State Geologist's Report
ON THE
GEOLOGY OF MAINE
1930 - 1932

SECOND SERIES

By
JOSEPH CONRAD TWINEM
State Geologist
and
EDWARD H. PERKINS
Assistant Geologist

Augusta
1932
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FROM

1836 to 1930

By

JOSEPH CONRAD TWINEM

State Geologist

AUGUSTA, MAINE

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Introduction

The bibliography of the Geology of Maine includes publications on economic and historical geology, mineralogy, paleontology, petrology, physical and physiographical geology and underground waters. In addition many general publications, newspapers and magazine articles are listed if they are of geological importance.

This bibliography has been compiled from various sources, including bulletins of the U. S. G. S. entitled "Geologic Literature of North America from 1785-1918," Bulletin No. 746, and "The Bibliography of North American Geology from 1919-1928," Bulletin No. 823. Much valuable material was also obtained from Cyrus C. Babb's report on the "Bibliography of Maine Geology," Reprint from the third annual report of the Maine State Water Storage Commission; "The Bibliography of American Natural History" by Max Meisel and the "Sixth Biennial Report of the State Survey Commission, 1909-1910."

The author wishes to thank Dr. Edward H. Perkins, Professor of Geology at Colby College for his valuable assistance and contributions to this bibliography.

It is hoped, from the large number of requests that are received by the State Geologist, that this Bibliography will, in some measure, be of service and assistance to those interested in the various publications on the Geology of Maine.
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<td>abst.</td>
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<td>Acad.</td>
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<td>adv.</td>
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<td>Agric.</td>
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<td>chem.</td>
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<td>G. S.</td>
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<td>ill.</td>
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<td>Wash.</td>
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<td>W. S. P.</td>
<td>Water Supply Paper</td>
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<td>Zeit.</td>
<td>Zeitschrift</td>
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<td>Zool.</td>
<td>zoology, etc.</td>
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Geological Publications


AGRIC. of N. Y.: Agriculture of New York.

AM. ACAD. ARTS. SC.: American Academy of Arts and Sciences, Memoirs, Proceedings; Boston, Mass.


AM. GEOL.: American Geologist, Minneapolis, Minn.


AM. JOUR. SC.: American Journal of Science, New Haven, Conn.

AM. MIN. CONG.: American Mining Congress. See also International Mining Congress. Report of Proceedings, Denver, Colo.

AM. MINER: American Miner.

AM. MINER.: American Mineralogist, Philadelphia and Lancaster, Pa., now Menasha, Wis.


AM. QUART. JOUR. AGRIC. SC.: American Quarterly Journal of Agriculture and Science, (later the American Journal of Agriculture and Science), Albany, N. Y.


APPALACHIA: Published by the Appalachian Mountain Club, Boston, Mass.

ASSOC. AM. GEOL.: Association of American Geologists and Naturalists, Reports.

ATLANTIC MONTHLY, Boston, Mass.

BOSTON ADVERTISER, Boston, Mass.; now non-existent.

BOSTON DAILY MAIL, Boston, Mass.

BOSTON HERALD, Boston, Mass.


BOSTON SOC. ARTS.: Boston Society of Arts, Proceedings.


BOWDOIN SC. REV.: Bowdoin Scientific Review, Brunswick, Maine.

BRITISH ASSOC. RPT.: British Association for the Advancement of Science, Reports, London.


CAN. INST. and CAN. JOUR.: Canadian Institute and Canadian Journal, Toronto.

CAN. NAT.: Canadian Naturalist and Geologist and Proceedings of the Natural History Society of Montreal.

CAN. REC. SC.: Canadian Record of Science, Montreal.

CAN. ROYAL SOC.: Canada, Royal Society; Transactions, Montreal.

CHEM. GEOL. ESSAYS: Chemical and Geological Essays, Boston, Mass.


COLBY COLL. BUL.: Colby College Bulletin, Waterville, Maine.

EASTPORT SENTINEL, Eastport, Maine.


ENG. MIN. JOUR.: Engineering and Mining Journal, New York, N. Y.

ESSEX INST.: Essex Institute, Bulletins, Proceedings, Salem, Mass.

GEOGRAPHICAL REVIEW, Published by the American Geographical Society of New York, 1901-1932.


GEOL. NAT. HIST. CAN.: Geology and Natural History of Canada, Annual Reports.


GEOL. SURV. MINN.: Geological Survey of Minnesota, Minneapolis, Minn.


GROTH'S ZEIT. f. KRYS T U. MIN.: Groth's Zeitschrift für Krystallographie and Mineralogie, Leipzig, Germany.


HOME and FARM, Louisville, Ky.

INDUSTRIAL JOURNAL, Bangor, Maine.

JAHRBUCH MINER.: Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde (Leonhard und Brom) Heidelberg.

JEWELER'S CIRCULAR, New York.

JOHN HOPKINS UNIV. CIRC.: John Hopkins University Circular, Baltimore, Md.

JOUR. ANAL. APP. CHEM.: Journal of Analytical and Applied Chemistry.

JOUR. FRANKLIN INST.: Journal Franklin Institute, Philadelphia.

JOUR. GEOL.: Journal of Geology, Chicago, Ill.


JOUR. PHYS.: Journal de physique, de chimie, d'histoire naturelle et des arts, Paris.


MACFARLANE'S AMERICAN GEOLOGY RAILWAY GUIDE.

ME. BOARD AGRIC.: Maine Board of Agriculture, annual report, Augusta, Maine.

ME. HIST. SOC.: Maine Historical Society, Collections, Portland, Maine.


ME. ST. COLL. LAB.: Maine State College Laboratory, Bulletins, now University of Maine State Highway Laboratory, Orono, Maine.


ME. ST. WATER STORAGE COMM.: Maine State Water Storage Commission, annual report, Augusta.

MINN. GEOL. NAT. HIST. SURV.: Minnesota Geological and Natural History Survey, Minneapolis, Minnesota.

MIN. WORLD.: Mining World, Chicago, Illinois.
Geological Publications

MOUNTAIN MAGAZINE: Published by the Associated Outdoor Clubs of America, 1922-1932.
NAT. ACAD. SC.: Natural Academy of Sciences, Proceedings, Memoirs, Washington, D. C.
NAT. HIST. GEOL. ME.: Natural History and Geology of Maine. Reports of Commissioner of Agriculture, Augusta, Maine.
NAUTILUS, Philadelphia, Pennsylvanias.
NEUES JAHRBUCH für MINERALOGIE, GEOLOGIC, und PALÄONTOLOGIE; Beilage Band. Stuttgart.
NORTHERN, The Northern, published by the Great Northern Paper Co., 1922—
PAN.-AM. GEOL.: Pan-American Geologist, Des Moines, Iowa.
PETERMANN'S MITT: Petermann's Mitteilungen; Ergänzungsheft, Gotha.
POP. SC. MONTHLY: Popular Science Monthly, New York, N. Y.
PORTLAND ADVERTISER, non-existent, Portland, Maine.
PORTLAND DAILY PRESS, PORTLAND, Maine, now Press Herald, Portland, Maine.
PORTLAND SUNDAY TIMES, non-existent, Portland, Maine.
PORTLAND TRANSCRIPT, non-existent, Portland, Me.
RHODORA, Boston, Mass.
ROCHESTER ACAD. SC.: Rochester Academy of Science, Proceedings, Rochester, N. Y.
ROCK PRODUCTS, now American Stone Trade, Chicago, Ill.
SC. AM.: Scientific American, New York, N. Y.
SCIENCE GOSSIP.
SEISMO. SOC. AM.: Seismographical Society of America, Bulletin, Stanford University, Cal.
SMITHSONIAN INST. REPT.: Smithsonian Contributions and Report, Washington, D. C.
SOC. MEX. GEOG. ESTADISTICA.: Sociedad mexicana de geografia y estadistica Boletin Mexico, D. F.
TORREYA, Lancaster, Pa.
U. S. COAST and GEOD. SURV.: U. S. Coast and Geodetic Survey, Reports, Washington, D. C.
U. S. DEPT. AGRIC.: United States, Department of Agriculture, Bulletins.
State Geologist's Report on the Geology of Maine


UNIV. of PENNA. LAB.: University of Pennsylvania. Contributions to Laboratory, Phila.


WHEELERS HISTORY OF BRUNSWICK and TOPSHAM, Boston, Mass.


ZIONS ADVOCATE, Portland, Maine.
Adams, Charles Baker, 1814-1853

Agassiz, Louis, 1807-1873
3. Glacial phenomena in Maine. Geol. Sketches, Boston, 52 pp., 1876. Relating especially to the central and eastern part of the State.

Allen, Oscar D.

Anonymous

Antevs, Ernest

Avery, Myron H.
1. (with Smith, Edward S. C.) A bibliography for Mount Katahdin, Revised. Appalachia 1, 6, 1924.
3. The Appalachian Trail. Mountain Magazine 8: 2-6, 1930.

Babb, Cyrus Cates

Bailey, E. M.
Bailey, Jacob Whiteman, 1811-1857

Bailey, Loring Woart

Baker, W. W.

Balch, D. M.

Baldwin, T. W.
1. Plan of a Part of the Town of Blue Hill, Maine. Showing the Location of Mining Properties.

Barker, Noah
1. Report of Commissioner on the Variations of Magnetic Needle. (Pub. by the State of Maine. No place or date.)

Barr, George
Bibliography of Maine Geology

Barrande, J.

Barrell, T.

Barrows, H. K.

Bartlett, Frank L.
3. State of Maine Mining Notes. Portland Transcript, Nov. 16, 1878. Descriptive of mines and the mineral belts, silver, lead, copper, etc., at Sullivan, Gouldsboro, Blue Hill, Eggamoggin, etc.
4. Mines of Maine. Portland, Me. 66 pp., 1879. Describes ore veins, mines and mining companies, contains but little scientific interest.

Bascom, Florence

Bastin, Edson Sunderland


Bather, William T.


Bayley, William Shirley


Beckett, Sylvester B.

1. Land Disruption at Stroudwater, Me. Boston Daily Mail, June 11, 1849.

Beecher, Charles E.


Belknap, Jeremy
1. An Account of a Fossil Substance Found at Lebanon in the County of York, etc. Mem. Am. Acad. Arts and Sc. 1: 377, 1785. The heading of this letter indicates Lebanon, N. H., but the author's mention of the county points to the Maine town. (This title is included with reservations).

Bement, Clarence S.

Benorsth (or Berwerth)
1. Analysis of Lepidolite from Paris, Me. Groth's Zeit. f Kryst. u. Min. 2, 523. year —.

Benton, Edward R.

Berman, Harry

Berry, Edward Wilber

Bickford, Rass L.
1. The Precious and Semi-precious Gems of Maine.

Bigelow, Henry B.

Billings, Elkanah, 1820-1876

Billings, Marland

Bishop, Sherman Chauncey
1. (and Clarke, Noah T.) A Scientific Survey of Turners Lake, Isle-au-Haut, Maine. ... 1922; with Special Examinations and Notes by John M. Clark and Others. 29 pp., 22 pls., New York State Museum, Albany, N. Y., August, 1923, published privately. Also issued with New York State Museum Bulletin No. 251, 1924.

Blake, John M.
Blake, William P.

Blaney, Dwight

Boardman, Samuel L.
1. Agricultural Survey of Somerset County, Me. Augusta: 71 pp., 1860, treating of the geology and products of the country.
2. A General View of the Agriculture and Industry of the County of Kennebec, Me. with Notes upon its History and Natural History. Augusta: 83 pp., 1865, Chap. 4, treats of its geology and mineralogy.

Bourne, Edward E.

Bouve', Thomas Tracy

Boyd, Charles H.

Brackett, C. F.

Bradbury, Charles
1. History of Kennebunkport, Me. Kennebunk, 1837. At page 219 is a short account of the granite quarries of the town with Prof. Cleaveland's opinion as to the fine quality of the stone, etc.

Bradbury, C. M.
Bradley, Frank H.

Brady, George Stewardson

Breger, Carpel Leventhal

Brewer, William H.

Brigham, William T.

Brown, Charles W.

Brush, George F.
1. (with Dana, J. D.) A System of Mineralogy, N. Y. A complete list of Maine minerals and their localities.

Brush, George Jarvis, 1831-1912

Burr, Freeman F.

Burr, Henry T.

Carmichael, Henry
Chadbourne, Paul A.

Chamberlain, T. C.
3. The Rock Scorings of the Ice Invasions. U. S. Geol. Surv. 7th Rpt.: 155-248, 1888. The map accompanying this very valuable paper indicates the glacial striatio in Maine, 200 instances of which have been recorded: 157. An alphabetical list of observers is also appended.

Chandler, C. F.
1. Report on the Deposits of Arrowsic Emery in Arrowsic, Me. N.Y.: 18, 1866. Its mineralogical character with map of the locality, geological features, etc.

Chapman, Henry C.

Chatard, T. M.

Chickering, John W., Jr.
1. Contrasts of the Appalachian Mountains. Saturday Lectures No. 3. At Nat. Mus. Wash.: 16, 1882. Refers briefly to outlying groups of this system in Maine.

Chute, A. P.

Clapp, Frederick Gardner
Clark, Thomas H.

Clarke, Frank Wigglesworth

Clarke, John Mason


Clarke, Noah T.

Cleveland, Parker, 1780-1858
2. Treatise on Mineralogy and Geology, Boston, 1816, 668 pp., pl. and map. Contains very numerous references to Maine Minerals and rocks with localities. It is curious to observe that tourmaline was then unknown in Maine.
3. Treatise on Mineralogy and Geology, Boston, 1822. Localities and descriptions of many Maine minerals and rocks.

Cogswell, Rev. J.

Colby, S. F. & Co., Publishers
1. Map of the Hancock Co. Section of the Mining District of Eastern Maine, Ellsworth, Me.

Cooke, Josiah Parsons, 1827-1894

Crosby, Irving Ballard

Crosby, William Otis, 1850-1925
Bibliography of Maine Geology


Cross, W. W.


Crosskey, Henry W.


Curtis, George Carroll


Dachnowski-Stokes, A. P.


Dale, Thomas Nelson


Dall, William H.


Daly, Reginald Aldworth.


Dana, Edward Salisbury


Dana, James Dwight, 1813-1895


Darton, Nelson Horatio


Davis, A. W., Jr.


Davis, Charles Albert, 1861-1916.


Davis, Leonard H.
1. A Submerged Forest at Kennebunk Beach, Me.
2. The Surface Geology About Kennebunk, Me.

Davis, William Morris

Dawson, John William, 1820-1899.

Day, David T.

DeGeer, Baron Gerard

DeLaski, John K.
Bibliography of Maine Geology


Derby, Orville A.

Desor, Edouard, 1811-1882

Dewey, Frederic P.

Dickerman, Q. E.

Dickerson, M. W.
1. Geological Survey, etc., of the Highland’s Cooper Mining Co. of Penobscot, Me., 1880.

Diller, Joseph Silas

Dodge, J. R.

Dodge, W. W.

Dole, R. B.

Drake, E. E.
1. Tourmalines in Mica.

Eaton, Amos
1. An Index to the Geology of the Northern States. Leicester, 1818, 1820.

Eaton, Cyrus
1. History of Thomaston and Rockland, Me. Hallowell, 1865. The first two pages make brief mention of the geological features of the towns.
2. Annals of the Town of Warren, Me. Hallowell, 1851, 2d ed. 1877. There are brief descriptions of the geology and topography of the town.

Eckel, Edwin Clarence

Elwell, Edward H.
1. Landslide near Stroudwater in Westbrook, Me. Portland Transcript, June 16, 1849.
3. Aroostook, Me. With some account of excursions thither, etc. Portland: 50, 1878. With a note on the geological features of the county; contributed by Dr. Wm. B. Lapham.

Emmons, Ebenezer, 1799-1863
7. American Geology, Containing a Statement of the Principles of the Science, with
Full Illustrations of the Characteristics of American Fossils; three

Emmons, William Harvey
1. Some Regionally Metamorphosed Ore Deposits and the So-called Segregated
432: 3 pls., 23 figs., 62 pp., map, 1910. Bibl., 8-10, 20 entries. 1837-
1909. Regional.

Fairbanks, Ernest E.

Fairchild, Herman L.
1918.
597-636, 3 figs., December 31, 1919; Abst. No. 1: 89-90, March 31, 1919.

Fernald, Merritt Lyndon
1. The Soil Preferences of Certain Alpine and Subalpine Plants. Rhodora, 9:
149-193, Sept. 1907.
Acad. Arts Sc. 15: 239-342, 1925.

Fernald, N. C.
Sc. 3d ser. 9: 238, 1875.

Feuchtwanger, F.
1. Remarks on a Collection of Tourmalines of Various Colors (red, yellow, etc.)
as Occurring near Bangor, Me. Proc. N. Y. Soc. Nat. Hist. ser. 1:
174, 1871.

Foote, Harry Ward
1. On the Occurrence of Pollucite, Mangano-Columbite and Microlite at Rumford,
Min. 27: 60-64, 1896.
Sc. 4th ser. 7: 97-125, 1889; Yale Bicen Pub., Contr. Miner: 297-324,
1901.

Ford, William Ebenezer
Sc. 4th ser. 44: 245-246, 1917.

Fraser, H. J.
1. Paragenesis of the Newry Pegmatite, Me. Am. Miner. 15 No. 8: 349-364,
Aug. 1930.

Frazer, Persifor, Jr., 1844-1909
Freeman, Charles

Fuller, Charles B.

Fuller, Myron Leslie

Gannett, Henry

Gardiner, Rev. Frederic

Gedney, E. K.

Genth, Frederick Augustus, 1820-1893

Gillson, Joseph L.

Goldthwait, James Walter
Gonyer, F. A.

Goodale, George L.

Gould, Albert

Gratacap, L. P.

Greenleaf, Moses
1. A Survey of the State of Maine in Reference to Its Geological Features. Statistics, etc. Portland, 1829: 37-85, relates to topographical and physical features: 114-119 give localities of many minerals and rocks. This author’s “View of Maine” 1816 makes no mention of its mineralogy or geology.

Gregory, Herbert Ernest

Haidinger, W.

Hall, F.

Hall, James
Hamlin, Augustus Choate, M. D.
2. Leisure Hours Among the Gems, 429 pp., Boston, 1884. It contains many numerous reference to Maine gem minerals.

Hamlin, Charles Edward

Hamlin, Elijah Livermore

Harper, D. N.

Harris, G. D.

Harvey, Francis L.

Harvey, LeRoy Harris

Haven, Herbert M. W.

Hayes, C. W.

Haynes, Henry W.

Haywood, John
Bibliography of Maine Geology

Heck, N. H.
1. Earthquake History of United States. Dept. of Commerce, special publication, 149, 1928.

Hendrickson, B. H.

Hess, Eva
1. (with Hess, F. L.) Bibliography of the Geology and Mineralogy of Tin. Me.—Smithsonian, Miscellaneous, coll. 58, No. 2 year —.

Hess, Frank L.
2. (and Hess, Eva) Bibliography of the Geology and Mineralogy of Tin, Me.—Smithsonian, Miscellaneous, coll. 58, No. 2 year —.

Hidden, William Earl, 1853-1918

Hill,—

Hillebrand, W. F.

Hills, B. W.

Hills, Rev. Luther

Hind, Henry Youle

Hitchcock, Charles Henry, 1836-1919


8. First Annual Report on the Geology and Mineralogy of New Hampshire. Manchester, 1869. 36 pp. On pp. 6-7 remarks that the auriferous shales and schists of the ammonoosic gold field possibly extend into Maine. In his geology of Maine he describes this supposed continuation as possibly auriferous.


Hitchcock, Edward, 1793-1864

Hitchings, S. K.
1. Handbook of Mineralogy. Biddeford, Me. 1855. 60 pp. (State Assayer of Maine.)

Hobbs, William H.

Hodge, James Thacher, 1816-1871

Holden, Edward Fuller, 1901-1925
Holmes, Ezekiel, 1801-1865

Houghton, John C.

Hovey, Horace Carter, 1833-1914

Howard, W. V.

Hubbard, O. P.

Hunt, Thomas Sterry, 1826-1892


Huntington, Joshua Henry, 1833-1904

Huntington, Oliver Whipple

Hurst, Lewis A.

Hutchins, C. C.

Iddings, Joseph P.

Jackson, Charles Thomas, 1805-1880
1. List of Mines and Minerals Belonging to the Maine Mining Co., 16 pp. Boston, 1837. This is more than a mere list, giving localities and interesting descriptions.
Bibliography of Maine Geology

37. Relations on Syenite at Richmond, Elevation of Coast of Hatteras Region in Maine.  Am. Nat. 5: 161, 1872.

Jackson, Daniel D.

John, B.

Johnson, Douglas Wilson

Johnson, J.

Johnson, S. N.

Johnson, S. W.
Johnston, John
1. History of the Town of Bristol and Bremen, Me. Albany, N. Y.: 4-8, 1873. Describes the geology of the towns, some of the facts derived from Jackson.

Josselyn, John
1. "New England's Rarities Disovered." London, 1672. (Reprint Boston 1865, Wm. Veazie). Mentions "Crystal" (quartz), "Muscovy glass" (Mica) Bog iron and many other minerals whose identity with existing Maine minerals can be more or less accurately determined.

Julien, Alexis A.

Jurgenson, C. M.

Katz, Frank James

Keeley, Frank J.

Keith, Arthur

Kemp, James Furman

Kempton, C. W.

Kennison, H. B.

Kimball, James P.

King, F. P.

Kitton, F.

Knobel, E. W.

Koenig, George A.

Kunz, George Frederick
37. Meteoric Stone from Andover, Me. Science n. s. 8: 840, 1898.

Lamb, Thomas F.
1. Maine Minerals, year —.

Lancaster, Albert

Landes, Kenneth K.

Lang, J. W.

Lapham, William B.
1. History of Woodstock, Me. Portland, 1882. pp. 7-8 gives brief account of the rock formations and a list of minerals contributed by N. A. Perry.
2. (and Maxim, S. P.) History of Paris, Me. 1884: 82-86 relate to the geology and mineralogy of the town.
3. History of Rumford, Me. Augusta, 1890. pp. 1-3 contains brief mention of the geology and principal minerals, apparently from Jackson's report.
4. History of Bethel, Me. Augusta, 1891. pp. 29-36 are devoted to the geology, topography and other natural features of the town.

Lawrence Portland Cement Co., Thomaston, Me.

Lee, Charles A.

Lee, Leslie Allen

Lee, Ora, Jr.

Leidy, Joseph, 1823-1891
Leighton, Henry

Leighton, Marshall Ora

Leith, C. K.

Leonard, Edward H.

Levesque, Raoul F.

Levy, E. C.

Lewis, Henry Carvill

Lewis, James F.

Lincoln, Theodore

Lindenkohl, A.

Lindgren, Waldemar

Lines, Edwin F.

Little, Rev. Daniel
Little, Homer Payson

Lobeck, A. K.

Logan, William E.

Longfellow, A. W.

Loomis, Frederic Brewster

Lord, Edwin Chesley Estes

Loring, Amasa

McGee, W. J.

McInnes, W.

MacKenzie, J. D.
Macfarlane, James

Mackintosh, James B.
1. Description and Analysis of Herderite from Oxford County, (Stoneham, Me.) Am. Jour. Sc. 3d ser. 27: 73 and 135, 1884.

Maclure, William

Maine (State) College
1. The Bulletin and Reports of the President and Trustees Containing Catalogues of the Maine Rocks and Minerals in the Cabinets, generally giving localities.

Maine (State) Geological Survey

Maine Geological Survey -- History*
"By act of the state legislature dated March 28, 1836, a geologic survey of the State of Maine was authorized. Charles T. Jackson was appointed state geologist. The investigation was continued during the following three years. The published results, considering the difficulties of transportation at that time and the non-existence of accurate maps are interesting. They include three annual reports entitled 'Geology of the State of Maine' and dated 1837, 1838 and 1839; a Report entitled 'Report of an exploration and survey of the territory of the Aroostook River'; and a Report entitled: 'Second Annual Report of the geology of the public lands belonging to the two states of Maine and Massachusetts. The state appropriated $5,000 for the survey.'

"By act of March 16, 1861, a detailed survey of Maine was authorized, and a report of the natural history and geology of the state was made by C. H. Hitchcock, geologist, and Ezekiel Holmes, naturalist..." Extracts from Hayes, p. 63. (See Annot. Bib).

* From "A Bibliography of American Natural History," by Max Meisel, B.S., B.L.S-
Jackson's assistants were James T. Hodge for Massachusetts, and Dr. T. Purrington for Maine.

The assistants for the 1861 survey were G. L. Goodale, botanist and chemist; John C. Houghton, mineralogist; A. S. Packard, Jr., entomologist, and C. B. Fuller, marine zoologist. G. L. Vose, N. T. True, John DeLaski, Oliver White, L. W. Bailey assisted in minor capacities. See also Merrill, (1), p. 290, 346-47, 511-12, (see Annot. Bib.) for critical discussion. For documents in state collection, see Hasse, (2), 1907, p. 73. See also Merrill. First 100 years. Amer. Geol. 1924. p. 189-91, 404-5.

Reports were also made by S. L. Stephenson to Jackson in 1839; and by P. A. Chadbourne, N. S. Manross, J. G. Rich, B. F. Fogg, A. E. Verrill, J. W. Dawson, and Forrest Shepherd, to Messrs. Holmes and Hitchcock, 1862-63.

According to Merrill (see Bibliography: 1920, below), the cost of the Maine surveys totalled $18,000.

Maine Geological Survey -- Bibliography

1. Maine


5. Maine. Board of Agriculture.


8. Maine


* From "A Bibliography of American Natural History" by Max Meisel, B.S., B.L.S.


14. Babb, Cyrus Cates

15. Merrill, George Perkins

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Jackson, Charles Thomas


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p. 13- 86 Topographical geology.
p. 87-116 Economical geology.
p. 117- 19 Specimens in the state cabinet.
p. 121- 27 Explanation of geological terms.


Contents:
p. 49-73 Hodge, J. T. On the Allagash section, from the Penobscot and the St. Lawrence.
appx. 37 p. Meteorology.


* From "A Bibliography of American Natural History" by Max Meisel, B.S., B.L.S.
Bibliography of Maine Geology


Contents:
p. 123-87 Agricultural geology.
p. 207-76 Meteorology.
appx. 64 p. Catalogue of geological specimens collected in the years 1836, 1837 and 1838, by C. T. Jackson, in the state cabinet. 1566 specimens enumerated.

Holmes, Ezekiel


Contents:
Pt. 1 p. 97-328:
General Reports upon the Natural History and Geology of Maine.
Pt. 2 p. 329-464:
Physical Geography, Agricultural Capabilities, Geology, Botany and Zoology, of the wild lands in the northern part of the state.
Holmes, Ezekiel. Notes and sketches of the wild lands explored: 331-60.
p. 352-59, White, Oliver. Allegash and Cauquomgomoc Lakes.
Goodale, G. L. Notes, botanical, on the new lands: 361-72.
Packard, A. S., Jr. Observations upon the physical and geological character of the country about the fish river lakes and the Aroostook.

Contents:
Pt. 1 p. 9-219:
Reports upon the Zoology and Botany of the State of Maine.
Holmes, Ezekiel. On the fishes of Me. including some elementary principles of ichthyology; pt. 1: 11-46.
Descriptive ichthyology: 47-117.

Pt. 2 p. 221-130:
A. p. 227-97. Geology of the more southern and settled portions of the state.
C. Geology of the more southern and unsettled portions of the state, p. 323-77.
D. Surface geology. p. 377-401.
F. Mineralogical notices: 406-12.
G. Economical geology: 413-30.
Notes by Forrest Sheppard, G. L. Goodale and Holmes. Index: 431-47.

Merrill, Lucius H. and Perkins, Edward H.


Contents:
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Maine Granites: 4-17.
A Diatomaceous earth deposit: 24.
Coal, petroleum and natural gas in Maine: 25.
Minerals of Maine; alphabetically listed by minerals and by towns: 25-32.
Smith, E. S. C. A new rhyolite from the State of Maine: 72-74.

Maine (State of) Publications on Geology:

Jackson, C. T. (See Me. Geol. Surv.)
1. First Report on the Geology of the State of Maine 1837
2. First Annual Report on the Geology of the Public Lands of Maine and Massachusetts. 1837
4. Second Annual Report on the Geology of the Public Lands of Maine and Massachusetts. 1838
5. Second Report on the Geology of the State of Maine 1838
6. Third Annual Report on the Geology of the State of Maine 1839
7. Catalog of Geological Specimens 1839

Holmes, E. (See Me. Geol. Surv.)
8. Exploration and Survey of Territory on the Aroostook River 1839

Maine Board of Agriculture (See Me. Geol. Surv.)
10. Second Annual Report upon the Natural History and Geology of the State of Maine. (Maine Board of Agriculture, 7th Annual Report). 1862

Wells, W.
11. Water Powers of Maine 1869

Lang, J. W.
12. Survey of Waldo County 1873

Wasson, S.
13. Survey of Hancock County 1878

Merrill, G. P.
14. Microscopic Examination of Building Stones of Maine (In University of Maine, Annual Report, 1882) 1882
15. Rock Formations of Auburn (In University of Maine, Annual Report, 1884) 1884

Harvey, F. L.
16. Catalog of Minerals and Rocks in the Museum (In Maine State College Laboratory of Natural History, Bulletin, Vol. 1, No. 1), now non-existant 1888

Smith, G. O.

Katz, F. J.
Babbs, C. C.

Burr, F. F.

Merrill, L. H.

Maine (State) Survey Commission

Maine (State) Water Storage Commission

Manchester, James G.

Manning, Prentice C.

Mansfield, F. A.

Marble, Charles F.

Marcou, Jules


Marmer, H. A.

Marsh, Othniel C.
1. List of Geological Surveys of All the States (including Maine) and the Territories, to 1867; and of Canada, British Columbia, the Arctic Regions, etc. Am. Jour. Sc. 2d ser. 43: 116, 309, 1867.


Marshall, R. B.


Martin, Daniel Strobel

Mason, William P.

Mather, William W.

Mathews, Samuel W.

Matthew, George Frederick


Maxim, S. P.
1. (with Lapham, W. B.) History of Paris, Me. 1884: 82-86, relate to the geology and mineralogy of the town.

Meade, William

Melville, W. H.

Merrill, George Perkins
12. Olivine Diabase from Addison Point, Me. Tenth Census Rpt. 10-24, year. —
14. The First 100 Years of American Geology. Yale University Press, 1924.
15. The Present Condition of the Knowledge of the Composition of Meteorites (listing four places where meteorites have fallen in Me.) Proc. Am. Philos. Soc. 45: 119-130, 1926.


Merrill, Georgia Drew

Merrill, Lucius Herbert

Meserve, Philip W.

Metcalf, Samuel L.

Mighels, Dr. Jesse W.

Miller, Clayton T.

Miller, S. A.

Minor, J. C., Jr.

Mitchell, Henry

Morgan, Henry J.
Morse, Edward Sylvester

Morton, Frank S.

Moulton, W. B.

Mower, Charles M.

Mt. Mica Tin and Mining Co.
1. A Prospectus. Bangor, Me. 4 pp., 1882.

Nevel, W. D.

Newberry, John S.

Norcross, G. A.
1. Gold in Oxford County, Maine. Industrial Jour. No. 522, Dec. 27, 1889. His opinion as a practical miner as to the gold at Swift River.

Noyes, H. Wallace

Nylander, Olof O.
1. Shells of the Marl Deposits of Aroostook County, Me. as Compared with the Living Forms in the Same Locality. Nautilus 14: 101-104, 1901.

Ogilvie, Ida Helen

Osborn, H. S.
Packard, Alpheus Spring, Jr., 1831-1905


5. Evidence of Ancient Local Glaciers in the White Mountain Valleys. Am. Jour. Sc. 2d ser. 43: 42, 1867. Their courses traced in Maine at Stowe, Gilead, etc.


Palache, Charles


2. The Chrysoberyl Pegmatite of Hartford, Me. Am. Miner. 9, No. 11: 217-221, 1 fig., Nov. 1924.


Peale, Albert C.


Penfield, Samuel Lewis, 1856-1906.


Penhallow, David Pearce, 1854-1910


3. A Blazing Beach (Kittery Point, Me.) Science n. s. 22, 794-796, 1905.


Perham, Stanley L.


Perkins, Edward H.


4. (and Smith, S. C.) Contributions to the Geology of Maine, No. 1; A Geological Section from the Kennebec River to Penobscot Bay: Am. Jour. Sc., 5th ser. 9: 204-228, 7 figs. (incl. maps), March, 1925.


Perry, John B.


Perry, N. H.


Pirsson, Louis Valentine, 1860-1919


Pratt, Joseph Hyde


Pressey, Henry Albert


Price, Eli K.

Prime, Frederick, Jr.

Prosser, Charles S.

Prout, H. S.
1. Description of a New Graptolithus Hallianus in the Lower Silurian Rocks near the Falls of the St. Croix River. Am. Jour. Sc. 2d ser. 11: 187. (It is questioned whether this is a Maine reference.)

Putnam, Allen, Chairman

Rammelsberg, C. F.

Rand, Edward L.

Raymond, Percy Edward

Redfield, John H.

Reid, Harry Fielding

Remmers, Otto
1. Untersuchungen der Fjorde an der Kuste von Maine ... Inaug. Diss. Leipzig. 64 pp., Leipzig, 1891.

Renner, George T., Jr.
Ricker, Hiram and Sons
1. Poland Spring, Me. South Poland, 83 pp., 1893. An illustrated pamphlet advertising their famous spring and hotels, but containing analyses and details of some value as to the composition and character of the water.

Ries, Heinrich

Riggs, R. B.

Risz, Erwin J.

Robinson, Franklin C.

Robinson, Dr. Samuel

Rogers, Henry Darwin

Rogers, William Barton, 1804-1882
State Geologist's Report on the Geology of Maine


Rolker, Charles M.

Rowe, R. W.

Ruedemann, Rudolph

Sayles, Robert Wilcox

Schaller, Waldemar Theodore

Schauzer, R.

Schneider, E. A.

Schuchert, Charles

Sewall, Joseph
1. Mention of Circular Depressions in Ledge at Georgetown, Me. 60 feet above tide-water which he supposes to be made by the Indians. Coll. Me. Hist. Soc. 2: 191, 1847. Probably glacial pot-holes.
Bibliography of Maine Geology

Sewall, Oliver

Sewall, Rufus K.

Shaler, Nathaniel Southgate, 1841-1906
Shannon, Earl Victor

Shepard, Charles Upham, 1804-1886

Shepard, F. P.

Sherman, Paul

Sibley, John Langdon
1. History of the Town of Union, Me. Boston: 97, 1851. Brief mention of its limestones, iron, ores, etc.

Silliman, Benjamin

Skinner, W. W.

Smith, Edward S. C.
2. (with Avery, M. H.) A Bibliography for Mt. Ktaadn, revised. Appalachia, 16, 1924.


Smith, Everett C.


Smith, George Otis

1. The Volcanic Series of the Fox Islands, Me. John Hopkins Univ. Circ. 15: 12-13, 1895.


Smith, John Lawrence, 1818-1883

Smock, John C.

Sperry, E. S.

Stephenson, Samuel L.

Sterrett, Douglas B.

Stevens, R. P.

Stevenson, H. K.
1. Effects of Post Pleistocene Marine Submergence in Eastern North America (Glacial Geology) Rhodora 29: 41-48; 57-72; 87-93; 105-114, 1927.

Stiles, C. W., Jr.
Bibliography of Maine Geology

Stone, George Hapgood, 1841-1917

Stover, Horatio R.

Sweet, Philip W. K.

Tarr, Ralph Stockman, 1864-1912
Taylor, J. E.

Taylor, Richard C.

Thoreau, Henry D.

Tower, George Warren, Jr.

Tower, Walter S.

True, Nathaniel T.

Tyrrell, T. B.

Ulrich, Edward Oscar

U. S. Geological Survey*

Triangulation and Leveling

Results of Primary Triangulation, 1894, Bull. 122, Maine: 5-12.
Results of Primary Triangulation, 1895, Bull. 123, Maine: 15-16.
Results of Primary Triangulation, 1900-01, Bull. 181: 18-22.
Results of Primary Triangulation, 1902-03, Bull. 216: 16-24.
Results of Primary Triangulation, 1904-05, Bull. 276: 50-53.
Results of Primary Triangulation, 1906-07, 08, Bull. 440: 311-318. See No. 1, Marshall, R. B.
Results of Primary Triangulation, 1909-10, Bull. 496; 153-158. See No. 2, Marshall, R. B.

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Surface Water Supply of North Atlantic Coast, 1907-1908, W. S. P. 241.
Surface Water Supply of the North Atlantic Coast, 1909, W. S. P. 261.
Surface Water Supply of North Atlantic Coast, 1911. W. S. P. 301.
**Water Resources**


Contributions to the Hydrology of Eastern United States by M. L. Fuller, W. S. P. 102.


Index to Papers on Underground Waters. W. S. P. 120.


**Geology**


The Glacial Gravels of Maine and their Associated Deposits by G. H. Stone, Monograph 34.


Index to the Stratigraphy of North America Text P. P. 71.


Slate Deposits and Slate Industry of the United States by T. N. Dale, Bull. 275.


Lime and Magnesia in Maine, Bull. 285 j.

Clays of the Penobscot Bay Region, by E. S. Bastin, Bull. 285 l.

Slates in Maine, Bull. 285 m.

Graphite in Maine, Bull. 285 o.


Building Stone and Road Material in New England, Bull. 315 j.

Quartz and Feldspar in Maine and New York, Bull. 315 l.


Maine, Molybdenum, Bull. 340 d.
Bibliography of Maine Geology

Geologic Folio, Eastport District, Geol. Folio 192.
Geologic Folio, Penobscot District, Geol. Folio 149.
Geologic Folio, Rockland District, Geol. Folio 158.
Mineral Resources, Yearly Statistics, Min. Resources.
Peat Deposits of Maine, by E. S. Bastin and C. A. Davis, Bull. 376.
Feldspar Deposits of the United States (Maine) by E. S. Bastin, Bull. 420.

Miscellaneous

Boundaries of the United States and of the Several States and Territories, etc., by Henry Gannett, Bull. 226.
Public Utility of Water Powers and Their Governmental Regulation, by René Tavernier and M. O. Leighton, W. S. P. 238.

Upham, Warren

Van Hise, Charles R.

Verrill, Addison E.

Villarello, Juan de D.

Vose, George L.

Wade, William Rogers

Wadsworth, Marshman Edward, 1847-1921

Walcott, Charles D.

Wandke, Alfred

Ward, Henry Augustus, 1834-1906.

Warren, Charles Hyde

Washington, Henry S.

Wassan, Samuel
1. A Survey of Hancock County, Me. Augusta, 1878, 91 pp. Pages 33-36 are devoted to the geology and to the minerals and ores of the County.

Watts, A. S.

Webster, J. H.

Webster, Dr. John W.

Weed, Walter Harvey

Wells, Horace Lemuel
Wells, Walter
1. The Water Powers of Maine. Augusta, 1868, 327 pp. Important tables of
elevations, discussion of the natural surface features as related to water
power, p. 29. "The development of water power in Maine results from
its geological structure," etc.
2. The Water Power of Maine. Augusta, 1869, 528 pp. map and 20 pls. of principal
waterfalls of the State. Minute description of the river systems
with geological and mineralogical details of their vicinity. The first
6 chapters occupied with geological and topographical matter.

Westover, H. L.
Field Operations of the Bureau of Soils, 34-70, 1908.

Wheeler, E. P., II
1. Olivine from Monhegan Island, Me.: Am. Mineralogist, 12, No. 6: 259-261,
June, 1927.

Whelden, Roy M.

Whipple, George C.
1. (and Levy, E. C.) The Kennebec Valley Typhoid-Fever Epidemic of 1902-
1903. (Maine) Jour. New England Water Works Assoc. 19: 163-214,
7 figs., U. S. Geol. Surv. W. S. P. No. 198: 108-211, year —.

White, Charles David
Geol. Surv. P. P. No. 35: 35-84, 5 pls., 1905.

White, O.
An. Rpt. of Me. Board of Agric.

Whitman, William E. S.
on mining and quarrying with descriptions and analyses, etc., pp. 346-
354 statistical.

Whitney, Joseph Dwight, 1819-1896
1. Chemische Untersuchung einiger Silicate, die Kohlensaure, Chlor, und Schwefel-
3d ser. 28: 313-314, 1884.

Whittlesey, Charles
1. On the Ice Movements of the Glacial Era in the Valley of the St. Lawrence.
2. On the Fresh Water Glacial Drift of the Northwestern States. Smithsonian
Contributions, 15, 38 pp., 2 pls., 11 cuts, 1867.
Wiesbach, A.

Williams, Albert, Jr.

Williams, George H.

Williams, Henry Shaler, 1847-1918


Williams, R. M.


Williamson, William D.

1. History of the State of Maine. Hallowell, 1832, 2 v., v. 1, pp. 174-182, giving account of the principal rocks and minerals then known in the State.

Willis, Bailey


Winchell, Alexander


Winchell, N. H.


Wolff, John Elliot


Wood, George McLane


Wood, William


Woodward, L. B.

Wright, George F.
3. The Ice Age in North America. New York, 1891. D. Appleton & Co. Contains numerous references to glacial action and evidences in Maine. Kames, absence of large drumlins, depth of drift, submergence, etc: 229, 309-311, etc.

Wyman, Jeffries

Yates, William S.
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Aroostook Co.: Holmes, E., 8.
Aroostook River region: Holmes, E., 2.
Bibliography: Avery, M. H.; 1, 2; Babb, C. C., 4; Smith, E. S. C., 2.
   Bibliography of North American Geology by Nickles: U. S. G. S. Bull. 823;
   Bibliography of American Natural History: Meisel, M.
   Maine State Water Storage Commission, 1;
   Geologic Literature of North America by Nickles: U. S. G. S. Bull. 746;
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Perry basin, southeastern Me.: Smith, G. O., 5; White, C. D., 1.
Pleistocene, Mount Desert Island: Blaney, D., 1.
Pleistocene plants, marine clays: Berry, E. W., 1; Blaney, D., 1.
Post-pliocene: Dawson, J. W., 1, Canada 8; Desor, E., 4; Marsh, O. C., 3.
Post-Tertiary: Brady, G. S., 1; Baker, W. W., 1; Marsh, O. C., 2.
Shells, Catalogue of fluvial and terrestrial: Mighels, Dr. J. W., 2.
Shells, fossil, nucula and bulla, Westbrook: Mighels, J. W., 1; Cleveland, P., 1;
marine, Desor, E., 2, 3; nucula portlandica: Hitchcock, E., 1; Jackson, C. T.,
17, 21, Muscle: Stover, H. R., 1.
Shells, fossil and living in Little Mud Lake- Nylander, O. O., 3.
Silurian: Beecher, C. E., 1; Billings, E., 1; Dodge, W. W., 1, 2, 3.
Silurian Mollusca, Washington Co.: Williams, H. S., 8, 9.
Silurian and Devonian: Billings, E., 1; Clarke, J. M., 3; Dana, J. D., 2; Plantae:
Dawson, J. W., 7.
Spirifer, Silurian, Washington Co.: Williams, H. S., 15.
Tertiary: Dall, W. H., 1; Marsh, O. C., 2.
Walrus: Boyd, C. H., 1; Fuller, C. B., 1.
Waterville fossils: Hubbard, O. P., 1.

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Andesites: Gregory, H. E., 1, 2.
Anorthite and epidote, Phippsburg: Clarke, F. W., 15.
Aroostook Co.: Gregory, H. E., 1, 2.
Auburn, rock formations: Merrill, G. P., 4.
Beryl: Hillebrand, W. F., 1.
Building stone, microscopic characters: Merrill, G. P., 1, 5.
Cape Neddiek gabbro, York County: Wandke, A., 3.
Dikes: Kemp, J. F., 1; Johns Bay: Bascom, F., 2; Portland: Lord, E. C., 1.
Eleolite syenite, Litchfield: Bayley, W. S., 2.
Fox Islands: Bascom, F., 1; Smith, G. O., 2, 3.
Igneous rock, Mt. Kineo: Smith, E. S. C., 5.
Litchfieldite: Daly, R. A., 1.
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Micas, optical characteristics: Lewis, H. C., 1; Biotite, Silliman, B., 3; Muscovite: Silliman, B., 3.
Monhegan Island: Lord, E. C. E., 2.
Mount Desert Island: Frazer, P., Jr., 1.
Mount Katahdin district: Hamlin, C. E., 3; Smith, E. S. C., 12.
Nodules in granite: Merrill, G. P., 2.
North Conway: Billings, M., 1;
Ogunquit: igneous rocks: Keeley, F. J., 1, 2.
Olivine bearing diabase, St. George: Dickerman, Q. E., 1.
Pegmatites and associated rocks: Bastin, E. S., 12.
Pegmatite in limestone, zonal arrangement: Schavizer, R., 1.
Peridotite, Little Deer Island: Merrill, G. P., 6, 7.
Prowersose and other unusual rocks: Bastin, E. S., 1.
Pyrrhotitic peridotite, Knox Co.: Bastin, E. S., 6.
Rhyolite: Smith, E. S. C., 12.
Road materials: Leighton, H., 1.
Soda syenite: Daly, R. A., 1.
Southern Me.: Ogilvie, I. H., 1.
Spherulites, North Haven, Bayley, W. S., 6.

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Appalachian structure: Keith, A., 2.
Boulders grooved, Bethel: True, N. T., 2.
Chagnes of level: Dana, J. D., 6; DeGeer, B. G., 1; Mitchell, H., 1; Shaler, N. S., 1, 3; Lewiston: Perry, J. B., 1; Portland: Perry, J. B., 1; St. Lawrence river basin: Upham, W., 9.
Continents and oceans: Crosby, W. O., 3.
Distorted pebbles, Rangeley Lake: Vose, G. L., 3, 4.
Earthquakes: Brigham, W. T., 1; Heck, N. H., 1; New England: Keith, A., 5; St. Lawrence: Keith, A., 3, 4; Southwestern, Me.: 1904: Reid, H. F.; Recent: Shaler, N. S., 15; our Maine Earthquakes: Perkins, E. H., 10.
Fulgurite, Waterville: Bayley, W. S., 3.
General: Boardman, S. L., 1; Brewer, W. H., 1; Johnson, J., 1; Keith, A., 6.
Geosynclines of N. Am.: Schuchert, C., 2.
Glacial erosion: Stone, G. H., 7.
Glacial potholes, Georgetown: Merrill, G. P., 13; Georgetown: Sewall, J., 1; Sawyers Island: Sewall, R. K., 1.
Granite pegmatites central Maine, paragenesis: Landes, K. K., 1.
Landslide, Mount Desert: Morse, E. S., 2; Portland: Bouvé, T. T., 1, 2; Jackson, C. T., 23, 26; Morse, E. S., 1; Westbrook: Elwell, E. H., 1, 2; Jackson, C. T., 26.
Lava flows: Smith, E. S. C., 14.
Orographic geology, Mt. Katahdin: Vose, G. L., 1; Northern Appalachians: Schuchert, C., 3.
Post-pleistocene subsidence: Stevenson, H. K., 1.
Sawyers Island: Sewall, R. K., 1.
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Submerged forest: Davis, L. H., 1.
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Wind action: Stone, G. H., 12.

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Androscoggin Co.: drainage, Burr., H. T., 1; Crosby, I. B., 1.
Androscoggin Glacier: Stone, G. H., 3.
Androscoggin River, former courses: Crosby, I. B., 1.
Aroostook Co.: Bailey, L. W., 7.
Champlain submergence, depth along coast: Meserve, P. w;,, 1.
Coast; Johnson, S. N., 1, 3; Shaler, N. S., 2; sea-level fluctuations: Marmer, H. A., 1.
Diluvium, divisions: Jackson, C. T., 17, 18; Perry, J. B., 1; Glacial clays: Sayles, R. W., 1; Stratified clays: Upham, W., 9.
Drift deposits: Stone, G. H., 2; Upham, W., 6, 8.
Eskers: Crosby, W. O., 4; Stone, G. H., 1, 4; Origin: Upham, W., 1.
Fall line: Renner Jr., G. T., 1.
Fiords: Remmers, 0., 1.
Floods: Kennison, H. B., 1; Fernald, M. L., 2.
Fundian faults and glaciers: Shephard, F. P., 1.
General: Anters, E., 1; Barrell, T, 1; Davis, L. H., 1; Holmes, E., 5; Jackson, C. T., 12, 35, 36; Shaler, N. S., 16; Stevens, R. P., 1; Vose, G. L., 2; Stone, G. H., 2; Towers, W. S., 1; True, N. T., 6; Upham, W., 2, 4; Wright, G. F., 1.
Glacial cirques: Goldthwait, J. W., 1.
Glacial deposits: Stone, G. H., 5, 6;
Classification: Stone, G. H., 15;
Succession: Upham, W., 3.
Glacial drift: Desor, E., 1; Hamlin, C. E., 2; Hitchcock, C. H.; 13, 18; Packard, A. S., Jr.; 3; Rogers, H. D., 1; Whittlesey, C., 2.
Glacial erosion: Stone, G. H., 7.
Glacial geology reports: Chamberlin, T. C., 1, 2.
Glacial gravels: Stone, G. H., 18.
Glacial lakes: Upham, W., 7, 8.
Glacial periods, complexity and stages in New England: Clapp, F. G., 1, 3;
Dana, J. D., 4, 5; Hitchcock, C. H., 21; Packard, A. S., Jr., 5; Perkins, E. H., 12; Price, E. K., 1; Shaler, N. S., 13; True, N. T., 5; Upham, W., 5.
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Glacial striae, scorings and local deflections: Chamberlain, T. C., 3; Hitchcock, C. H., 13; Jackson, C. T., 31; Packard, A. S., Jr. 4; Mount Desert: Redfield, J. H., 1; Stone, G. H., 9, 11.
Glaciation: Agassiz, L., 1, 2, 3; Clapp, F. G., 2; Desor, E., 1; Mount Desert Island: Blaney, D., 1; Mount Katahdin: Curtis, G. C., 1; De Laski, J., 8; Tarr, R. S., 2; New England: Packard, A. S., Jr., 8; Penobscot Bay Region: De Laski, J., 3; Dana, J. W., 2, 3; De Laski, J., 4; Southern Me.: De Laski, J., 3; Vinalhaven Island: De Laski, J., 1; Waterville, Quaternary: Little, H. P., 1; Tyrrell, T. B., 1.
Glacier, motion of: De Laski, J., 6, 7; Whittlesey, C., 1.
Gravel system: Stone, G. H., 14.
Gulf of Maine: Lindenkohl, A., 1.
Gulf of Maine: morphology: Johnson, D. W., 2.
Physical hydrography: Mitchell, H., 2.
Physical oceanography: Bigelow, H. B., 1, 2.
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Ice age: De Geer, B. G., 2, 3; Gratacap, L. P., 1; Wright, G. F., 3.

Kames, marginal: Lewis, H. C., 2.

Origin: Shaler, N. S., 10.

Origin: Upham, W., 1.

Kame rivers: Stone, G. H., 8.

Kames: Stone, G. H., 2, 4, 10; Wright, G. F., 2.

Kennebec River basin: Smith, G. O., 16.


Lake basins, classification: Davis, W. M., 1.

Marine erosion: Clarke, J. M., 6; Tower, G. W., Jr., 1.

Moraines: Stone, G. H., 13; Wright, G. F., 2; Newington moraine, Katz, F. J., 3; Perry, J. B., 1.

Mount Desert Island: Bascom, F., 3; Davis, W. M., 3; striations: Redfield, J. H., 1.

Mount Katahdin district: Hamlin, C. E., 2; Harvey, L. H., 1.


Osar gravels, coast: Stone, G. H., 10, 16, 17.

Peneplain: Davis, W. M., 5; Lobeck, A. K., 1; Tarr, R. S., 1.

Physiography: Davis, W. M., 4; Johnson, D. W., 1, 4.

Pleistocene glaciation: Antevs, E., 2, 4, 5.

Pleistocene shore lines: Katz, F. J., 5, 6.

Postglacial uplift: Fairchild, H. L., 1, 2.

Quaternary changes of level: Antevs, E., 3.

Quaternary ice sheet: Upham, W., 5.

Rippogenous gorge: Smith, E. S. C., 7.

River and Lake Surveys: See U. S. G. S.

Rock Creep: Smith, E. S. C., 3.

Shoreline, New England: Johnson, D. W., 1, 4.

Stream Measurements: U. S. G. S.

Submarine physiography of Gulf of Maine: Johnson, D. W., 3.

Swamps, seacoast: Shaler, N. S., 9; fluviatile: Shaler, N. S., 17.

Three pleistocene tills, southern Maine: Sayles, R. W., 2.

Underground water

Artesian well, Winslow: Little, H. P., 2; Water: Smith, G. O., 8.

Augusta: Glacial gravels, water supply; Smith, G. O., 10.

Bibliography: Fuller, M. L., 1.

Flowing well, Winslow: Little, H. P., 2.

General: Bayley, W. S., 7, 8; Fuller, M. L., 2, 3; Jackson, D. D., 1; Typhoid, Kennebec Valley: Whipple, G. F., 1.

Glacial gravels, water supply, Augusta: Smith, G. O., 10.

Mineral springs, composition: Clapp, F. G., 7; Peale, A. C., 1; Poland Spring: Ricker, H. & Sons, 1.

Mineral waters, see U. S. Geol. Surv.: Goodale, G. L., 2; Peale, A. C., 2, 3; Skinner, W. W., 1, 2.


Southern Me.: Clapp, F. G., 4; deep wells: Bayley, W. S., 9.

Spring, Hollis, Me.: Cogswell, Rev. J., 1.

Spring water, analysis: Clarke, F. W., 11; Poland Springs: Ricker, H. and Sons, 1.


Water resources: See U. S. Geol. Surv.

Well waters in the slates: Clapp, F. G., 5; in the granites: Clapp, F. G. 6.

Well records: Lines, E. F., 1.

Wells, southern Me.: Bayley, W. S., 9.
Selected Bibliography of Minerals and Their Identification

By

OLIVER BOWLES
Selected Bibliography of Minerals and Their Identification

By OLIVER BOWLES

INTRODUCTION

Many inquiries are received by the United States Bureau of Mines for the names of elementary books on geology, mineralogy, methods of identifying minerals, prospecting, and similar subjects. In response to this demand the following brief bibliography has been prepared. As many of the inquiries are received from those who have limited technical knowledge of the subjects involved, the bibliography includes the simpler texts which present the subjects in non-technical language. Other texts contain glossaries which define the technical terms used. A short note following the title indicates the character of each book, the number of pages, and the price. Thus, elementary mineralogists, or geologists, prospectors, mineral collectors, nature students, or travellers may select the texts that best suit their requirements and their capabilities.

To supply the needs of more advanced students, quite a number of the standard texts used in schools and colleges are included in a second group. A short list of books on economic geology and mineralogy has also been added.

ELEMENTARY BOOKS

The following books are elementary in character and are best adapted for those who have a limited technical knowledge of geology and mineralogy:


Butler, G. M. *A pocket handbook of minerals.* 2nd ed., John Wiley & Sons, Inc., New York, 311 pp. $3. A book designed for use in the field or classroom; contains little reference to chemical tests. Gives physical characters needed to identify most of the minerals which students or collectors are apt to encounter.


1 "Printed by permission of the Director, U. S. Bureau of Mines. (Not subject to copyright.) from I. C. E 140, by Oliver Bowles.

2 Supervising engineer, building materials section, U. S. Bureau of Mines."
Selected Bibliography of Minerals and Their Identification


**Standard Textbooks**

The following are standard textbooks on geology and mineralogy:


Rogers, A. F. *Introduction to the study of minerals and rocks.* McGraw-Hill Book Co., New York, 1921, 527 pp. $4. Covers the whole field of mineralogy, including crystallography, blowpipe analysis, and descriptive and determinative mineralogy; for use in the field or in the classroom.


Standard Economic Texts

The following books are standard texts on economic geology and mineralogy:


Progress Report of Highway Materials Survey of Maine

By H. WALTER LEAVITT

and

DR. EDWARD H. PERKINS
Progress Report of Highway Materials
Survey of Maine

By H. WALTER LEAVITT

Since the establishment of the Highway Materials Testing Laboratories at the University of Maine in 1914, there has been collected much information concerning the rocks, sands, and gravels of the State, in connection with the examination of samples submitted for analysis. However, because of the lack of uniformity in the methods of sampling and the general inadequacy of the data accompanying the samples as to the exact location, area, and volume of the deposit, and the omission of any information as to the glacial and geological character of the deposits, the information gained from this service of the Highway Materials Testing Laboratories is not a satisfactory basis for informing those interested concerning the resources of the State in these important highway materials. There is an urgent demand for such information today because of the extensive road and bridge building program of this state, with the resultant increased need for greater quantities of better quality material.

Accordingly, such a State Materials Survey was started on June 17, 1930 and is still in progress. The cooperating agencies behind this project are the Maine State Highway Commission; the University of Maine (Coe Research Fund); and the Maine Technology Experiment Station, Paul Cloke, Director. Valuable assistance and help has also been furnished by Mr. Joseph Conrad Twinem, State Geologist; Dr. Edward H. Perkins, Assistant State Geologist; Mr. M. R. Stackpole, District Engineer Water Resources Branch of the Maine Public Utilities Commission; and Professor James W. Goldthwait of the Department of Geology at Dartmouth and geologist for the New Hampshire State Highway Department.

This project is unique in that it is planned to be the most complete survey of its kind ever attempted by any state. New Hampshire has worked along similar lines and the New Hampshire Highway Reports for the years 1919-20, 1921-22, and 1925-26 give excerpts from progress reports of their work. Some of the mid-western states have also made gravel surveys, but so far as the authors have been able to learn the scope of the work has, in most cases, been limited to economic interests only. The Maine Survey will include both economic and geological data. The final report will be divided into two parts and published separately. Part I will deal with the economic aspects of the survey which are of immediate interest to engineers and contractors using the materials for building purposes; and Part II will describe the glacial geology of the State. Part I will supplement

Maine Technology Experiment Station Bulletin No. 6*, and will be edited by the writer of this report. Part II will supplement the report of Mr. Geo. H. Stone, “The Glacial Gravels of Maine and their Associated Deposits,” U. S. Geological Survey, Vol. XXIV, (1899) and will be reported by Dr. Edward H. Perkins, Professor of Geology at Colby College, and consulting geologist of this survey. The method which Dr. Perkins plans to use follows later in this report and is entitled “Glacial Geology of the Buckfield Quadrangle.”

The field work of this survey started June 17, 1930. During the first season’s work the party consisted of Horace A. Pratt, Assistant Field Engineer; Joseph M. Trefethen, Assistant Field Geologist; Dr. Edward H. Perkins, Geologist; and H. Walter Leavitt, Director of the Survey. The second season’s work employed the same crew with the addition of two new members, Mrs. Pratt and Mrs. Trefethen. The equipment consisted of one and one-half ton G. M. C. State Highway truck with canvas covered body, (See Fig. 1) tenting and camping outfit, sampling kits, etc.

The method of attack consisted in first locating all deposits that had been opened. Information as to locality of existing deposits was obtained from local road men, maintenance patrol men, town road commissioners, and local inhabitants. Whenever and wherever these worked deposits were extensive enough to define the local conditions, no exploring was done. When few deposits were found, an

endeavor was made to locate new deposits. The geologists were very
helpful in this connection, in many cases their study of the topographic
sheets leading to some important discoveries. After the location of
a deposit, the whole crew began immediately to gather the required
information. Fig. 2 and Fig. 3 below show the forms of data sheets
used.

### Maine State Materials Survey

#### Gravel

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>936</td>
<td>9-8</td>
<td>Bluehill</td>
<td>Allen Fisk</td>
<td>Delta</td>
<td>Bushes</td>
<td>20</td>
<td>1 ft.</td>
<td>200,000 c.y.</td>
<td>40,000 c.y.</td>
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<table>
<thead>
<tr>
<th>Lithologic Count</th>
<th>Shape</th>
<th>%</th>
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<tr>
<td>Aplite</td>
<td>Round</td>
<td>2</td>
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<tr>
<td>Diabase</td>
<td>Subangular</td>
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<td>Felsite</td>
<td>Flat</td>
<td>2</td>
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<tr>
<td>Gabbro</td>
<td>Wear Test</td>
<td></td>
</tr>
<tr>
<td>Granite</td>
<td>Grading</td>
<td></td>
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<tr>
<td>Limestone</td>
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<td>Pegmatite</td>
<td>Use</td>
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<tr>
<td>Phyllite</td>
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<td></td>
</tr>
<tr>
<td>V. Quartz</td>
<td>Tar by State</td>
<td></td>
</tr>
<tr>
<td>“ (Micac)”</td>
<td>Remarks:</td>
<td></td>
</tr>
<tr>
<td>Rotten</td>
<td>Fisk lives in Ellsworth</td>
<td></td>
</tr>
<tr>
<td>Sandstone</td>
<td>Can go deeper</td>
<td></td>
</tr>
<tr>
<td>Schist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shale</td>
<td></td>
<td></td>
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<tr>
<td>Slate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trap</td>
<td>5</td>
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**Total**

*Fig. 2*
## Maine State Materials Survey

### Sand

<table>
<thead>
<tr>
<th>No. S</th>
<th>Date</th>
<th>Party</th>
</tr>
</thead>
<tbody>
<tr>
<td>S745</td>
<td>9-8, 193</td>
<td>Pratt &amp; Pratt</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Town</th>
<th>Route No.</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluehill</td>
<td>106</td>
<td>Allen Fisk</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta</td>
<td>Bushes</td>
<td>I ft</td>
<td>20 ft</td>
<td>80</td>
<td>200,000 c. y</td>
<td>160,000 c. y</td>
<td>Coarse</td>
<td>Tar</td>
<td>See G-936</td>
</tr>
</tbody>
</table>

**Fig. 3**

A nestable set of sieves was used to screen the proper sizes for the test samples. The location data was recorded, together with such characteristics as character of top of pit, amount of overburden, average face, etc. The geologists classified the deposits as to glacial origin, etc. A lithological count was made upon 100 gravel pebbles, selected at random and recorded on the gravel data sheet. A rough estimate was also made of the volume of the deposits and the respective percentages of sand and gravel. The location of the deposit was marked on topographic sheets by the method shown in Fig. 4.

Whenever possible, as in the case of Figure 4, the U.S. Topographic sheets are used for basic maps in the survey, all the survey data being indicated in red. The Maine State Highway Commission's system of numbered routes are also indicated in red. The numbers of the samples are located in the margin of the map as “S-271” for sand sample No. 271 and “G-218” for gravel sample No. 218. The position of the deposit is marked by a red dot. Some deposits were located but not sampled. These are indicated by small red dots such as the one located in the lower left hand portion of the top half of the quadrangle near sample G-302. Portions of two eskers are shown by long
discontinuous red lines running diagonally across the maps. Such deposits locally known as “horsebacks” or “whalebacks” are good sources of sand and gravel. It will be noted that several samples were taken from these two esker systems.

This particular section of the State is quite well supplied with both sand and gravel deposits. Many portions of the State, however, are not so well blessed and in those portions the data of this survey will be very valuable. Of course, most all the deposits shown are of good and acceptable quality. One interested in the physical characteristic of any deposit must refer to the record of tests performed upon the sample taken for that deposit. In this way, not only the good and bad materials may be located, but in sections where there are many deposits, one may choose that deposit which gives the best test results for the particular use to which the material may be put.

The area of the State to be surveyed is shown in Fig. 5. This cut also shows the areas covered in the first two season’s work. In 1930, 3,694 square miles were surveyed and a total of 670 samples were taken for test. In 1931, an area of 6,739 square miles were surveyed, and 1,264 samples were taken. Improved technique and the two additional members of the survey party made possible this marked increase over the first season’s work. There is left for the season of 1932, 7,639 square miles to complete the survey. It is expected that it will be necessary to gather 1100 or 1200 samples to complete the project.

No small portion of the work involved in this survey is the testing of the samples collected by the field party. These samples are trucked to the Highway Materials Testing laboratories in Wingate Hall at the University of Maine. Here they are being tested by the regular laboratory force consisting of Mr. Leo Day, Mr. Clayton Sawyer and Mr. R. L. Annis. Mr. Pratt has also devoted much time to the testing work, as well as to the final mapping and drafting work.

The gravel samples are given a severe wear test during which eleven barrels of the material of four sizes are rotated in a steel drum for 10,000 revolutions. The time required for each wear test is five hours. Four samples are run at the same time, and the machines are equipped with an electric stop-clock so that an extra run can be made at night. Other testing upon gravel is performed as indicated in the outline of gravel tests which follows:

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Town</th>
<th>Owner</th>
<th>Date Tested</th>
<th>Specific Gravity</th>
</tr>
</thead>
</table>
The sand samples are tested also in the Highway laboratories. Briefly, the sand is mixed with a standard portland cement and tested in tension and compression at the ages of seven and twenty-eight days. Twelve test specimens are made from each sample of sand. The grading of the sand is also determined, as well as the colorimetric test for organic impurities and other tests as outlined in specimen of sand data sheet as follows:

<table>
<thead>
<tr>
<th>Sand No.</th>
<th>S. Town</th>
<th>Owner</th>
<th>Date Mixed</th>
<th>Color</th>
<th>% Water</th>
<th>Flow</th>
<th>% Granitic</th>
<th>Mechanical Analysis</th>
<th>Tensile Strength (7 and 28 day)</th>
<th>Compressive Strength (7 and 28 day)</th>
<th>Volume in Cu. Yds.</th>
<th>Specific Gravity</th>
<th>Surface Area</th>
<th>Surface</th>
<th>Overburden (in ft.)</th>
<th>Average Face (in ft.)</th>
<th>Type of Deposit</th>
<th>Used for</th>
<th>Remarks</th>
</tr>
</thead>
</table>

The rock samples are also given a wear test somewhat similar to that of the gravel samples. A specimen of the rock data follows:

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Town</th>
</tr>
</thead>
</table>
The report will be published in two volumes as previously indicated. Volume I will give the data of immediate concern to the engineering and commercial interests. There will be over two hundred pages of maps similar to Fig. 4. In addition there will be data test reports on at least 3,000 samples.

The issuing of this report at this time is for the purpose of acquainting the people of the state with the scope of the project with the hope that some constructive criticisms may result. It is the desire of all of the members of the survey to make this work as useful as possible. With this end in view, they sincerely hope that those who read these pages will send in their criticisms and suggestions of both the economic and geologic phases of this work so that the final report may be more valuable to all concerned. All suggestions should be addressed to the author at the University of Maine, Orono, Maine.
Glacial Geology of the Buckfield Quadrangle*

By

DR. EDWARD H. PERKINS

Physiography

The topography of the Buckfield Quadrangle* consists of rolling hills separated by valleys tending in a general northwest-southeast direction. The chief valley is that of the Androscoggin River crossing the northern part of the quadrangle. The highest elevation is in the northwestern part of the quadrangle, where one of the peaks of Black Mountain reaches the height of 2,200 feet. The lowest point is Turner village, which is at an elevation of a little less than 300 feet.

This topography is the result of a long period of erosion punctuated by intermittent uplift and ending in the events of the glacial period.

Early in Tertiary time a great plain extended over this part of Maine, dotted here and there by isolated hills of resistant material. Rivers flowed over this plain to the sea to the southeast. This plain was elevated and the rivers revived, cutting valleys in the weaker beds of rock. These valleys were widened until broad valley floors were formed. Uplift occurred once more, and again the rivers cut down making valley floors and plains inside the older ones. This process was repeated several times until just before the ice age, the country reached very nearly the present topography. The plains which had been formed at the various levels are recorded by accordant hill tops and rock-carved terraces along the valley sides.

The drainage just before the glacial period followed the present valleys, but the major streams were different than now. The Androscoggin River in the upper part of its course probably flowed westward into the Connecticut River.\(^1\) Its present valley was occupied by a stream flowing eastward to the neighborhood of Canton where it was joined by a stream from the north. Below the junction the stream flowed southeastward to join a major stream which flowed southward from northwestern Maine to Casco Bay.

The coming of the continental glacier buried the region in ice covering even the highest peaks. As the ice advanced it scoured over the hills, rounded off the sharp crests and leaving the subdued topography of today. At weak places in the ridges the ice eroded deep U-shaped valleys parallel to the direction of ice movement. Examples of these valleys are the notch between Tumbledown Dick Mountain and Black

* Note: This paper illustrates the method of geological discussion of Vol. II of Highway Materials Survey of Maine.

\(^1\) Former Courses of the Androscoggin River. Irvine B. Crosby, Jour. of Geol., 30, 232-247, 1922.
Mountain, and the valley of the West Branch of the Nezinsect River between North Buckfield and North Sumner.

The melting of the ice left the valleys filled with gravel and sand deposits of various types and the rivers from the melting ice were forced to find their courses over these deposits. The result was that the surface of the glacial deposits, rather than the bed rock topography determined the courses of the streams. The present drainage is therefore out of adjustment with the old topography. In places, where the valleys were dammed or ice blocks melted, lakes and swamps were formed; and where streams were forced over ledges, waterfalls developed. In fact, most of the beauty of the Maine scenery and the economic value of the streams is the direct result of the great ice age.

**Bed Rock**

The bed rock of the Buckfield Quadrangle consists of two types: metamorphosed sediments, and igneous rocks.

The metamorphosed sediments represent muds, sands, and limestone laid down in a sea which covered the eastern part of North America. These sediments were a product, of weathering and erosion on the old land of Nova Scotia to the east of the present coast line. Streams carried this material westward to the sea and spread it in beds over the sea floor. The beds gradually became cemented and compacted into rock; the sands becoming sandstones, the muds becoming shales, and the limy material limestones. Later intrusions of igneous materials and folding of the earth's crust recrystallized the rocks. Mica and other foliated minerals developed and the rocks became the highly crumpled and foliated gneisses and schists of today.

The igneous rocks were intruded into the sediments as magma or very hot rock solutions. Some of this material may have reached the surface as lava flows from volcanoes. In the Buckfield quadrangle all such surface material has been removed by erosion, but to the west in the White Mountains such volcanic rocks are found. The magma below the surface cooled slowly forming masses of crystalline granite. The granite masses were probably intruded at different times as some of the masses have been altered into foliated gneisses showing that they were intruded before the mountain folding movements. Other masses show no signs of compression and cut the older foliated granites and therefore represent a period of intrusion later than the youngest orogenic movement.

Closely associated with the granites are the pegmatite intrusions. These were formed by the intrusion of very active rock fluids which replaced the intruded sediments forming the great bodies of feldspar, quartz, and mica which are of such economic value to the state. In many cases the first pegmatite intrusions were followed by later fluids
which deposited the rare minerals as tourmaline, beryl, pollucite, apatite, etc., which have made the Maine pegmatites famous among mineral collectors. Such intrusions which are especially well known are the pegmatite bodies at Mt. Mica in Paris, Bennett's (Mine) Quarry in Buckfield, and Ragged Jack Mountain in Hartford.

The age of the bed rock of the Buckfield quadrangle has never been determined. No fossils have been found and on account of the intense metamorphism of the rocks it is doubtful if any will be. Judging from the evidence in other parts of New England and Canada the sediments are Precambrian or Paleozoic while the granite and pegmatite intrusions were intruded in Precambrian times or during the Devonian and Permian periods of the Paleozoic era. Probably there are representatives of all these ages.

Glacial Geology

The deposits of the glacial period are of great value especially for road work and hence were carefully mapped by the Road Materials Survey.

As the ice melted away the first exposed surface consisted of the hill tops which rose through the ice as nunataks. As the melting continued the exposed surface became greater until ice tongues were left along the valley. These tongues receded northward and westward until the land was clear of ice. The retreat of the ice was followed by the advance of the sea which filled the valleys of Turner and Buckfield in the southern part of the quadrangle and extended up the Androscoggin valley across Canton and Dixfield.

The glacial deposits are of two types; till, material deposited by ice alone, and wash, material deposited by the combined action of ice and water.

Till consists of coarse and fine material mixed with none of the stratification or sorting characteristic of water work. Over the hill tops and higher lands it is very thin and sometimes entirely absent. Locally in the valleys where it accumulated about the sides or end of the ice tongue it may be very thick. These deposits are common in most of the valleys of the Buckfield quadrangle. As a source of road material they are useful only as fill.

Wash deposits are composed of eroded material from the glacier worked over and deposited by water. These deposits have been washed and sorted and are deposited as beds or strata. On account of their method of formation they are far more valuable for highway material than till. The chief faults are the variability of composition due in part to the material furnished by the ice and in part to the great fluctuations in the melt-water streams.

2 In western Maine these till deposits are known as "marl." Geologically, this use of the word is incorrect as true marl is a fine grained earthy limestone usually formed in fresh water.
As the ice receded from the quadrangle during the later stages of melt the front receded northward. The first valley floor to be uncovered was the lowland about Turner Village. At this point the ice broke into two tongues, one extending up the Turner Plains toward Brettun’s Mills and the other up the valley of the Nezinscot toward Buckfield. As the front of this western valley glacier receded gravels were deposited between the valley walls and the ice. These appear today as Kame terraces on the valley sides between Turner and Buckfield and were composed of well stratified material which should be excellent although limited sources of gravel. From the receding ice front sand and fine gravel was washed into the sea which followed the ice up the valley and was deposited as a sand plain. As this plain was built to water level an upper layer of coarse material was laid over the sand forming the present surface of the plain. Thus a plain of this time is likely to yield gravel only in a thin wide spread surface layer.

At Buckfield the Nezinscot ice tongue in turn split into two, one receding up each branch of the stream. The West Branch glacier as it melted back deposited terraces along its sides, while along the center of the valley, a sub-glacial stream deposited gravels, forming an esker which may be traced from North Buckfield to West Sumner. An isolated mass of ice was protected from the sun on the north side of Down’s Hill and lingered until the main ice had receded up the valley. The water from this isolated block formed a group of gravel Kames between Down’s Hill and Mount Oxford which should be a source of good gravel. North Pond is a kettle hole where the last residue of this ice mass melted. The ice continued receding up the West Branch of the Nezinscot forming terraces along its sides but the esker formed along the valley floor has been buried. The last stand of this ice was in the valley heads of Black Mountain from which the last of the melt water washed the sand plains of Sumner.

The ice tongue filling the valley of the East Branch of the Nezinscot was larger as the extensive and well developed gravel deposits testify. Kame terraces at several levels are found along the valley walls especially east of Mt. Oxford, at East Sumner, and along the eastern side and to the south of Fields Hill. Along the valley floor a discontinuous esker was formed which may be traced all the way from Buckfield to Worthley Pond in Peru. Both the kame terraces and the esker should furnish good supplies of gravel.

The valley of the West Branch of the Nezinscot opens out into the valley of the Androscoggin River at East Peru. Only a gravel dam forms the divide between Worthley Pond and the West Branch and only glacial material forms the divide between the East Branch and West Branch in Sumner. Before the glacial period a stream of some size probably flowed southward through Dixfield and down the valley.
of the East and West Branch of the Nezinscot to Turner. Why did not the postglacial Androscoggin follow this valley instead of taking its roundabout course through Jay? The answer probably is that the ice lingered in the mountain-surrounded valley of Worthley Pond until the Androscoggin's course had been determined. The basin of Worthley Pond is a kettle hole formed by the melting of the last of this ice.

The large ice tongue which filled the valley of Martin Stream and covered the Turner sand plains repeated the history of the other two tongues. It receded northward up Martin Stream building terraces against its sides and an esker on the valley floor. Its wash into the sea which followed it formed the Turner Sand plains beneath which all but the highest parts of the esker is buried.

At Brettun's Mills the ice was broken into a series of isolated blocks about which gravels were deposited. On the melting of the ice a reticulated kame system was left with Brettun's Pond filling the largest depression.

Between Brettun's Mills and the Androscoggin at Gilbertville is one of the largest eskers of the region. It was deposited by a large stream flowing in the ice from the present valley of the Androscoggin southeastward through Canton.

The question arises once more as it did in Peru, why did not the Androscoggin River flow southeastward through Canton instead of swinging northward to Jay? The reason is probably that the valley now occupied by Leavitt Brook was checked by the esker gravels. The water backed up until it formed a lower path to the north.

As the glacier receded up the Androscoggin valley it spread a wash plain over the valley floor between the kame terraces. Most of this material was sand but here and there are coarser bands of gravel representing the old stream channels.

During the post-glacial uplifts the Androscoggin carved the flood plain into a series of terraces at lower levels than the original kame terraces. In places these terraces have been worked for gravel but usually they are too sandy to yield suitable materials.
Elevation and Geological Formation
of Maine Mountains

By

EDWARD H. PERKINS
124  State Geologist's Report on the Geology of Maine

Elevation and Geological Formation of Maine Mountains

By EDWARD H. PERKINS

The elevations are mostly from the maps of the United States Geological Survey. Where not otherwise indicated the compiler is responsible for the geological formation. Letters indicate authorities as follows: AK, Arthur Keith, U. S. Geological Survey; FK, the late F. J. Katz, U. S. Geological Survey; P, the late L. V. Pirsson, of Yale University; and ES, Edward S. C. Smith, of Union College.

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The following are the largest mountains in order of their elevations:

- Katahdin: 5267 feet
- Old Spec: 4250 feet
- Sugarloaf: 4237 feet
- Crockertown: 4168 feet
- Bigelow: 4150 feet
- Saddleback: 4098 feet
PALEONTOLOGY
Oldhamia in Maine

By

EDWARD S. C. SMITH
Oldhamia in Maine

By

EDWARD S. C. SMITH

The genus Oldhamia (Murchisonites) was set up by Edward Forbes in 1848 to peculiar, radially arranged fronds which to him were suggestive of some sort of bryozoan. These forms appeared in greenish arenaceous and purplish argillaceous slates of lower Cambrian age at Bray Head, County Wicklow, Ireland. In 1859, J. R. Kinahan gave added descriptions and figures of specimens from this locality. Later J. W. Slater and others gave these problematic forms some attention, and referred them to the algae.

In 1895 C. D. Walcott wrote a short paper mentioning the discovery of Oldhamia in the Cambrian rocks of Farnham Province of Quebec, and Rensselaer County, New York. By this time the European paleontologists had established two species, Oldhamia antiquia and O. radiata, but Walcott described the New York specimens as Oldhamia (Murchisonites) occidens sp. nv. Those from Quebec were not named as, according to Walcott, they were too poorly preserved for exact identification. In 1900 G. F. Matthew described Oldhamia from Caton's Island, in the "Long Reach" of the St. John River a few miles above St. John, New Brunswick, and B. F. Howell has reported Oldhamia from the purple of lower Cambrian slates of Weymouth, Mass.

In the summer of 1927, during the course of an investigation of the rhyolite of the Traveller Mountains, a thick series of green sandstones and slates just east of the mountains became the object of examination by the writer. This series is well exposed along the course of the East Branch of the Penobscot River in Township 5, Range 8, Penobscot County and at several localities between the "Grand Pitch" and the "Hulling Machine" falls occur the beds bearing Oldhamia (Murchisonites) occidens. The specimens in the best state of preservation are from the purplish red slates although good ones are found in the greyish green sandy beds and fair ones in the reddish sandy beds. These localities were visited the following field season by the writer in company with Dr. Howell who considers them the most notable occurrences of this fossil at present known, both as to quantity of productive beds and splendid state of preservation, being equaled perhaps as to quality only by the Nassau, N. Y. locality mentioned below.

The Maine organisms are found as branching clusters of a dozen or so stems or tubes at the bases of which may often be seen a bulbous enlargement. The stems or tubes average from one to two centimeters in length and are about 0.25 millimeters in thickness, many of which appear to be segmented. They are usually to be found as casts on
the one surface with corresponding depressions on the other. Recently,
(1929) Dr. Rudolf Ruedemann, State Paleontologist of the New York
State Museum, has described a new locality for *Oldhamia occidens* at
Nassau, N. Y., discovered by him while mapping the geology of the
Capital District, N. Y. In addition to bulbous bases on the stems he
cites several other hitherto undescribed structures all suggestive of a
calcareous alga.

So far as the writer is aware the Maine *Oldhamia* are the first Cam-
brian fossils which have been found within the boundaries of this
state although on stratigraphic grounds certain formations in the
Penobscot Bay and Rockland areas have been assigned to the Cam-
brian by members of the U. S. Geological Survey. While working in
Aroostook County many years ago the late H. S. Williams suspected
certain slates to be of Cambrian age but stated that “Positive evidence
of the age is wanting.” More recently C. W. Brown has urged the
correlation of “the fine-grained, even-bedded, Purplish, quartzose
flagstones” of North Haven, Mount Desert and elsewhere on the Maine
coast with the Cambrian of Nahant and Braintree, Mass.

To the writer the significance of the discovery of *Oldhamia occidens*
in Maine lies in the fact that it furnishes definite evidence of the
existence of a Lower Cambrian seaway in central Maine. The
similarity amounting almost to identity of the Irish sediments with
those of Maine and New York suggests that this Lower Cambrian
seaway was continuous through the regions mentioned.

Although not nearer than several miles the known Devonian
(Moose River) sandstones exposed farther up the East Branch appear
on structural grounds to be separated from the Lower Cambrian either
by a fault or a profound unconformity. If the Lower Cambrian has
been fauled down into its present position, it is possible that it is the
only occurrence, but perhaps there may be other fortunately located
areas which will be discovered in the future.
Oldhamia occidenta, from grey arenaceous slate
T. 5, R. 8, Penobscot County, Maine
Red slate with specimens of Oldhamia occidentalis,
T. 5, R. 8, Penobscot County, Maine
Oldhamia antiqua, from the green arenaceous slates of Bray Head, County Wicklow, Ireland.
New Fossil Localities in Maine

By

EDWARD H. PERKINS
New Fossil Localities in Maine

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I. Grindstone

A new locality for the “worm trails” known as *Nereites* has been found just below Grindstone on the East Branch of the Penobscot River. A Forestry Camp Site is located at this point on Route 211 about half way between Stacyville and Medway. The Penobscot River flows over ledges, which outcrop at the camp site. The rocks are dark blue limy slates interbedded with coarser more sandy beds sprinkled with minute pyrite crubs. The beds strike N20E and dip 80-85° NW.

When the place was visited by the author in company with Doctor L. H. Merrill, then State Geologist, the resemblance of the beds to those in Waterville where *Nereites* is found was noted. After half an hour hunt two specimens of the trails were found. These were typical and closely resembled those found at Waterville.

The Waterville trails have been found associated with Silurian graptolites (1) and so the new find places the Grindstone beds in that period.

II. Houlton

In the construction of a new hotel in Houlton, a ledge was uncovered in the center of the town. This was examined by Roy A. Bither, of Ricker Junior College, who found a slab containing two graptoliths. These were submitted to Doctor Rudolf Ruedemann who identified the fossils and submitted the following notes which he has permitted us to use.

“A slab of black slate sent by Prof. Edward H. Perkins and collected by one of his students at Houlton, Maine contains fragmentary graptolites, *viz.*

Climacograptus cf. hughesi Nicholson and

Rastrites cf. peregrinus Barrande

The rock is strongly compressed and the graptolites therefore distorted and unfit for positive identification. Nevertheless there is little doubt that they represent two species, in both the form of the thecae and the dimensions. *Climacograptus hughesi* ranges in Great

---

Britain through zones 16-21, or nearly all of the Birkhill (Llandovery), *Rastrites peregrinus* only through upper 19 and 20 and occurs doubtfully in zone 21. It is therefore a fair conclusion that the slate containing these two graptolites belong: either to upper zone 19 or 20. As *R. peregrinus* is most common in zone 20, it is probable that zone 20 is represented in the slab from Maine. That is the zone of *Monograptus convolutus* (upper most Middle Birkhill and lower Upper Birkhill.*)
STRUCTURAL GEOLGY
The Hallowell Intrusives

By

HORACE TRUE TREFETHEN
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The Hallowell Intrusives

Introduction

The district in which the Hallowell Granite occurs is roughly about two hundred square miles in area. It embraces in whole or in part, the townships of Augusta, Hallowell, Chelsea, Windsor, and Vassalboro, in Kennebec County, Maine. The area is included in the Augusta and Vassalboro quadrangles of the United States Geological Survey topographic maps.

This paper embodies the result of investigations concerning the distribution and the structure of the so-called Hallowell granite.

Augusta, the largest city near the district, is on the Maine Central Railroad, and the granite area itself is traversed by several state highways and numerous country roads.

Previous Work

The report of Dr. Charles T. Jackson, state geologist in 1838, contains the first recorded geological study of the Hallowell Granite. (Jackson, 1838, pp. 92-95)* His report, like all that have followed, dealt only with conditions at the quarries located on Lithgow Hill, and made no attempt to describe the extent of the outcrop, or explain its structure.

Hitchcock mentions the Hallowell Granite briefly in his report on the geology of Maine, (Hitchcock, 1861, p. 196), but on the whole, does nothing more than repeat the observations of Jackson in 1837.

The most complete report available is the one by Dale in U. S. Geological Survey bulletin on the New England granites. (Dale, 1923). The section of this publication devoted to Maine is an enlargement and revision of a previous bulletin on the granites of the state. (Dale, 1907.)

The above reports have been made, without exception, from the economic standpoint. The extent of the granite area has never been determined, and no study of its structure has ever been published. These reports have been concerned only with the smaller granite area on the west bank of the Kennebec, localized about Lithgow Hill. No recognition has been made of the fact that the same granite extends eastward, on the other side of the Kennebec River, over a much larger area.

Physiography

The region in which the Hallowell granite occurs is one of moderate relief. The even skyline indicates that it is a portion of one of the

* For publications cited, see list of references at end of thesis.
several piedmont terraces developed in central Maine during the Tertiary Period. (Perkins and Smith, 1925, p. 216) and rejuvenated by glaciation and uplift during the Pleistocene and post-Pleistocene times.

The drainage, tributary to the Kennebec, has been disorganized by glaciation. A great number of ponds and lakes exist in the debris-dammed remnants of pre-glacial river valleys.

The topography is dominated by two features.

(1) the north-east south-west ridges, which are due to the more resistant folded sediments with an average strike of N 35° E, and which are common over large areas of Maine, and,

(2) local oval hills of granite the long axes of which have a general north-west south-east trend. Lithgow Hill, west of Augusta, and Bolton Hill, west of Togus Pond, are good examples. (See map.)

Glaciation is responsible for the peculiar trend of these hills. The ice moving from the northwest tended to elongate their more or less circular outline into elliptical form through lateral erosion. The lower and less resistant ridges of the country rock were also cut through in many places, though not sufficiently to destroy their trend, except in a very few cases where because of unusually resistant strata small areas stand well above the general level. Such an area may be seen in the case of the small hill on the Augusta-Vassalboro town-line, just north of Seven Mile Brook.

Throughout this area bed rock outcrops are common above the three hundred foot level, particularly on the southeast slopes where only thin deposit of till was made; below this level, except in some of the stream beds, the country is mantled with marine clays which were laid down during the period of depression, subsequent to glaciation. The shape of the outcrops is roughly circular to irregular and they often occur as knobs in the higher hill tops.

By reference to the map it will be seen that the granite occurs in two districts on opposite sides of the Kennebec River. The western area centers about Lithgow Hill, while Togus Pond and Porcupine Hill are about the middle of the eastern area.

**Structure**

*Biotite Schist*

The country rock of the district, into which the granite is intruded, is biotite schist. This schist varies in composition and structure, from laminated slates to more or less massive quartzites. Biotite in varying amounts is present everywhere. This biotite schist occurs over large areas of central Maine, extending to the Rockland limestone on the east, passing beyond the Waterville slates in the north, and having undetermined boundaries on the west and south. That
the schist is of sedimentary origin may be seen in those areas where it has the slaty structure mentioned above. Here the outline of the original beds can be clearly traced. The formation has been folded until the dip of the beds is vertical or steeply inclined to the southeast. The strike is variable, varying from 20 to 60 degrees east of north with an average strike of N 35°E. Because of the amount of metamorphism, however, no detailed structure can be worked out.

The metamorphism shown by the schist is very evidently due to regional force or forces, and in no degree to the intrusion of the Hallowell Granite. This is shown by the fact that outcrops a number of miles from the contact zone show as much alteration as those in which the schists and granites are closely associated. The strike of the schistosity is approximately that of the strata, N 35°E, and has no relation to the granite masses which in numerous places cut the structure at high angles. The schistosity, then, is not connected with the granite intrusion, but is associated with antecedent folding.

The almost negligible amount of metamorphism which can be traced to the intrusion would seem to indicate that at the time it took place the country rock over a large area was heated. This supposition is further supported by the lack of any marginal chilling about the borders of the granite.

This schist can apparently be correlated with the Branch Pond Formation of Perkins and Smith. (Perkins and Smith, 1925, pp. 224, 225.)

**Hallowell Granite**

The Hallowell granite is a muscovite biotite rock of light gray color and fine texture. The texture and biotite content vary within small limits, over the area examined. Associated with the main masses of granite are differentiated dikes which will be considered later.

As stated above, the granite occurs in two masses, one on each side of the Kennebec River. By reference to the map their boundaries, size, and areal distribution may be seen. It will be noted that the area west of the river is roughly circular in shape, about three and a half miles in diameter, and reaches its maximum elevation, five hundred feet, at the centre, in Lithgow Hill. The eastern area is roughly oval in outline, and lacks the symmetry of plan possessed by the western district. Along the central portion of its major axis, however, it is distinctly higher than the surrounding country. The hills north and west of Togus Pond form the nucleus of this area and reach an elevation of four hundred sixty feet. Profiles of the areas (Figures 1 and 2) show their relative heights and surface features.
Figure 1. Section along line C-D (see map in back of book) through Lithgow Hill showing dome-like form of intrusive.

Figure 2. Section along line A-B (see map in back of book) through the eastern and western cupolas of the batholith.
Figure 3-A. Sheet Structure in East Wall of Lithgow Hill Quarry

Figure 3-B. Sheet Structure in North Wall of Lithgow Hill Quarry

Notice parallelism of sheet structure with the surface and increase in thickness of the sheets downward.
The contact between the edges of the granite masses and older schists is very indefinite. More properly the two could be said to merge into each other over a contact zone varying from a few feet to several miles in width. In most cases, as one passes over this zone, from the schists toward the granites, quartz veins first become abundant and small pegmatite dikes appear, often forming the backbones of the little ridges which occur in this zone. Closer to the granite mass outlying dikes and knobs of granite occur, and the outcrops of schist decrease in size and frequency. Occasionally small areas of schist can be found completely included by the granite, and fragmental inclusions up to several feet in size are common.

In these contact zones there also occur dikes, and more rarely; rather massive outcrops of tourmaline granite. In this rock crystals of black tourmaline take the place of the usual biotite content of the Hallowell granite. This tourmaline granite seems to be a peculiar differentiate of the Hallowell Magma, and so far as known is unique in Maine. A more detailed description of this rock will be found under the section on petrography.

The Hallowell granite is cut by two important sets of joints and numerous smaller joints, both types varying with the location. In some outcrops a faintly gneissoid foliation can also be observed. The following table gives data, taken from various widely scattered localities, on the important joints and the foliation.

<table>
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<th>Main Joints</th>
<th>Minor Joints</th>
<th>Foliation</th>
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<tr>
<td>A</td>
<td>N 42° E</td>
<td>N 87° E</td>
<td>N 4° E</td>
</tr>
<tr>
<td>B</td>
<td>N 60° E</td>
<td>N 13° E</td>
<td>N - S</td>
</tr>
<tr>
<td>C</td>
<td>N 75° E</td>
<td>N - S</td>
<td>None</td>
</tr>
<tr>
<td>D</td>
<td>N 82° E</td>
<td>N 12° E</td>
<td>None</td>
</tr>
<tr>
<td>E</td>
<td>N 102° E</td>
<td>N 3° W</td>
<td>None</td>
</tr>
<tr>
<td>F</td>
<td>N 112° E</td>
<td>N 22° E</td>
<td>None</td>
</tr>
</tbody>
</table>

**List of Localities**

A. Abandoned quarry west of Hallowell.
B. Lithgow Hill Quarry.
C. Abandoned quarry on China Road east of Augusta.
D. Hill northwest of Hallowell.
E. Hill west of Three Mile Pond.
F. Hill west of Three Mile Pond.

Sheet structure is very well developed in both areas of the granite and is especially well exposed in the quarry walls. (See Figure 3.)
Near the surface the sheets are only a few inches thick but their depth gradually increases downward until they have a thickness of six or eight feet at the bottom of the quarry. Dale attributes the cause of this sheet structure, at all lower levels, to compressive strain, while the surface sheets he considers due to expansion caused by solar heat. (Dale, 1923, pp. 26-37).

It will be noted that in the photograph the sheet structure is horizontal. It varies in different places, however, being roughly parallel to the surface trend of the granite.

Associated with the Hallowell granite are found differentiates of three kinds, tourmaline granite, pegmatite dikes and quartz veins. The tourmaline granite appears only about the margin of the Hallowell granite, but the pegmatites and quartz veins are found cutting the granites, and in the schists at considerable distances from the intrusion. The relative ages and structural relations of these differentiates may be seen in an excellent exposure along Bond Brook, northwest of Augusta. Here a cliff face gives a section in which can be observed the Hallowell granite intruded in the schist, the younger pegmatite cutting the granite, and the still younger quartz vein cutting the pegmatite. (Figure 4.)

![Figure 4. Cliff Face, Bond Brook, Augusta.](image-url)

No tourmaline granite appears here, but where present is always cut by the pegmatite and quartz. The age relations stand thus; oldest, Hallowell granite, and in order, tourmaline granite, pegmatite dikes, quartz veins.
Mode of Occurrence

There is very strong evidence pointing to the intrusion of the Hallowell granite as batholithic in nature. Much of this evidence has been presented under previous sections, but will be summed up here.

The occurrence of the granite in two dome-like masses of similar composition and structure indicates that they are cupolas of a batholith which thus far has been laid bare by erosion at these points only. The great width and irregularity of the contact zone indicates that the lower portion of the batholithic roof is still covered by the schist. Figures 1 and 2 illustrate this, the uncovered cupolas showing at Lithgow and Bolton Hills, while a covering of schist still remains over the Kennebec River area. The present valley of the Kennebec here, is undoubtedly due to the form of batholith. The profile (Figure 2) shows that the river follows the path of least resistance through the weaker metamorphic trough between the resistant granite domes on either hand.

The abundance of inclusions is still another evidence for the batholithic mode of occurrence, these as before noted vary in size. Most of them possess the same strike as the country rock and are apparently truncated roof pendants. The abundance of these pendants indicate that the top of the granite intrusion was not far above the present level. The form of the granite itself is characteristic of intrusions at considerable depth, probably in or near the zone of flowage. As this means a cover of considerable thickness it is obvious that a vast deal of erosion has gone on since the time of intrusions.

Petrography

Biotite Schist

The country rock into which the granite is intruded is a bluish-gray biotite schist. On weathering this rock usually stains a dark rust brown from the oxidation of small amounts of iron present. Megascopic examination shows mainly quartz grains and biotite mica. Occasionally small quantities of muscovite are present. The bedding is visible and supplies clear proof for the sedimentary origin of the schist. The percentages of quartz and mica vary greatly with the strata. The foliation is parallel to the bedding.

Under the microscope the schist shows practically the same features as noted above. (Slide P-6)\(^1\)

\(^1\) The slides referred to are on file in the Geological Dept. of Colby College. They were prepared from specimens selected to show average conditions prevailing in localities from which they came. An index to the slides will be found at the end of the paper.
Major minerals:
Biotite—shows parallel arrangement of crystals as the result of metamorphism.
Quartz—somewhat shattered; extinction undulatory, also result of strain.

Minor minerals:
Muscovite—much shredded.
Apatite—scattered crystals in quartz.

Normal Granites

The Hallowell granite is a light gray, fine textured rock. The megascopic minerals are feldspar, quartz, muscovite, biotite and occasional small garnets. The feldspar is more or less prophyritic, with the average diameter of the phenocrysts slightly over five millimeters. The other particles average about .75 millimeters in diameter. In some instances the biotite is smeared or slickensided, showing faulting after the magma has cooled.

The phenocrysts have a tendency to line up parallel to the faint gneissic structure of the rock.

Microscopic examination of the normal granites (Slides P:1, P-2).

Major minerals:
Quartz—abundant, undulatory extinctions.
Microcline Plagioclase—about equal amounts of albite and anorthite (Andesine).

Minor minerals:
Biotite—this shows parallel arrangement of the crystals as the result of strain. This gneissic tendency of the normal granite is mentioned above.
Muscovite—slightly less in amount than the biotite.
Apatite—rare.
Kaolin—small amounts resulting from weathering of feldspar.

Coarse Normal Granite

Megascopically this granite is of somewhat different aspect since the mineral particles are larger. This gives it a coarser appearance. It is also somewhat lighter in color.

Under the microscope this granite (Slide P-5) shows the same composition as the normal type. The crystals are larger. There is somewhat less biotite and it fails to show any alignment like that noted in Slides P-1 and P-2. This is a coarser phase of the normal type, and was undoubtedly intruded at a somewhat later date.
The Hallowell Intrusives

Tourmaline Granites

The tourmaline granite occurs about the margin of the Hallowell, in various places. This rock is coarser in texture than the normal granite and contains less quartz. The feldspar is porphyritic, some of the phenocrysts being a centimeter in diameter. Scattered throughout the ground mass are black tourmaline crystals of varying sizes. (Two or three centimeters down to a millimeter or less). There is no megascopic mica.

Microscopic examination of the tourmaline granites. (Slides P-3, P-4).

Major minerals:
Microcline—abundant.
Quartz—undulatory extinctions.
Plagioclase—between oligoclase and andesine; much less abundant than in the normal granites.

Minor minerals:
Tourmaline—quite abundant; the crystals cut the other minerals and seem to be due to replacement of them by tourmaline at a later stage of the intrusive period.
Biotite—present in small amounts though not shown by megascopic examination. Like the biotite in the coarse normal type it does not show any parallel arrangement of crystals.
Apatite—rare.

The tourmaline granite seems to be an intermediate stage between the true granites and the pegmatites.

Pegmatites

Pegmatite dikes are found over the entire area studied, cutting both schists and granites of the various types. These dikes vary in width from an inch or two, to more than a foot. They are composed of quartz and feldspar crystals of varying sizes, and minor amounts of muscovite mica, black tourmaline and occasionally small garnets. Because of their coarse texture no slides were prepared.

The extinctions of the quartz, which are undulatory in every case, the gneissic tendency of the granites, and more locally the slickensides, all show that the rock masses have been under rather severe strain. This was probably incident to the intrusion and cooling of the magma.

Age Relations

Because of the thoroughness of metamorphism it is impossible to date the sediments by means of fossils. Had any existed they must necessarily have been destroyed in the complex folding to which the
area has been subjected. The nearest formation which has been definitely dated is the Waterville slate. This is known to be of Clinton, or mid-Silurian age, (Perkins, 1924, pp. 223-227). Since the schist is highly metamorphic even away from the granite intrusion, and does not pass gradually into the unmetamorphic Silurian, it must of necessity be pre-Silurian.

In the absence of any fossil record the date of deformation becomes of primary importance in determining as closely as possible the age of the schist. Previous to the Silurian there were two periods of orogenic movements in eastern North America which could have caused such metamorphism. The first was the Killarney Revolution, which came during the Late Proterozoic. The second was the Taconic Disturbance in the Late Ordovician. Recent work seems to indicate that only over a small area of western New England was this latter disturbance of an orogenic nature. (Pirsson and Schuchert, 1924, pp. 243-244) (Clark, 1921). Eliminating the Taconic Disturbance, we have left the Killarney Revolution as the cause of our regional metamorphism. This occurred in the Killanean and would obviously place the rocks themselves in a still earlier period. This schist closely resembles known Precambrian rocks of southern New England.

The granites are intruded in the schists, hence they are younger. Dale classes the Perry Basin granites, to the eastward, as late Silurian or early Devonian, and is of the opinion that most of the Maine granites, with the exception of those in the southwest, are of the same age. (Dale, 1923, p. 209). A dike of granodiorite cuts the Waterville slate and is therefore late or post-Silurian. Since general igneous activity was taking place in Maine at this time, it seems reasonable to suppose that the Hallowell granite was also intruded during the late Silurian or Early Devonian. At best this is only a supposition, as the granite might also have been intruded in the Ordovician or in the Carboniferous period, since igneous activity was taking place in both these times.

**Economic Aspect of the Hallowell Granite**

The quarry on Lithgow Hill, now operated by the Hallowell Granite Works, Inc., was first opened in 1826. Since that time it has been in continuous operation, and several new openings on various parts of the same hill, have been made by the company.

At the present time six derricks are in operation in the quarries, their capacities vary from ten to forty tons each. In the cutting plant five derricks are used, with two outside cranes for loading. The plant is equipped with saws, pneumatic tools, and surfacing machines. Much of the product is of such nature as to require finishing wholly by hand, and about three hundred cutters are employed. Because of the skilled artisans at this plant, granite from other quarries is often brought
The Hallowell Intrusives

here for finishing. The product is transported from the cutting sheds to Hallowell by auto truck or trolley freight. There the stone may be loaded directly on the sea-going barges in the Kennebec River, or shipped by freight on the Maine Central Railroad.

Because of its fine texture and light color, the Hallowell granite is particularly adapted for carving, and is used extensively for monumental work and architectural embellishment. Some of the better known monuments and buildings constructed from it are: the Manhattan Bridge Plaza, and the Hall of Records, in New York City; the Marshall Field Building in Chicago; Academic and Library Buildings of the Naval Academy at Annapolis; the Soldiers and Sailors Monument in Boston.

Summary

The area covered by this report is located near the city of Augusta, Maine. Previous material available in the district has been concerned only with the economic aspect of the granites.

Physiographically the region is one of moderate relief dominated by two factors; north east south west ridges, the result of folding and erosion, and oval hills of granite, the result of intrusion and glacial erosion. The drainage is tributary to the Kennebec.

The country rock of the region is biotite schist. It is of sedimentary origin and shows regional metamorphism. It is a bluish gray in color and stains rust brown on exposure.

The granite is intruded in this schist in a mass which has two areal exposures, one on each side of the Kennebec River. Tourmaline granite, pegmatites, and quartz veins, are present as differentiates from the original magma. The quartz content of all rocks of this district show undulatory extinctions and give evidence of molecular strain.

The age relations are uncertain. Without much question the schist is Precambrian. The granites are probably late Silurian or early Devonian but any positive evidence of their age is lacking.

The Hallowell Granite Works, Inc., operates a quarry on Lithgow Hill, from which they take a high grade building and monumental stone.

REFERENCES


Pirsson and Schuchert (1924) Text Book of Geology, Part II.

Index to Microscopic Slides

P-1 Granite from Lithgow Hill quarries, Hallowell, Maine.
P-2 Granite from China Road, east side of Kennebec River.
P-3 Tourmaline Granite. Farmingdale, Maine.
P-4 Tourmaline Granite, China Road.
P-5 Granite from hill west of Three Corners Pond.
P-6 Biotite Schist from Augusta District.