E.

NNE 1 John Brocks Drift 40 to shale
NSW 2 Dundas canning Co. Drift 43, shale 220, limestone 10 Total 273
SWSW 3 Emery Beach Drift 33 to shale. Total 300.
NENE 4 John Lappen Drift 106 (bored well)
NENE 5 Meyerhoffer Drift 130, limestone 24, Total 154.
SWNE 9 Drift 80, shale 132, limestone 104 Mrs. Schreck.
SESW 10 Herman Bloy Drift 84, shale 50, Total 134.
NWNW 10 Fink Drift 103, shale 30, limestone 216, sandstone 33, total 382.
NWNW 11 Jno.Gerritts Drift 69
SWNW 11 Obenschur Drift 96, shale 90, limestone 113, total 288. Water at 142.
SWSW 11 Plotz Drift 100, shale 163, total 263.
SESE 11 Henry Fink Drift 78 to gravel.
NENE 12 B. Mickey Drift 72, shale 30, total 103.
W¼ post 14 Frank Wolfinger Drift 127, shale 61, total 188.
Center 15 Gust.Bloy Drift 100, shale 95, limestone 423, total 618. Very little water
NWNE 24 Will Wolf Drift 58, rock? total 111.
N¼ post 3 Drift 20, shale 160, total 180.
NENE 34 St. John creamery Drift 28, shale 244, limestone 253, sandstone 10, total 535.

T. 20, R. 20 E.

SENW 5 Drift 100. Big gas pressure blew out 60 yds sand.
SESE 6 Harry Stanell Drift 98 Big gas pressure.
SWSW 6 H.Mickey Drift 50, shale 80, total 130.
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
NWSW 7 John Flatly Drift 80, shale 31, total 111.
NWNW 7 M.Flatley Drift 56, shale 61, total 117.
SENW 7 Al. Ott Drift 115, shale and lime 132, total 247
NWSE 7 Aug. Ihe Drift 120, shale 61, total 181 Big gas pressure.
NWNW 8 Art. Stanell Drift 108 to sand
NENE 8 Mrs. Stanell Drift 121
SWSW 9 Emil Dickfuss Drift 135 to sand-gas.
SWSE 9 Julius Krueger Drift 133, rock 167, total 300.
SENW 15 Drift 15.
NWNE 16 Chas Parsons Drift 123 , rock 445, sandstone, 5, rock 95, total 663.
NWNW 16 Mrs. Wolfmeyer Drift 349½ to gravel.
NENE 17 Otto Weigert Drift 325 to gravel
NESW 18 Brahm Drift 124, limestone 4, total 128 Much, wood, and moss.
NENE 19 Schubring Drift 152 to hardpan-bored.
SWSE 17 J. Slineback Drift 401, rock 483, total 884. 81 sandstone located 2m SE Forest Jct.

T. 21, R. 20 E.

SWNE 6 Jno. Brittnacher Drift 40, limestone 139, total 179 Flow.
SENW 5 Jno. P. Brittnacher Drift 191, rock ? 22, total 213.
SWSE 5 Gilson Drift 117 sand and gravel. Store 140 to sand.
NWNE 8 High School Drift 175, shale 89, limestone 189, sandstone 65, total 518, gravel 155-175.
NWNW 8 Ed.Ellis Drift 203(clay 120, gravel 15, sand and gravel 65), shale 11, limestone 208, sandstone 22, total 444.
S¼ post 6 McGawn Drift 178, limestone 27 XXXXXXXXXXXXX
N¼ post 7 H. Roloff Drift 190, limestone 22, total 212.
W¼ post 7 XXXXX Spitz Drift 160, shale 43, limestone 9, total 212.
SWSE 8 Jno.Clancy Drift 125 bored.
NENE 16 Adolph Meyer Drift 72, limestone 18, total 90.
NESE 17 Pat. Haha[illegible] Drift 155, shale 157, limestone 212, sandstone 51, total 575.
SWNE 17 M.Clancy Drift 79 bored.
S¼ post 18 M.J.Summers Drift 128 sand and gravel.
S¼ 18 XXXX

21-20 E. cont.

Well records, cont.

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

T. 21, R. 19 E.
SENW 2 High School Drift 90.
NWNE 10 Scall Drift 108 , limestone 22, total 130.
NWNW 11 Pete Berken Drift 128, limestone 12, total 140.
NWNE 13 Dan Summers Drift 134, rock 366, sandstone 34, total 544.
NENE 14 Wm.Boartz Drift 140, limestone 69, total 209.
SESE 14 Ed.Kerner Drift 109, shale 65, limestone 202, ss and sh 97, total 473.
NWNW 14 Drift 127, rock 8, total 135. Dexheimer.
NENE 15 Leibergen Drift 130, rock 58, total 188.
SWSW 14 Freeman Drift 100, rock 7, total 1o7.
SESE 15 Pat.Golden Drift 113, rock 261, total 374 in sandstone.
SWNW 16 Verbeten Drift 110, limestone 200 to ss, total 310.
SENW 17 Arnold Biese Drift 120 to hardpan.
NENE 19 Mike Nytes Drift 112, limestone 5, total 117.
SWNE 19 Matt.Feldkamp Drift 100, limestone 16, total 116.
SWSE 19 Louis Schermitzler Drift 112, limestone and sandstone 141, total 253.
S¼ post 20 Fahrman Drift 131, limestone 6, total 137.
SESE 20 Mitchler Drift 111, limestone 200, sandstone 14, total 325.
SWNW 21 Chas.Clune Drift to hardpan 120.
SWSE 21 Tom.Clune Drift 67½, rock 272, total 339½.
NENE 22 Hugh Finnegan Drift 95, rock inc. ss 286, total 381.
E¼ post 22 Wolfgang Pritzal Drift 90, rock inc. ss, 227, total 317.
NESW 22 Hefner Drift 70, shale 90, limestone 201, sandstone 18, total 379.
NWNW 23 Frank Maloney Drift 94, rock 64, total 158.
SESE 23 Jno.Flynn Drift 86, shale 108, limestone 215, sandstone 32, total 441.
NWNW 24 Frank Schmidt Drift 123 to shale.
NENW 24 Rudolph Scjultz Drift 95, rock inc. ss 321, total 416.
NENW 24 Frank O8Neil Drift 81, rock inc. ss. 328, total 409.
NENE 24 Edgar Borneman Drift 95, rock 115, total 210.
SESE 25 Tom Cox Drift 156, shale 37, total 193.
E¼ post 25 Van Den Wettering Drift 67 to gravel.
NENE 25 Jno.Beyers Drift 92, shale 17, total 109.
SWSE 26 Tom.Rohan Drift 61, shale and limestone 182, total 243.
SESE 26 Jim Moffet Drift to shale 76 bored.
NENE 26 XXXXXXXXX Drift to shale 82 bored. Ed.Finnegan.
SWNW 26 Adam Holzschu Drift 14, shale 80, total 94.
NESW 27 Kountjes Drift 14, shale 72, total 86.
E¼ post 28 Fox Drift 2, shale 78, total 80 Shale outcrop.

21-19E cont.
E¼ post 28 Fox Drift 2, shale 78, total 80 Shale outcrops here.
S¼ post 28 Pat. Rohan Drift 8, shale, limestone, sandstone 441, total 449.
N¼ post 28 John Powers Drift 89, shale 40, total 129.
SWNE 29 Barney Wilpolt Drift to gravel 108 bored.
Center 29 Theo.Barber Drift and rock 153.
N¼ post 29 Dan.Glaschine Drift 114, rock inc. ss. 258, total 372.
E¼ post 30 Rupert Drift 131, limestone 22, total 153.
NESE 30 Levi Rupert Drift 123. limestone 16, total 139. Very little water.
NWNE 30 Wm.Rohan Drift 120, limestone 28, total 148.
SWSE 30 Jim.O'Connor Drift 131, limestone 13, total 144.
NWSW 30 Adam Killian Drift 131, limestone 28, total 159.
W¼ post 31 Mike Loderbauer Drift 142, limestone and sandstone 209, total 351.
NWNW 32 Wm.Kobbusen Drift 120, limestone 20, total 140.
NENW 32 A.Keating Drift 131 to hardpan.
SENE 31 Frank Thilman Drift 136, limestone 19, total 155.
SESW 32 Frank Schmidt Drift 150, limestone 200, sandstone 23, total 373.
NESW 33 Mike Maloney Drift 6, shale 200, limestone 200, sandstone 55, total 461.
In road W. of house shale outcrops.
SENW 33 Mike Weiss Drift 6, shale 84, total 90.
SESE 28 Henry Penterman Drift 12, shale 138, total 150.
SWNW 34 Theo.Eiting Drift 20, shale 55, total 75.
NWSW 34 Wm.Biese Drift 18, shale 66, total 84.
SENW 34 A.Tiesling Drift 15, shale 85, total 100.
E¼ post 34 Fassbender Drift 14, shale 208, limestone 214, sandstone 69, total 505. show of oil.
SWSE 35 Mrs. Williams Drift 40, shale 60, total 100.
SENW 36 C.Keller Drift 71, rock 93, total 164.
SWNE 36 Stabonic Drift 99, shale 213, limestone 3, total 315.
SWNW 36 Amy Knoesph Drift 70

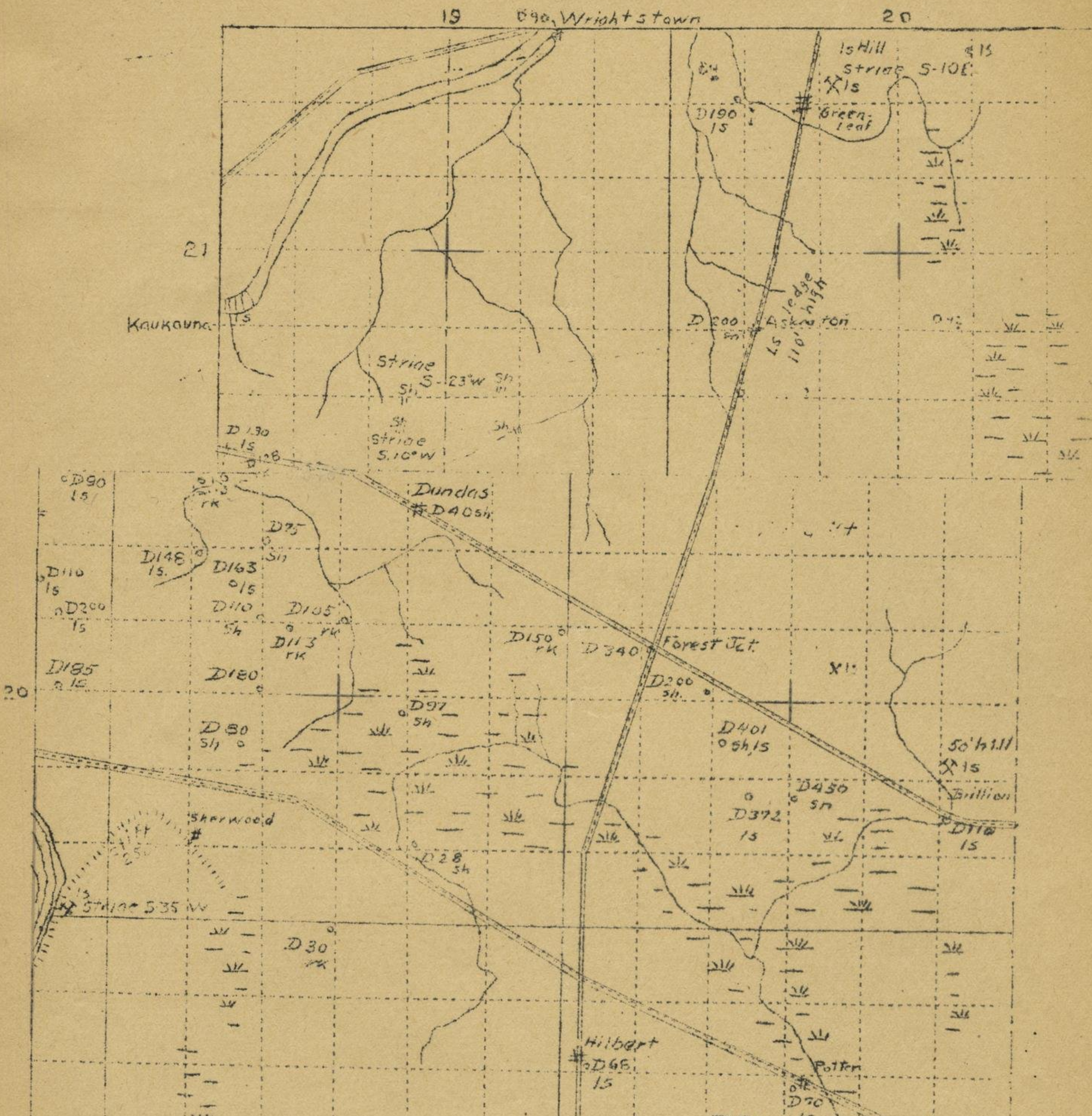
T. 21, R. 18 E.
SESE 25 Meyer Bros. Drift 126, limestone 18, total 144.
SWSE 25 Jos. Lehrer Drift 56, limestone 179, sandstone 130, total 365. In ravine flow.

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

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

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

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



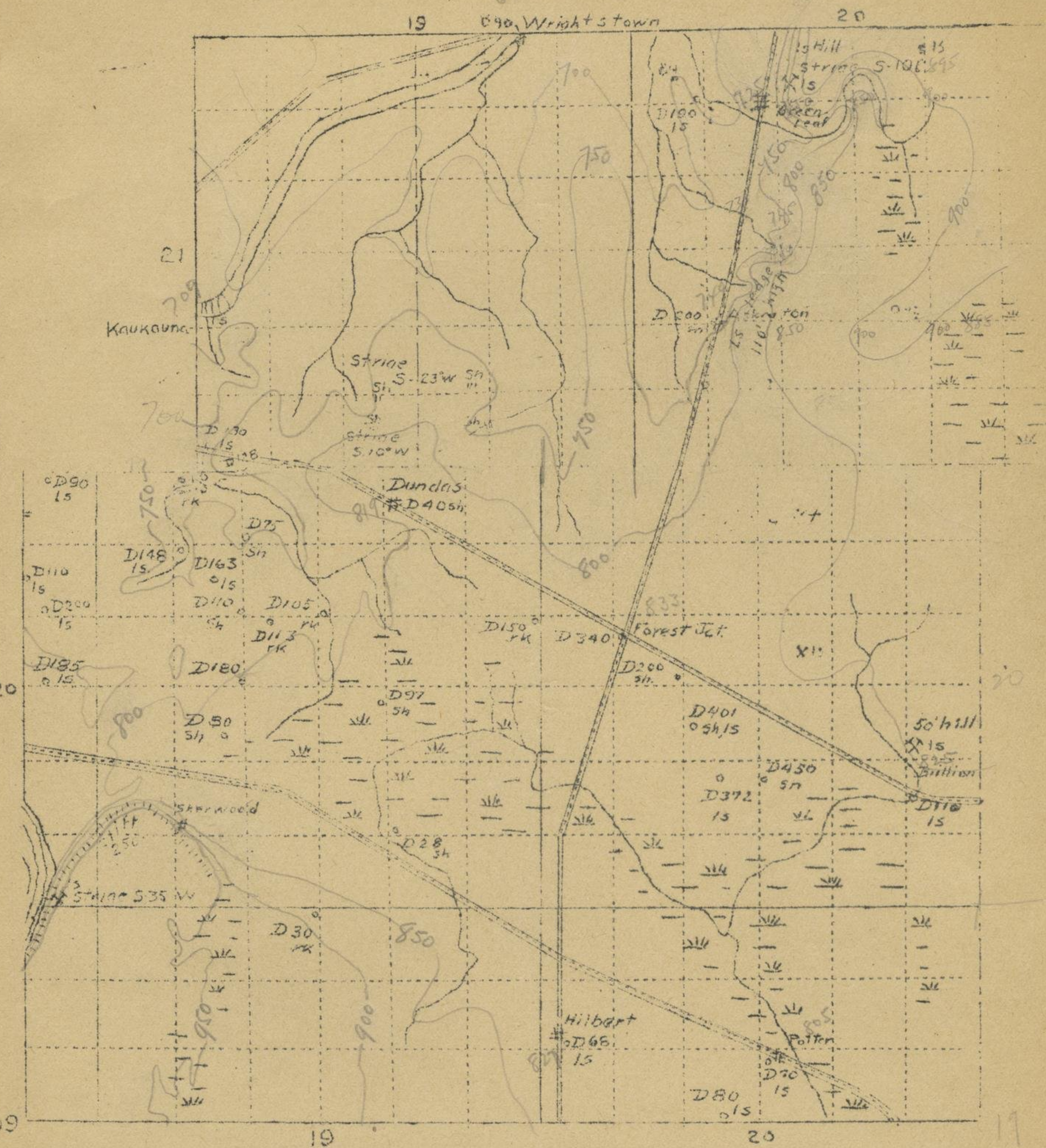

Well 2m. W. of Brillion. NW 27, 20-20 E. 0-90 clay, 90-111 sand, 111-226 clay, 226-234 muck and sand, 234-450 clay, 450-460 soft shale, 460-466 Ls.

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

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

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

# Map of present probable topography.




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

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

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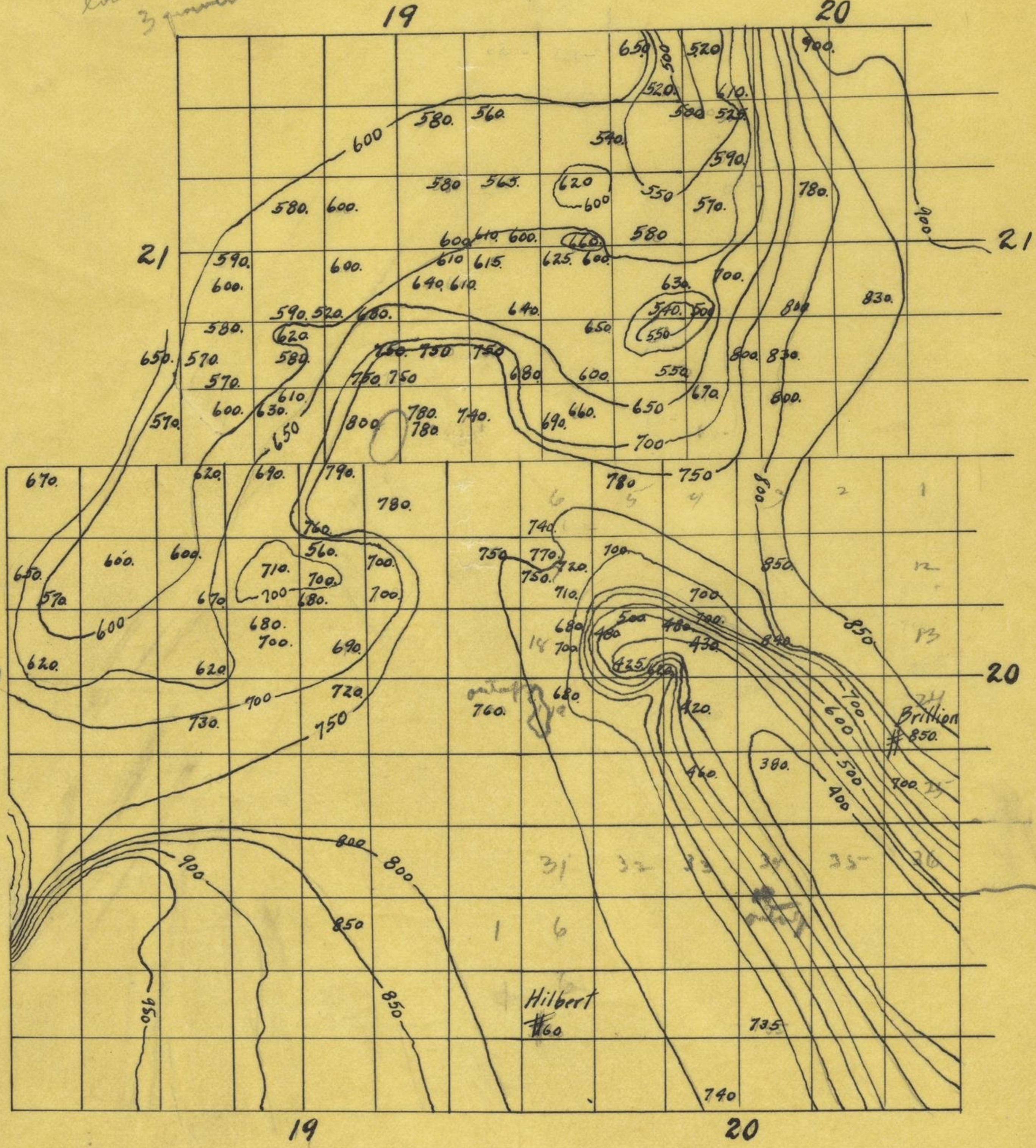
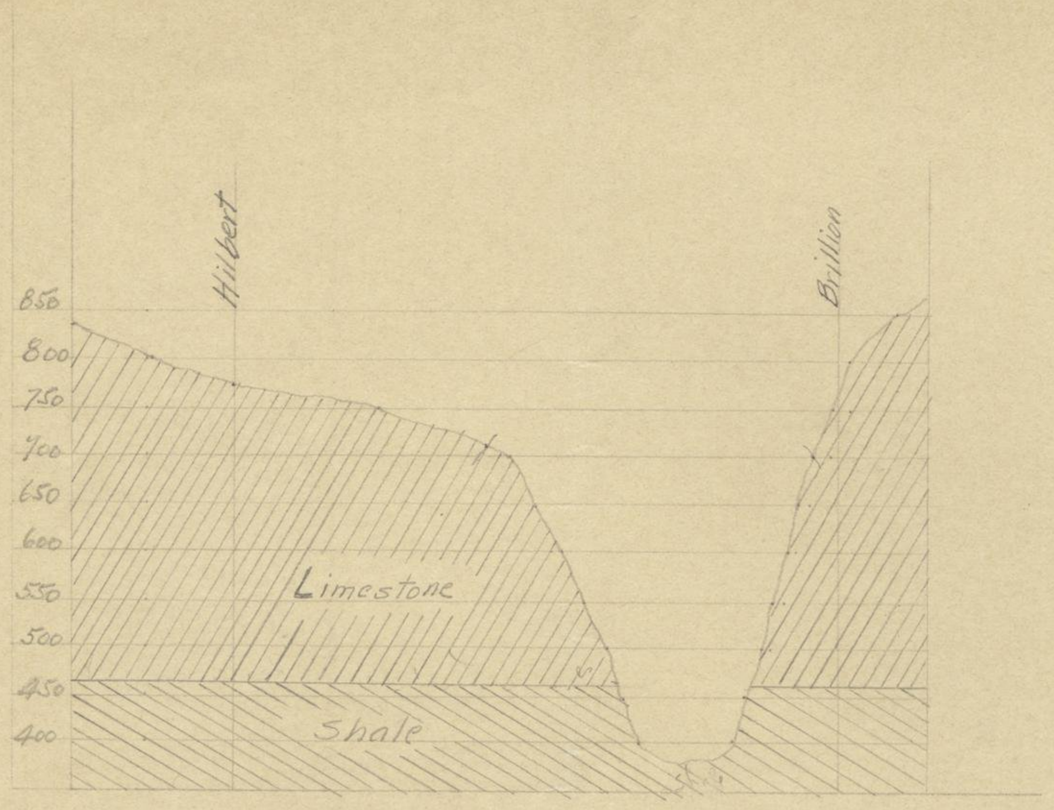
# Probable Pre-Glacial Topography

50' contour interval.





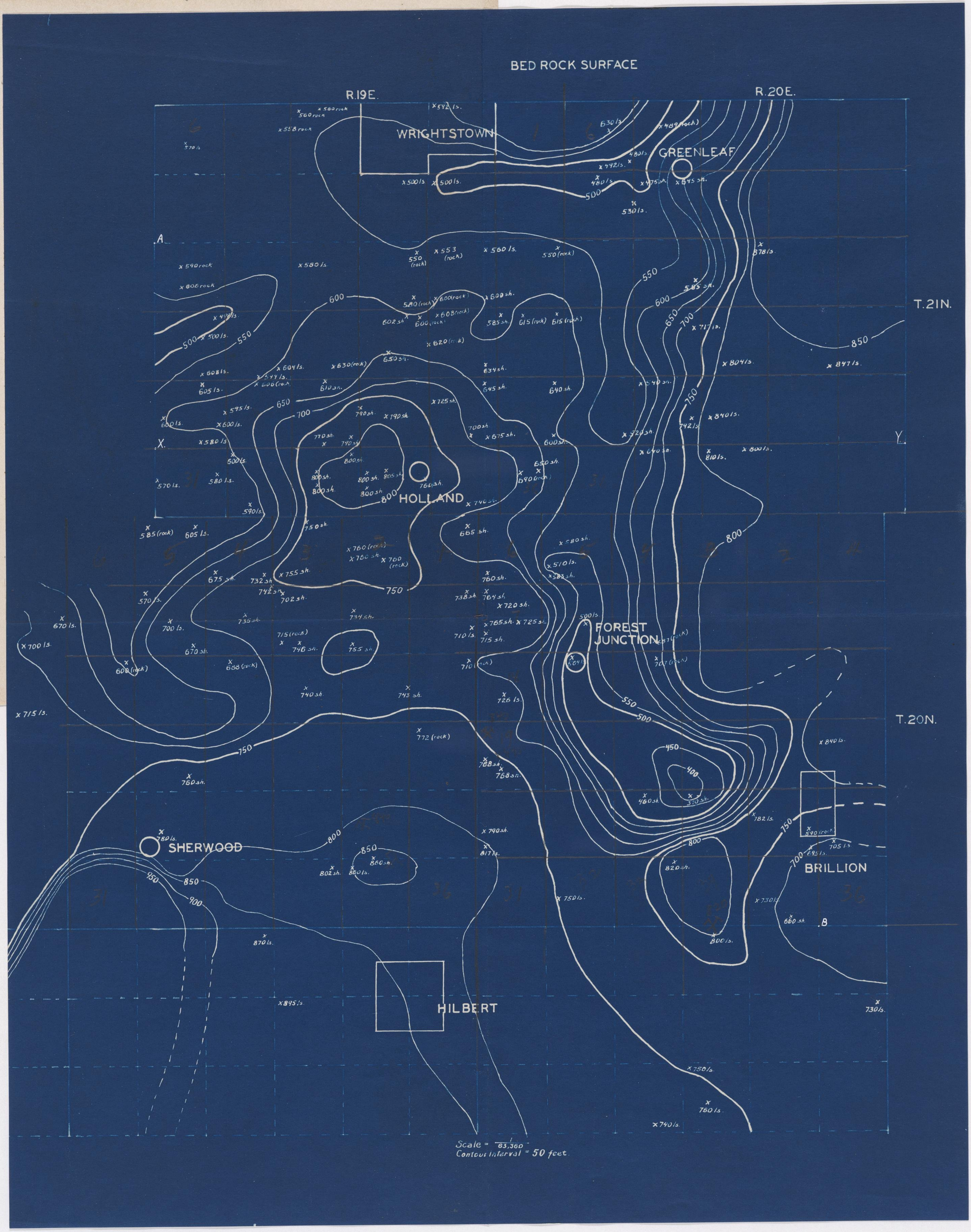

Log of well in SE, SE, 20-20E

will, according to my section, show

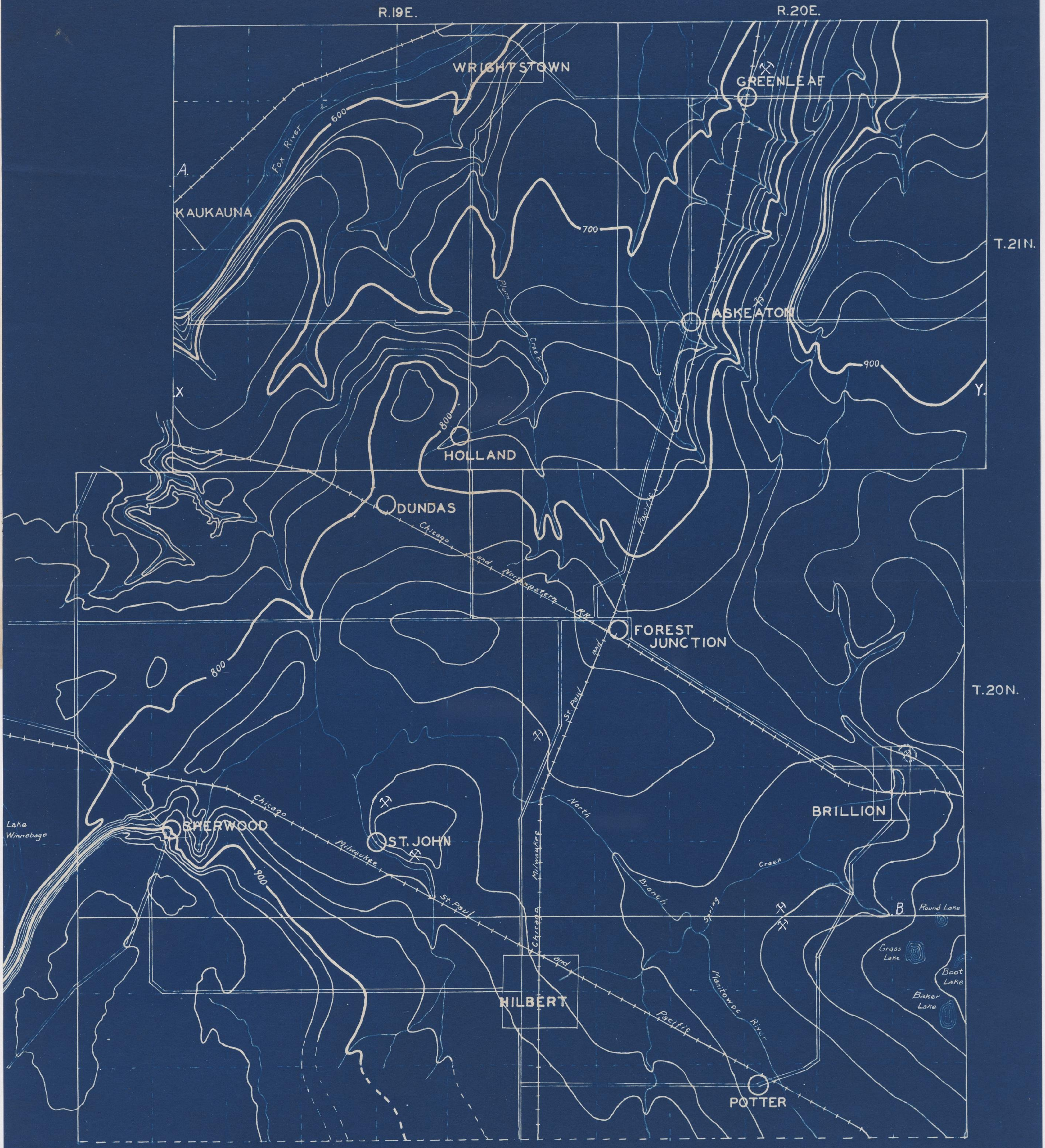
D 200 feet,
ls 500 feet,
Shale —

Limestone will be struck at an elevation of 630 feet.

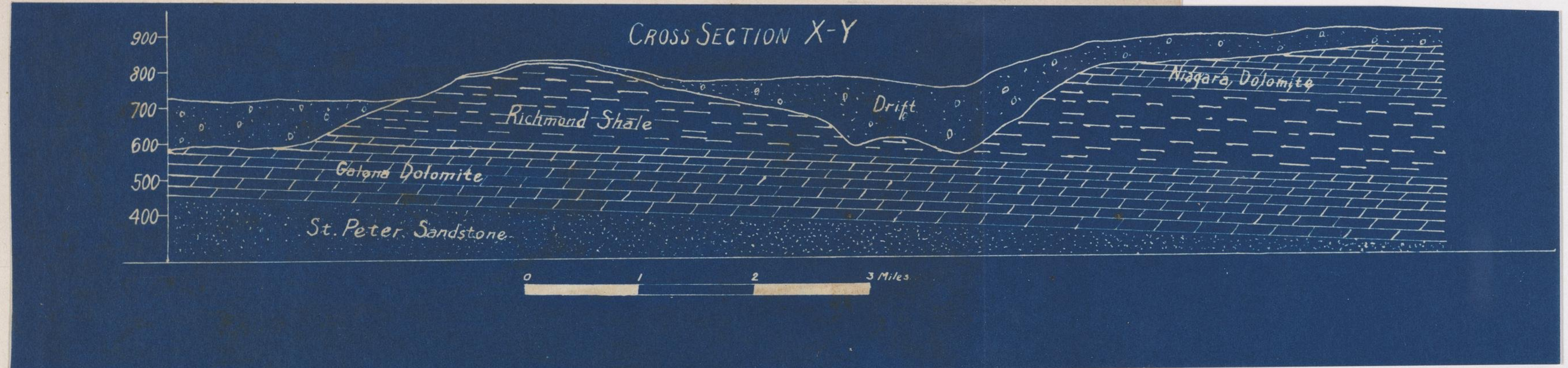
Use for Fig 15 pt II
or use the Black Creek Figure in NE Wis

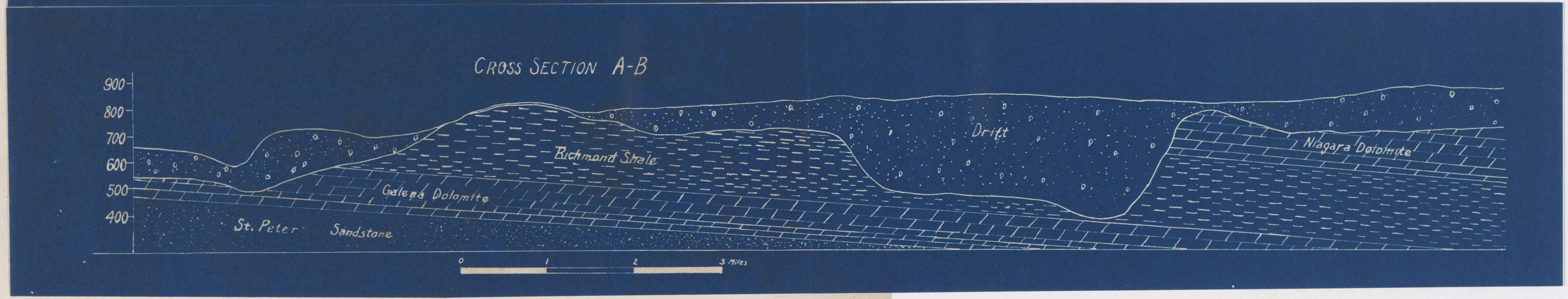


# TOPOGRAPHY




Scale = $\frac{1}{63,360}$
Contour Interval = 20 feet
Base Map = Wisconsin Highway maps of Brown, Calumet and Outagamie Counties.
Main Roads = ═══


Cross Section X-Y
900
800
700
600
500
400
Richmond Shale
Drift
Niagara Dolomite
Galena Dolomite
St. Peter Sandstone
0
1
2
3 Miles


Cross Section A-B
900
800
700
600
500
400
Richmond Shale
Drift
Niagara Dolomite
Galena Dolomite
St. Peter Sandstone
0
1
2
3 Miles

Piedmont and mountain glaciers Feb. 16, 1921

Map of Controller Bay Region, Alaska.

(1) Compare method of showing glaciers with that employed on other maps. Which is best?
(2) To what class of glaciers does Bering belong?
(3) Account for the lakes along its northern edge.
(4) Account for Kushtaka Lake.
(5) Account for the braided streams and for the course of Bering River.
(6) If a drill hole were put down just east of Bering lake. Suggest the probable succession of material.

Geology 143

Map questions, Mountain glaciers.

Feb. 16, 1921.

Mt. Rainier National Park, Washington.

(1) What is the annual ~~XXXX~~ precipitation on Mt. Rainier?
(2) On which side of the mountain are glaciers best developed? Why?
(3) What are the brown stippled areas on some of the glaciers?
(4) What are the strips of the same pattern along some of the streams?
(5) What name is applied to the rock islands in the glaciers?
(7) ( What do they give rise to?
(8) Explain the peculiar course of White river and Kautz Creek.
(9) Account for the names White river, Muddy Fork.
(10) Tabulate the elevations of the lower ends of several of the larger glaciers. Name factors which influence elevation to which glaciers desend.
(11) To what extent was this region formerly glaciated? Cite definite evidences.

Geology 143

No field trip Monday

Glacial Geology, March 14, 1921.

Eskers.

Passadumkeag quadrangle, Maine.

(1) What name is used locally for the eskers shown on this map?
(2) Note the length, width, course, heigth, and crest of the eskers.
(3) Do any of them join and where?
(4) What relation have eskers to direction of ice movement?
(5) Note relation of esker ridge to ground moraine hill west of Clamon stream.

Leverett Vol III cuts

Glacial Geology, March 21, 1921.

Lake beaches.

Berea quadrangle, Ohio.
(1) Account for the three ridges, North, Middle and Butternut.
(2) What kind of material would you expect in them?

Note: For graphs use vertical scale of 1 in = 10 %

Geology 143, Feb.28, 1921.
Marseilles quadrangle, Ill.
(1) Contrast the topography of this moraine with that shown on the Vergas quadrangle.
(2) Compare the degree and constancy of direction of slopes in the moraine with those of the extreme northwest and southeast parts of the map neglecting slopes due to post-glacial causes.
(3) What modifications have been made in the topography in post-glacial time?

Text references, Chamberlin & Salisbury Vol III, 362-367
~~Chamberlin~~ Salisbury, Geol of New Jersey, Vol V, 90-101
Chamberlin, Geol. of Wisconsin, Vol I, 275-282

Geology 143, Feb.28, 1921. These all cover same ground

Terminal moraines, general.

(1) Explain the conditions necessary for the formation of a terminal moraine.

(2) Contrast the probable topography of a terminal deposit with that of deposits which have been under the ice.

(3) In which of the above classes will there probably be the greater percentage of water deposited materials?

Vergas quadrangle, Minn.

(1) Describe the characteristics of the topography of the Towns of Burlington, Candor, Dunn, Lida, and Maplewood (as a whole)

(2) Construct a slope scale and measure the angle of slope of several hills.

(3) Suggest possible modes of origin of the enclosed depressions.

(4) What evidence can you find as to the direction from which the ice came which deposited this moraine?

(5) Construct an accurate profile along the line indicated between Reeves Lake and Eagle Lake, vertical scale 1 inch to 500 feet.

Map questions, Mountain glaciers, Feb.16, 1021

Nyack, Mont.Quadrangle.
This is one of the latest maps and is far more accurate than some of the older ones.

(1) What evidences do you see of former more extensive glaciation?
(2) What factors determined its distribution?
(3) Locate a true hanging valley. What has happened since it was abandoned by the ice?
(4) Compare annual precipitation and ~~mean annual~~ summer temperature with the area around Mt.Rainier.

Geology 143

Terminal moraines---Geology 143.

Show the principal moraines in red.

Illinois-Mon. 38 ( Wisconsin moraines) map, p.24.

Indiana and lower Mich., Mon.53, map in pocket.

Ohio and parts of Penna & N.Y., Mon. 41, map, p.50.

New Jersey, N.J.Survey 5, map in pocket.

Long Island, Prof. Paper 83, map in pocket.

Northern Michigan, wall map. - map in Pub 25

Wisconsin, Prof. Paper 106, map in pocket; State Bull. 16, map in pocket; model on 3rd floor ( out of date)

Minnesota, wall map.

Dakotas, U.S.G.S.Bulls. 144, p14 158. p14 Jour.Geology 24, pp.521-532

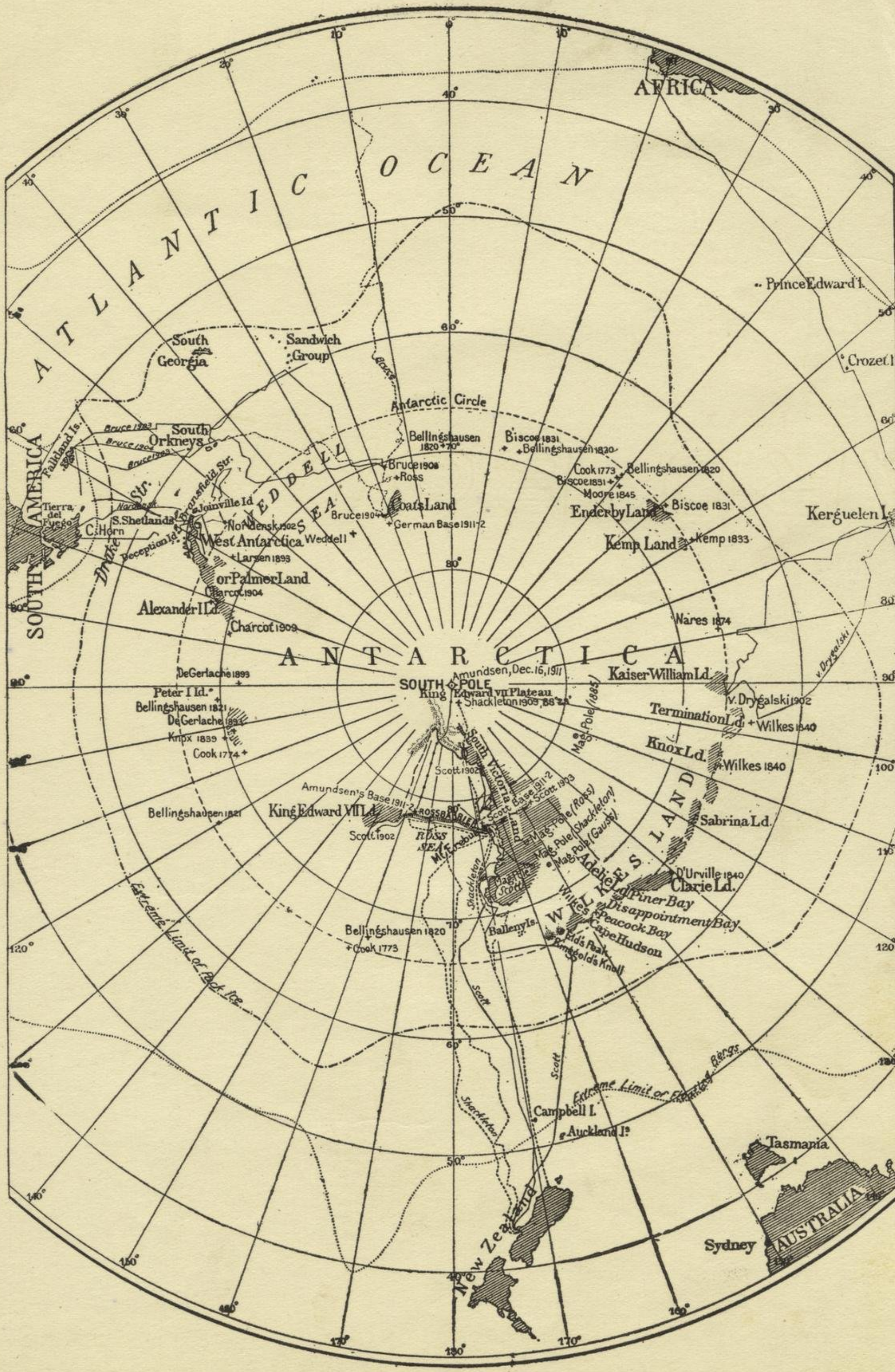
Iowa, State Survey vol.26, map in pocket. Mon 25, map p 132

Montana, Bull. G.S.A. 24, p.529. Prof Paper 50, p1

Penn Rept Z map in pocket

Glacial Geology, March 30, 1921.

Camp Dodgerquadrangle, Iowa.
(1) What evidence do you find of a difference of age in the glacial drift of different parts of this quadrangle?
(2) Along what line did the later glacier halt?
(3) Contrast its marginal deposits with those of Wisconsin.
(4) Note their relation to the valley of Beaver Creek. Explain difference between this valley and that of the Des Moines.
(5) Read the text on the back of this map.


ATLANTIC OCEAN
AFRICA
SOUTH AMERICA
Prince Edward I.
Crozet I.
Kerguelen I.
South Georgia
Sandwich Group
Antarctic Circle
Falkland Is.
South Orkneys
Tierra del Fuego
C. Horn
S. Shetlands
Drake Str.
Joinville Id.
WEDDELL SEA
Coats Land
Bellingshausen 1820
Biscoe 1831
Cook 1773
Moore 1845
Enderby Land
Kemp Land
Kemp 1833
West Antarctica or Palmer Land
Larsen 1893
Charcot 1904
Alexander I Ld.
Charcot 1909
Nares 1874
ANTARCTICA
SOUTH POLE
Amundsen, Dec. 16, 1911
King Edward VII Plateau
Shackleton 1909, 88°23'
Kaiser William Ld.
v. Drygalski 1902
Termination Ld.
Wilkes 1840
Knox Ld.
De Gerlache 1898
Peter I Id.
Bellingshausen 1821
Cook 1774
South Victoria Land
Amundsen's Base 1911-2
King Edward VII Ld.
Scott 1902
ROSS SEA
Sabrina Ld.
WILKES LAND
Adelie Ld.
D'Urville 1840
Clarie Ld.
Piner Bay
Disappointment Bay
Peacock Bay
Cape Hudson
Balleny Is.
Bellingshausen 1820
Cook 1773
Extreme Limit of Pack Ice
Extreme Limit of Floating Bergs
Campbell I.
Auckland Is.
Tasmania
AUSTRALIA
Sydney
New Zealand

Terminal moraines- geology 143.

Vergas quadrangle, Minn.
(1) Describe the topography of the Towns of Burlington, Candor, Dunn, Lida and Maplewood. Note elevations of hills, size, shape, slope etc.
(2) Measure the maximum slopes of some of the knolls using following table.

Slope 1° equals 9 ft in 1/10 mile

| | |
|---|---|
| 5 | 46 |
| 10 | 93 |
| 15 | 142 |
| 20 | 192 |
| 25 | 248 |

(3) Suggest three possible origins for the undrained depressions. How can you distinguish each?

(4) What evidence can you find as to direction of movement of the glacier which made this moraine? What would you look for in the field to check this?

Terminal moraines- Geology 143.

Urbana quadrangle, Ill.

(1) Yankee Ridge is a moraine. Contrast with other maps.
suggest why different

(2) To what degree has it been altered by postglacial erosion?
Why more than other areas?

Marseilles quadrangle, Ill.

Terminal moraines- Geology 143.

(1) To what degree and how and where has this area been altered in postglacial time?

(2) What part of the area is terminal moraine? Contrast with rest of area in slope, size of hills, etc.

(3) Contrast this moraine with that of the Vergas quadrangle. Why different?

Slopes 1/10 m
5° - 46
W 93
15 142
20 192
25 248

Geology 143 March 2, 1921

Sun Prairie Quadrangle, Wisconsin.

(1) Define "drumlin".

(2) Locate exactly several typical drumlins on this map. Compare the slope of the sides; the slopes of the two ends.

(3) Contrast the shape of a drumlin with that of an ice-worn rock hill. (4) Suggest reason for difference.

~~(4)~~ ~~Tabulate length,~~ width, and heigth of several drumlins and give the average.

(5) Examine some which depart from typical form. Classify these

~~(5) What is the maximum slope in degrees to be found on drumlins?~~

(6) Examine the area between the drumlins. Describe its general nature and the degree of slopes.

~~(7)~~ Examine some of the drumlins which depart from the typical form. Classify some of the variations.

(7) Are there any terminal moraines on this map? How known?

(8) Relative age?

Text references.

Alden, Drumlins of SE Wisconsin, U.S.G.S. Bull.273 and Prof.Paper 106, pp. 253-256.

Geology 143, Feb.28, 1921.

St.Croix Dalles quadrangle, Minn.Wis.

(1) Can you tell which side of the north-south moraine was occupied by ice when it was formed? State how.

(2) Make a sketch of the quadrangle in pencil showing area of terminal moraine in symbol ~ used by Wisconsin State Survey. Keep this sketch for further use.

(3) Is the valley of St.Croix River below Taylors Falls older or younger than the moraine? How known?

Geology 143, Feb.28, 1921.

Map showing the surficial deposits of southeastern Wisconsin.

(1) Account for the cresentic form of the moraine of the Green Bay glacier.

(2) Account for the reentrants near Baraboo. See model of Wisconsin.

(3) Count the terminal moraines between the outer border of the Green Bay glacier and the red till moraine at Fond du Lac. Suggest reasons for the poorly marked form of these moraines as compared with the outer two moraines.

(4) What is an interlobate moraine?

## Geology 143, March 9, 1921.

### Outwash plains.

Janesville, Shopiere, Wis., Rockford, Belvedere, Ill. quadrangles.

(1) Construct and hand in profile along the center line of the outwash plain from the moraine to Rockford. Use a horizontal scale of 1 inch to 4 miles and a vertical scale of 1 inch to 200 feet. Use ruler graduated into quarter inches and lay out quarters on your profile for inches on the map. Project elevations of points not on the line along lines at right angles to the line of section. Show top of plain as originally formed and present stream grade. Explain the difference. (2) Why does bed rock outcrop in the Rock river at many points near Janesville? See pre-glacial topography map by Alden. (3) Was outwash brought into the Rock valley from any other moraine than that north of Janesville?

(4) Large gravel pits are located at Janesville and Beloit. Comment on factors which led to the selection of these points. What limits depth to which deposits can be developed?

(5) Suggest explanation of relation of the valley trains of Sugar and Rock valleys. What kind of material would you expect to find in the lower part of the Sugar-Pecatonica valley? Note meanders and their meaning.

GEOLOGY 143

GLACIAL GEOLOGY

Calendar 1954-55

Pages in Thwaites "Outline of Glacial Geology," 1953.

| | | |
|---|---|---|
| Feb. | 7 | Organization |
| | 9 | 1-3 |
| | 11 | 3-5 |
| | 14 | 5-7 |
| | 16 | 7-9 |
| | 18 | 9-11 |
| | 21 | 12-13 |
| | 23 | 13-16 |
| | 25 | 16-18 |
| | 28 | 18-20 |
| Mar. | 2 | 20-22 |
| | 4 | 22-25 |
| | 7 | 25-26 |
| | 9 | Exam |
| | 11 | 26-29 |
| | 14 | 29-32 |
| | 16 | 32-34 |
| | 18 | 34-36 |
| | 21 | 36-39 |
| | 23 | 39-40 |
| | 25 | 40-43 |
| | 28 | 43-46 |
| | 30 | 46-49 |
| Apr. | 1 | 49-52 |
| | 4 | 52-54 |
| | 6 | 54-57 |
| | 8-17 | Spring Recess |
| | 18 | Slides, cont. |
| | 20 | Exam (to date) |
| | 22 | 58-59 |
| | 25 | 59-61 |
| | 27 | 61-65 |
| | 29 | 65-67 |

| | | |
|---|---|---|
| May | 2 | 67-70 |
| | 4 | 70-75 |
| | 6 | 75-80 |
| | 9 | 80-86 |
| | 11 | Trip to Monticello, 2:25 P.M. |
| | 13 | ~~15-80~~ 86-88 |
| | ~~14~~ | ~~Armed Forces Day~~ - Trip to ~~Walworth~~, ~~7:30~~ A.M. |
| | 16 | Review on trip |
| | 18 | ~~86-88~~ |
| | ~~20~~ | ~~Trip to McFarland, 2:25 P.M.~~ |
| | ~~21~~ | ~~Trip to Forest Bed, 5 A.M.~~ |
| | 23 | ~~Review of trip~~ |
| | 25 | Exam on trips |
| | 27 | ~~88-96~~ |
| | 30 | Holiday (no classes) |
| Jun | 1 | 96-106 |
| | 3 | 106-110 |
| | 8 | Final Exam 7:45 A. M. |

Field trips are required. Dates for the short field trips (McFarland and Monticello) are subject to change. Option is given of either writing a report on all trips combined by subjects seen, or taking the usual final examination which will be largely on the trips (see review questions). Report due at time of final exam. Those taking cars on trips please see that they are insured and keep record of expenses. Collection will be taken up after trips are over. Bus is impracticable on account of weight limits on bridges and roads.

Armed Forces Day May 21

96-100

Late glacial and postglacial
  Definition of postglacial
      weathering and erosion
      sedimentation
        wind action, confusion over direction of wind
      trails, ice ramparts
      local glaciation
      climatic changes-climatic optimum and Little Ice Age-present-day changes
Summary of Pleistocene succession
   number of glaciations

Driftless Area omit
   causes
   borders
   topography

100-106 100-104 104-106 Wednesday

Origin of glacial climate
The problem
Distribution of glaciers-general nature of climate
temp. vs precipitation
glacial vs interglacial climates
Types of hypotheses terrestrial, cosmic
eccentricity theory
earth's axis
movement of continents
oceanic changes
1951 dust in air $CO_2$
changes of topography or shape of lands
X cosmic-solar radiation

Duration of Quaternary Friday
erosion Everything
sedimentation how many for exam?
weathering
temperature change
Radio activity

106-110 Friday

Life
migration extinctions marine Pliestocene of California

Human remains
early man of Europe and Asia
early man in America

Economic geology
gravel problems relation to engineering
sand
clay
miscellaneous-diamond problem
Soils
basis of divisions
water supplies
excavation
drilling
geophysics
field methods

# WELL OF FARMERS COOPERATIVE PACKING CO.

NEAR CENTER S.W. 1/4 Sec. 31, T. 8, R. 10 E. MADISON, WIS.

M.T. Peterson Well & Electric Co., Contractors } Completed April, 1917
G.W. Peterson, Driller

Samples examined by F.T. Thwaites, U.W. #50381-50415

Elevation of curb 855

1" = 100'

| Formation | Depth | Scale | Description | Remarks |
|---|---|---|---|---|
| DRIFT | 0-5 / 5-10 | | Glacial deposit, large boulders / Quicksand, no sample | Water at 1' depth |
| | 10-20 | | Coarse gravel, no sample | |
| | 20-46 | | "Hard pan", glacial deposit, no sample | |
| | 46-52 | | Glacial deposit, sandy, limey, yellowish-gray | |
| | 52-88 | | Glacial gravel, coarse to fine | |
| | 88-98 | 100 | Sand, medium, gray, limey, small pebbles | |
| | 98-132 | | Quicksand, very fine, gray, very limey | |
| | 132-225 | 200 | Clay, gray, very limey, sometimes sandy | |
| | 225-230 | | Sand, medium, gray, limey | |
| | 230-350 | 300 | Clay, gray, very limey | |
| 372 | 350-372 | | Gravel, coarse, many sandstone pebbles | |
| POTSDAM | 372-410 | 400 | Sandstone, medium, light gray, limey, hard to soft, some shale, pink and blue, limey. | |
| | 410-465 | | Sandstone, medium, light gray | |
| | 465-475 | | Sandstone, light pinkish gray, very limey | |
| | 475-500 | 500 | Sandstone, medium, light gray, hard | |
| 95½ | 500-567½ | | Sandstone, coarse to fine mixed, gray, mainly soft | |

88-96

Toronto
    Definition
    Distribution includes beds near James Bay
    Fossils
    Climatic interpretation

omit Eastern United States
    Older views
1949 X Method of retreat of last ice-Antevs vs Flint

omit Western United States
    Nebraska-outwash-inwash
    Terraces of Great Plains
X Mt. glaciation and pluvials

omit ? omit omit

Marginal Lakes nomenclature
    pre-Wis. and earlier Wisconsin
    Lake Wisconsin-Lake Chicago L. Oshkosh
    Effect of Valders readvance
  Lake Algonquin
Low interval
  Lake Nipissing    Agassiz, etc.

Niagara gorge omit

Table on p. 94

1952 X

Earth movements
    hinge lines, isobases
    Isostacy points for and against
1949 Depression of Great Lakes region
    Changes of level of oceans

X

Glacial

1-3

Field of glacial geology - (glaciology)
Methods of approach

Definition of glacier
Classification: Mountain or valley= ice stream
Piedmont
Continmental = ice sheet Ice caps

Origin of ice
Snow Rime firn alteration , change in density layers

Motion-evidence of measurment-distribution of material- breaking-
(crevasses) - rock flour -polishing and acratching of rock
Physics of motion- relative speed of movement like river
tension vas compression - definition of solid, liquid, plastic
viscosity-elastic limit- molecular readjustment , pressure melting
work of Demorest- laminar flow- zones of fracture, flow,
strain ellipsoid
Gravity flow- analysis of forces involved-effect of included solids
derive equation for velocity at depth d

dv/dd x vis= d sin slope x density x g

$v = d^2$ sin slope $\cdot$ g / 2 vis. vis = about $10^{14}$ poise

with a semi-circular valley this becomes 32 x vis. and for one deg. slope and 100 meters thickness velc at top should be about 3.5 cm/day
Relation of viscosity to depth? decrease prop 4th power at or below melting point

Obstructed gravity flow dueto less thickness of ice at terminus
Fracturing of lower part of glacier, shearing
Extrusion flow - Demorest
Difference from gravity increase of velocity downard
Crevasses -bergschrund bending downstream-chevron struture
relation to strain ellipsoid

For wide glacier

$$V = \frac{Force}{3u} z \quad \text{where } z \text{ is depth} \quad \frac{dz}{dt} = V$$

$$\frac{dz}{z} = \frac{Force}{3u} \cdot dt$$

integrate

$$\log_e \frac{z}{z_0} = \frac{Force \cdot t}{3u}$$

$$\frac{z}{z_0} = e^{\left(\frac{Force\, t}{3u}\right)}$$

$$t = \frac{3u}{Force} \cdot \log_e \frac{z}{z_0}$$

Taking $\frac{z}{z_0} = \frac{1}{10^6}$ then $1 = \frac{3 \times u}{Force} \log_e (1 - 10^{-6})$

370 meters = $3.7 \times 10^4$ cm

$3.7 \times 10^4 \times 9.8 \times 10^2 \times$ density

$\frac{3.7 \times 2.65 \times 98 \times 10^6}{10^2 \times 10^6} = 10^8$ dynes/cm²

$v = \frac{df\, d}{df\, dv}$ force per unit vol.

$\frac{dv}{dd}\left(\frac{df}{dv}\right) = F$

pp. 3-4

Classification of valley glaciers

Snowbank
Cirque
Dendiritic
Piedmont
Tidal
Temperate
Polar

Nourishment

Snow line - wind drift
Precipitation

Derivation of rate of flow

$$\mu \frac{dv}{dx} = x \times \text{density} \times g \times \sin S \quad = \text{Force or wt} \times \sin S$$

$$dv = \int_0^D \frac{x \cdot \text{density} \times g \times \sin S \cdot dx}{\mu}$$

(v =

$$V = \frac{x^2 \times \text{density} \times g \times \sin S}{2\mu}$$

mult by average depth, sin S = slope

let x = D

$$V_{top} = \frac{D^2 \times \text{density} \times g \times \sin S}{2\mu}$$

for infinite width $= \frac{D^2 \cdot \rho \cdot g \cdot S}{2\mu}$

---

$V = h F \cdot \text{density}$

Error in legend of fig. 8 this does agree with strain ellipsoid

Effect of wind drift on snow a ccumulation
Glaciers mainly on E slopes   Pikes Peak
Firn or neve line

Summary  Note time factor in flow vs breaking ~~xxxfixwx~~

Wastage
  Melting     ablation   condensation
    Source of heat  relation to debris  interior heat of earth
    Sublimation
  1451 Mass wastage  shape of terminus
    Position of terminus

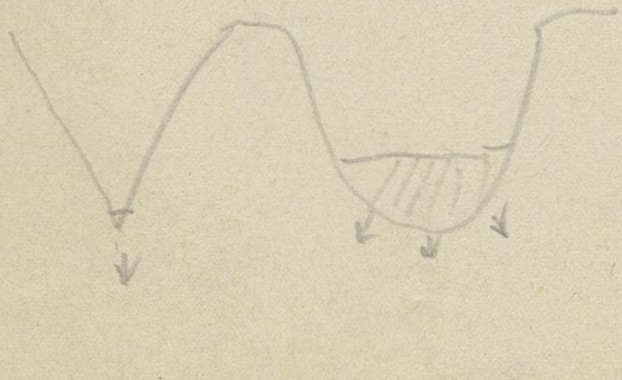
Erosion
  Controversy  why
  Observations  unique land forms  transported material
  Theory  force-work
  Water erosion
    washing away
    impact
    cavitation
    abrasion

    relation of velocity to slope, hydraulic radius   $V : R^{2/3} S^{1/2}$
      energy lost to k. e of rotation-temperature rise   $\frac{V^2}{R} = R^{1/3} S$
      sixth power law   $D : V^2 \quad wt : D^3 \quad so \quad wt : V^6$

  Ice erosion
    friction  relation of coefficient to velocity, total weight
    relation of velocity of ice to depth?   $v \; \& : D^2$

$c = \frac{F}{W} \quad F = W \cdot c$

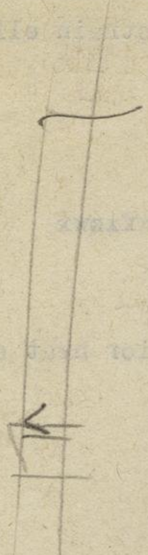
$Power = \frac{FS}{t} \quad S = Vt$   F resultant of wt and V
hence $P = FV$



$u = v_x$

$$\frac{\partial p}{\partial x} = \mu \nabla^2 u$$

$$\frac{\partial^2 u}{\partial x} + \partial^2$$



$$\frac{\partial p}{\partial y} = \mu \nabla^2 v$$

$$\frac{\partial p}{\partial z} = \mu \nabla^2 w$$

$$\nabla^2 u \equiv \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}$$

Erosion
Erosive force of ice   Mis use of word power
Method of application of force to bed. Impact unimportant
Friction
Inclusion of loose material into glacier

Coefficent of friction- not related to either velocity or tottoal weight

Work = force x distance   Powen = work/time = Force x velocity
Velocity related to some expnental power of thickness
If this is the square the power : thickness cubed (for waeight : thickness)
Demonstration:
rate of increase in veloity to increase in depth is(dv/dx) vis.
force in small increase of depth = force of total unit column
vis dv /dx = x density.g,.s in S°XX
clearing dv= x. den. g. sinS/ vis.
integrating: v= $\frac{x^2}{d}$. den.g. sin S / vis.   v at base = 0
x= depth

higher power of depth

This applies only to a glacier of considerable width. If semi-circular
then it becomes 32 x viscosity forces expressed in dynes/$cm^2$
and velocity mean ~~not maximum~~ (ratio 2 to 1) to max
Catch: this formula refers to top velocity and not bottom since top rideson lower layers
viscosity is not same all the way through except possibly below the firn line
wet or dry ice.

Retarding force = force down slope in order to have non-acclerated flow

No turbulent flow in ice.

Mechanism of plucking = flow around loose particles including them in moving ice
How much potential energy of the ice is wasted?
Conversion into heat with tranmission upward
Pressure melting + refreexing = no loss
1949 Plucking favored by greater pressures than under streams.
Bottom of temperate glacier at melting point
Chemical weathering   under ice slight
Tools held firmly in thin ice
Formation of rock flour
Limit of load not easily reached = capacity
Width of glaciers exceeds that of rivers because slow  Width lessens work per unit area with same total energy available
Hence less rapid deepening of valley unless by plucking

Plucking versus grinding in energy consumption?

here

Land forms: cirques, hanging valleys, U-shaped valleys, rock basins, roche moutonees fiords

Cirque= corrie or cwm   description

7-10 7-9

Land forms due to glacial erosion
    Cirque    corrie cwm
        Description   tarns
        Explanation
            down grinding
            headward erosion in bergscrund, melting there or above?
                sapping - rock structure
                similar landfroms - nivation
    Hanging valleys
            Playfairs Law
            confusion with cirques
1949 — explation of discordance
                greater erosive power of large glaciers    $P = W \cdot V$   $W \, D$
                difference in bed rock    $V \div S^n D^{n+1}$
                widening of vallyes vs deepening    $P \div S^n D^{n+2}$
            Other hangigg valleys
                faulting-differential river erosion- wave erosion-faulting

    U-shaped valleys
            "catenary"
            Cause

leave 51
    Rock basins   and steps
            Relation to jointing

1951
    Roche mountonee
        Definition   relation to streamlining
        Cause   controversy

p9

    Fiords
            Description
                threshold irregular bottom
                drainage pattern
            Cause
                sinking of land
                differential glacial erosion_ hanging tribuataries
                    floating of ice

    Cycle of mountain glaciation x

p10
Transportation of debris
        superglacial, subglacial and englacial  changes in position

1950 — 1954
        moraines in transit   after deposition

    nature of till, many anglular stones also others plus fine material
        fresh drift    buried ice masses   earthquake moraines

11-13 Dep.
Stream - dep - eros

Continental
ossintory

11-13

~~10-12~~

Conditions for formation of endmoraine or terminal moraine recessional
    may be readvance

Stream deposits etc. deltas, outwash see Part II

Erosional work of meltwaters
    potholes
    notches

Part II Continental glaciers
  Definition
  Differences
    Valley, small, local, flow by reason of slope below, last through life
    Continental, covers very large area, dome form, extrusion flow,
      may stagnate, radiating winds, no sapping,

  Existing continental= Greenland, Antarctica

next page

12-15

Gre enland glacier

Extent   Basement   geophysical exploration

Elevation

Borders similar to valley glaciers

Nunataks  cirques local glaciers   former extent

Antarctica

Extent  Basement   Wastage

B arrier or shelf ice   nature of ice

end 13

13' Motion of continental ice

Exposed parts

Extrusion flow (?) shear at border = obstructed extrusion flow (?)

no obstruction where ending in water

Passage to gravity flow in tongues

Computation of velocity

viscosity = ratio of force to velocity      = F/v

hence velocity = force / viscosity

force at a given point is component of weight of column parlal

surface = density x g x sin slope

Assuming a viscosity of $10^{14}$ even a glacier 5000 meters thick

would move a very small distance per day

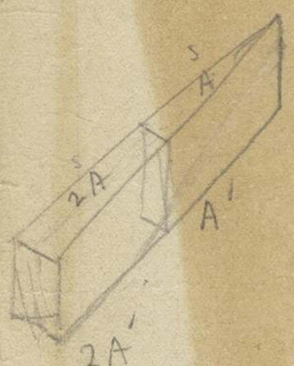
Analysis shows that velocity is directly proportioned to distance

from center of a circular accumulation so that slope must

increase in same ratio.

Does this not neglect factor of weight of column?  Slope must be

greater than direct ratio to take care of this.




Flow in area of ablation is "obstructed" and shearing occurs.

Stagnation

Expansion of margins after supply ceases

When is an angle of repose reached?  Resistance = force

Effect of melting of margins in maintaining slopes

Thinning and letting down of thin rigid ice onto land

Survival ~~of the~~ longest in valleys

Reinstatment of flow

Nourishment

1949 Two effects

(a) As a mountain range

(b) Creation of air drainage or anticyclone

1950 Causes of modern precipitation

Mountains vs air mass relations

15-18

Nourishment

Causes of modern snowfall

cyclone vs air mass interpretation

Snowfall on continental glacier

Hobbs theory 1954

p16 rising air mass theory

Wastage

glaciers extended into areas of no surface accumulation-evidence

Temperatures within glaciers, pressure melting, normal gradient

difference of temperate and polar glaciers

Bottom vs top melting

1953 Radiation vs conduction for winds

Sublimation vs melting

1954 wastage in water

Thinning during deglaciation

Preservation of residual masses

1954

18-20

Erosion

Methods; distribution of maximum velocity
maximum plucking
pressure melting

Evidences

no residual soil-striae, polishing, fresh material,
volume of drift- disturbance below-form of hills-
rock basins-escarpments, caves, hanging valleys

1952 X little erosion

soils etc-never much residuium-no striae-weathered glac.
1951 stones. undisturbed basement-false roch. mout.-
rock basin problem- caves, escarpments- relation to direc.
overridden drumlins, etc. X

problem of volume wells
1954 Great Lake problem
Finger Lake problem p. 21

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20-22 22

Great Lakes

Relation of basins to geology cuestas
rock barriers
possibilities
drift dams
warping of land
glacial erosion

Finger Lakes

relation to geology hanging valleys through valleys
are they rock basins? evidence
theories
preglacial reversal of direction
meltwater erosion
interglacial stream erosion
1952 glacial erosion depth for pressure melting?

Rock basins

Warping
Glacial erosion
Plunge pools

Exfoliation phenomena
Gravel boulders
Survival of drift hills
Comparison of resistance to glacial erosion vs resistance to water erosion
Jointing bedding- vs vegetation. Physical vs chemical nature

25-26

Transportation of debris

Position of loa d   derivation

overriding near margin only

melting out on top

rising toward margin    falling in crevasses

levation of debris

istance of transportation

Cause of dominantly local material

loss, spreading out, destruction, relative hardness

Evidence of Pleistocene glaciers

Early geology, use of float  erratics, drift

First explantions, waves, floods, marine, icebergs, comet   diluvium

1953 Glacial hypothesis  first applied to Alps etc.

Difficulties in New England

1951 Proofs

trans portaion without regard to size

distance of movement, crossing mts. etc.

polis h, striation etc.

1954 form of margin demonstrates solid

removal of old mantle rock

mechanical origin of drift

1952 constructional topography

water deposits in places now impossible

22-25

~~Striaxis~~

Striae

- Definition
- Origin, conditions for beginning, ending
- P olishing
- Marks res embling
    - Slickensid es
    - Water work
    - Iceberg
    - Wind
    - Mudflows
    - Landslides
    - work of man
- Direction of motion
    - abrasion
    - form of marks
    - crossing marks – causes of change of direction – relative age
    - 1955 1953 1952 discovery

Friction or chatter marks

- Forces involved
- 1952 Discrimination of true chatter mark

Crescentic gouges

- Forces involved

Direction of motion from friction phenomena

Faceted stones

$F = wt \cdot coeff$

$coeff = \frac{F}{wt}$

26-29

Pleistocene continental glaciers

1954 Evidence, striae destroyed-formation of postglacal towers, etc. "previously glaciated"

Glacial centers continental, local

initiation of glaciation Flint's theory, a single Laurentide

glacier orginating in mts. of Labrador

later shifts in center

1952 Antevs hypothesis assumptions

Continental glacier of Europe-Asia

1953 local centers of British Isles, Siberia, etc.

Thickness of glaciers

Attempts to find thickness in middle, difficulties

limits of glaciation-botanists nunataks

1951 Conclusion, not over 18000 feet maximum.

Volume of glaciers

contempraneous?

lowering of sea level.

29-32

Glacial and glacio-aqueous deposits

Boulder trains-shape, recognition

Till
Definition vs drift boulder clay
1954 Size classifications clay, silt, sand, granules, pebbles, cobbles, boulders
Structure
Study relation to source material
1953 1951 Similar deposits coarse gravel, weathered boulder beds, clays with stone,
1950 talus, mud flows, residual dep. Difficulty with weathering

195 Glacio-aqueous dep. fluvial, lacustrine marine

Material, Definition of gravel, latitude in classifications
Source of water-underground escape, evaporation, slow melting,
subglacial escape
Amount of deposits
Ice rafting — anchor ice
1953 Included ice masses
Ice walls
Effect of moving ice

next 32-34

32-36

32-34

Glacio-fluvial deposits $v:R^{2/3}S^{\frac{1}{2}}$

Stream transportation velocity related to both hydraulic radius and slope

Competence vs capacity

1954 Variation in velocity on escape from ice Black River

Suspended load Bed load saltation

turbulence, energy absorbed in

failure of forumulas relating capacity to any single variable

1952 Little's suggested formula based on observed loss of head in pipes

32-34 true derivation of sixth power law

Uniformity of tractive force on bed

Attempt to measure turbulence

1950 relation of width of channel to bed material

curved streams, crossing, cut bank, built bank threads of turbulence

straight streams-threads of turbulence, building of sand bars

subaqueous dunes, natural levee

braided streams causes change to normal form

1953 bedding- result of high grade, variable volume, high velocity, high turbulence

slope mainly less than 40 ft/m

t hickness of layers-cross bedding in sands

ripples, direction of foresets clay balls

here

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34-36 Glacio-lacustrine deposits 34-36

causes of standing water original surface obstruction by ice

melting of buried ice masses- melting through of hills blocking of valleys by outwash and by differential rate of outwash formation

arugument af over ice dams

outlets over land over ice through ice

deposition along shore from icebergs in deeper water

deltaic-shore- deep water deposits

1951 Deltas-foreset, topset, bottom set beds backset? 1951 1953

Shore

1952 strength of wind-reach of waves(fetch)

here 1946 ripple marks, breakers undertow

transportation along beach by diagonal waves

beach profile function of undertow in transportation off shore

problem of alongshore current for sand movement

of waves base or edge of built terrace.

1954 wash across barrier into lagoon

1949 bedding of barrier. of built terrace

shape of pebbles

perfection of sorting openwork gravels

constancy of force

1951

1957 36 -39 next time

Deep water deposit s silt, clay

floating of meltwaters
rate of se ttling depends upon viscosity hence temperature
flocculation absent
hence slow settling and perfect separation

interbedding with shore deposits in winter

chemcial character of lake clays

varves-definition origin absence in temperate lakes
turning over
work of organisms

glacio-marine sediments
more wave action flocculation tides variations

Deformed layers- icebergs, sliding

1950

Varve correlation
Determination of length of time of deposition
here — Correlation- theory Original method - later method 1953
errors-too little variation-personal equation
the solar curve

Glacio-aeolian deposits dune bedding

39-40 next

~~39-43 next~~

Review bedding of dunes

Glacial topography
- Erosional (39-40)
  - Roche mountonee
  - Rock basins
- Depositional
  - moraines
  - drumlins, etc.
  - glacio-fluvial forms
  - glacial lake forms
  - Impracticable to make entire separation from water depos its

Terminal moraine
- Definition
- Classification
  - terminal or end vs recessional need term for moraines of readvance
  - till, waterlaid, delta, kame (1952 1948)
- Matrial
  - Till, kames abuse of word kame
    - abundance of boulders
    - kame gravel
- Topography
  - Ridge form minor ridges (1953)
  - Kettles and other enclosed depressions
  - Clay vs stony moraines-angle of repose (1949)
  - gullies vs kettles
- land moraines at maximum stand or readvance after long time
- water moraines-ice aground- delta cones
- recessional- simple new balance vs readvance. Evidence of readvance (40) (40-43)
- causes of stationary margins (1951)
  - Balance
- causes of readvance-climate, steepening (1954)
  - isolated ice masses
- overridden moraines- how discriminated
- continuity of moraines - why some areas have no moraines
- interlobate moraines-moulin kames
- similar topography
  - dunes-outwash-karst-landslide- gullies-drumlins (1952)
- filed mapping (1953)
  - alignment
  - nature of details,no even skyline "short hills"
  - kettles notsure criterion
  - nature of material (1949)
  - deltas
  - where greatest difficulty, in previously glaciated area
    - inner vs outer edges-breaks, higher outwash

Drumlins next

43-46

Drumlins
Definition-oval hill of glacial hill, streamlined form

1954 Topography
stoss and lee ends heigth, length, width, slopes
compound forms

Material
Till very compact, sorted beds disturbed in many
1?5 Gravel or sand basement
rocdrumlins

Distribution
thick drift paha of Iowa (McGee) in belts parallel ice margin

Origin
Destructional
conclusions- narrow belts, roche mountonee form, coarse gravels etc.

Constructional
Streamlined form, compact till, concentric banding distance from moraine
under thick moving ice

1952 Reshaped drumlins-little erosion

Iniation of deposition. crevasses, obstructions. Conditions under ice

X Similar deposits, moraines, eskers, rock hills

Ground moraine
1954 Definition-theoretical vs practical
Rock hills
drift plains
1953 1955 overridden forms

Material, almost all till, lenses of sorted materials

Origin, drift under ice vs melting of last ice. flow of till to form drift plains

46-49 next

46-49

Outwash unpitted, pitted

unpitted topography-valley trains

grade, method of derivation- tilting of earth?

$y = C.x^n$ or $\log y = \log C + n \log x$ plat on double log paper

1952 $y = C.c^{ax}$ or $\log y = \log C + ax.\log c$ plat on single log paper

conditions of origin

pitted topography

conditions of origin (buried and projecting masses)

kettle chains

1949 1948 boulders in outwash

1951 sublacial wash????

frozen ground

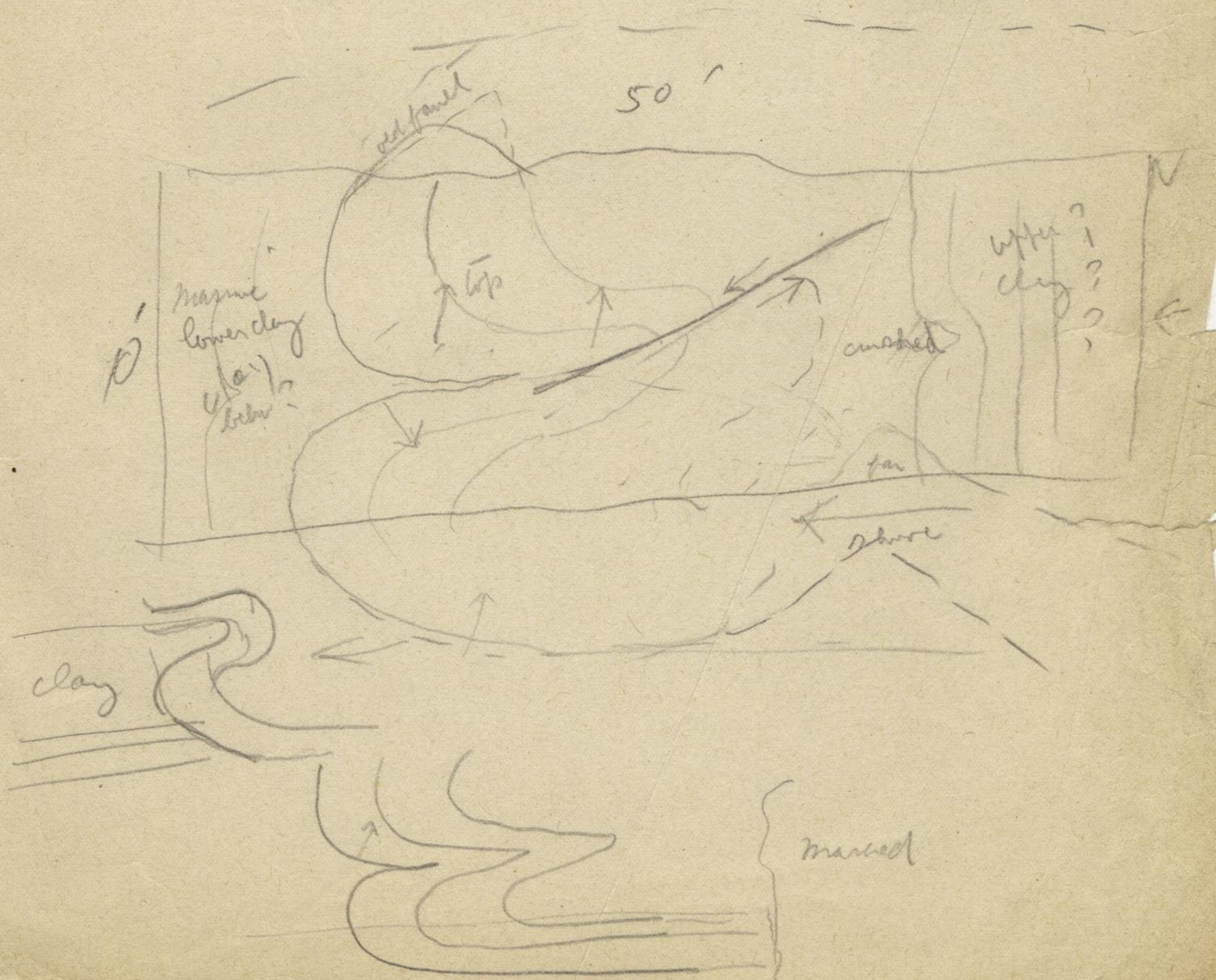
time of formation

here overridden outwash 2 conditions

gravel boulders

till cover, how distinguished from weathering

end



49-52

Delta plains

Outwas h terraces

meader scars slip off slopes

causes:

melting ice blocks-ice-fed springs-opening of lower outlets blocks-
recession of main body of ice - lake outlets
retreat of source-postglacial erosion-erosion of rock barriers
temporary agradation-size of meanders of organized streams
Ice contact terraces or kame terraces -confusion with stream
terraces fromed with buried ice masses
Outwash in tributary valleys and differential junctions

Summary

bedding- sorting- topography even if pitted
absence of outwash in kettles
where to draw boundary?
in photographs

52-54

Eskers and crevasse filings

Definitions-why roofed tunnel omitted

Topography-eskers, legth, cross section, sides, trough? crest
crevasse fillings crest

Materia l openwork gravel
position of base- till cover?

Relation to other drift
eskers in ground moraine, outwash, deltas, drumlins, moraine
crossing of hills- kettles-drumlins
mainly in low ground, swamps
crevasse fillings in pitted outwash, pitted lake terrace, drumlins,
moraines-junction with plain

Origin

Ice walls certain, roof? Ice moving? or stagnant?
Eskers, winding courses, disregard of basement, till cover, buried
extensions indicate stagnant ice tunnels
origin of trough. breaks, uphill deposition, sectional
deposition
deposition on ice let down?
crevasse fillings
Scandanavian eskers concentrated drainage in crevasses
melting though of tops of hills,
Mapping, distinguished by form, material, distribution
confused with sand dunes, crevasse fillings
Erosional features, scabland problem
Bretz., Flint, Allison

Lake basin topog. Review origin of lakes

Erosional
- Peculiar conditions of glacial lakes
- Cliffs profile of equilibrium-boulder line, terrace

Depositional
- Built terraces-barriers- bars, hooks-spits-ice push
  - problem of wave base
  - kettles
- Shore drainage
  - deltas-ice margin-land-outline-kettles
    - discrimination from pitted outwash
- Deep water sediments-local absence

Lake outlets-form, recognition of

Mapping terraces
- beach xxxxx-level, s orted gravel
- cliffs-xxxx same, boulder lines, same level as built topog.
  - horizontal plan
- bars-level top, cross section bedding-form-relation to cliffs
- measuring water levels
- lake sediments

Pleistocene succession

Older ideas

Evidence of multiplicity + long duration of Pleistocene
- plant and animal remains
- non-glacial sediments
- buried soils
- differences in weathering and erosion
- shifts in source

Definition: Pleistocene Glacial Quaternary Recent interglacial
stage substage subinterval or interstadial

Criteria
Fossils erosion weathering stratigraphic succession loess
volcanic ash evidence in unglaciated areas

Paleontological evidence
- Fossils must be between tills
- Danger of error
  - vegetal remains-forest beds- recognition, annual rings- direction of logs
    - pollen studies
  - animal remains-interpretation- outwash vs tributary deposits

X 59-61

Erosion
- wind-gulley-sheet wash
- age with reference to glaciation preglacial vs postglacial erosion
- erosion as a time measure
  - elevation = slope, material climate vegetation
  - 1950 effect of glacial waters
  - stream diversions
  - quanitative estimates ???

61-65
Weathering
Nature of alterations-distinguishing of soil formation and inorganic weather ing
oxidation-reduction, hydration, leaching, decomposition cementation
1953 1952 soil profile formation
1946 two systems of nomencalture 1950
Speed of weathering-climate, topography, material
Use of weathering phenomena as a time measure

65-~~70~~ 67
Stratigraphic correlation
Includes buried soil profiles
Comparison withproblem of marine sediments
Propiety of using formation names
Causes of difference in tills
1952 what relation to age
Discrimination of unconformites
Conclusion

67-70 Loess
Definition
Material-fossils
Thickness
Distrabution-underlying materials-controls of deposition, valleys etc.
49 Deposits mistaken for loess
Problems: where from? How deposited? When deposited?
1954 Is there both interglacial and glacial loess?
Evidence of more than one age of loess
Volcanic ash

70-75
Evidence from outside glaciated area
Lakes of Basin and Range
1957 Terraces, age glacial or interglacial
Plants and animals
Altered soil profiles
1954 Deep sea cores-determination of age
Frozen ground or permafrost
Periglacial phenomena

Europeaansuccession-importance placed on Alps

Beginning of Pleistocene

Naming of the glacial and interglacial stages

~~European succession~~

75-80

Nebraskan-definition, distrubution, nature and interpretation

Old drifts of east, controversy

1954 Aftonian

Kansan

Yarmouth nature of type section

1950 Illinoian-Lake Calvin

Sangamon.-problem of correlation Loveland loess now placed here

exam to here

80-88 86

Wisconsin drifts why different from older drifts?

1957 Subdivisions
Iowan-Tazewell-Cary- Valders-Mankato
Correlation of last two

Iowan
Distribution and definition
Topography
Controversy over existance and correlation
Validity of doubts
conclusion based on stratigraphy plus weathering

1954 Peorian
Type section-why chosen Peorian loess

Tazewell
Distrubution etc. Loess cover-age of

Cary- distribution- Kettle moraine

Two Creeks subinterval

1954 Valders red drift-cause

Mankato gray drift-cause

Later readvances?