LAUDABLE LEGACY -----a synopsis of the titans of geology and paleontology in New York State

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"Not to know the events which happened before one was born,
that is to remain always a child" ..... Cicero

Someone famous once said, "Great minds talk about ideas, average minds talk about events, and small minds talk about people." At the risk of becoming a target for a brusque and unflattering categorization, I shall nevertheless proceed to talk about people, events, and ideas in that order of emphasis. Because people report on events and ideas, it seems to be the most expedient procedure to introduce you to the notable personages who fostered geological and paleontological thought prior to offering an analysis of the events and ideas that have transpired. Tracing almost two centuries of the history and development of geology and paleontology in New York State is no small story. The abridgement that follows focuses on the highlights of that evolution.

Within the designated scope of this overview, it is impossible to acknowledge all those who have made significant contributions toward a better understanding of the sediments, rocks, fossils, geologic processes, depositional environments, geologic structures, and geologic history within the Empire State. Those whom I have chosen to recognize are regarded as having contributed the most toward the elucidation of the geology and paleontology of New York State. Doubtless, a few of you may disagree with some of my choices or omissions. This, of course, is your privilege (and mine!); I offer no apologies for my selection.

Prior to the 1820's, geologists and paleontologists did not exist as such. Instead, those who observed, lectured on, and wrote about geological things usually were physicians, lawyers, theologians, philosophers, or travelers. Customarily, these learned ones also concerned themselves with botany, chemistry, physics, and zoology. Because of their broad interests in natural history, they were labelled "naturalists." Probably the most gifted and versatile of these late 18th century-early 19th century scientists was the physician-lawyer Samuel Latham Mitchill (b. 1764, North Hempstead, Long Island; d. 1831, New York City) (Plate 2). As a youth, he studied medicine with an uncle, Dr. Samuel Latham and, later, with Dr. Samuel Bard in New York City. Mitchill received his Doctor of Medicine from the University of Edinburgh, with honors, in 1786 and it seems likely that he must have come under the "spell" of the famous James Hutton, while there. Mitchill studied law with Robert Yates, Chief Justice of New York.

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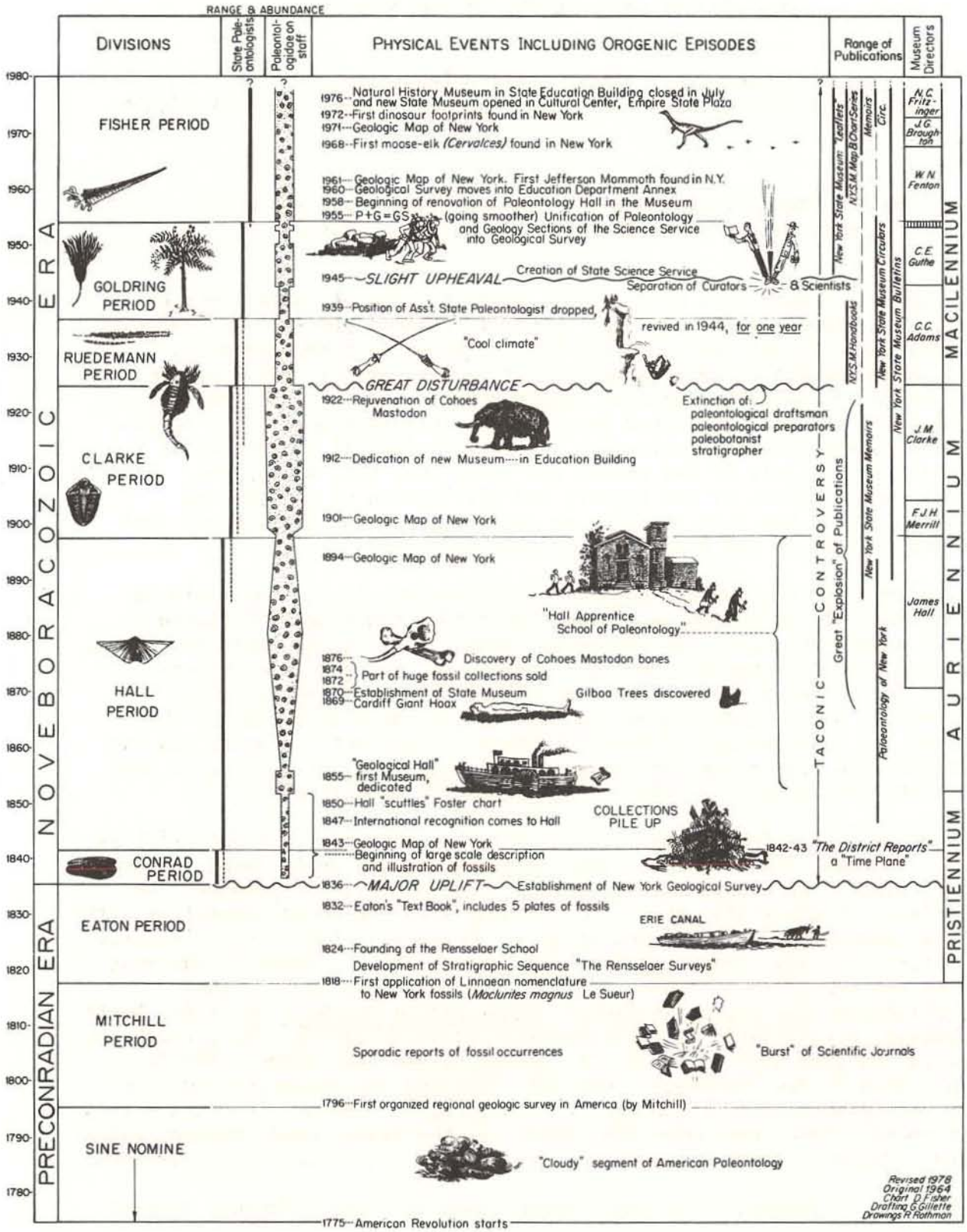
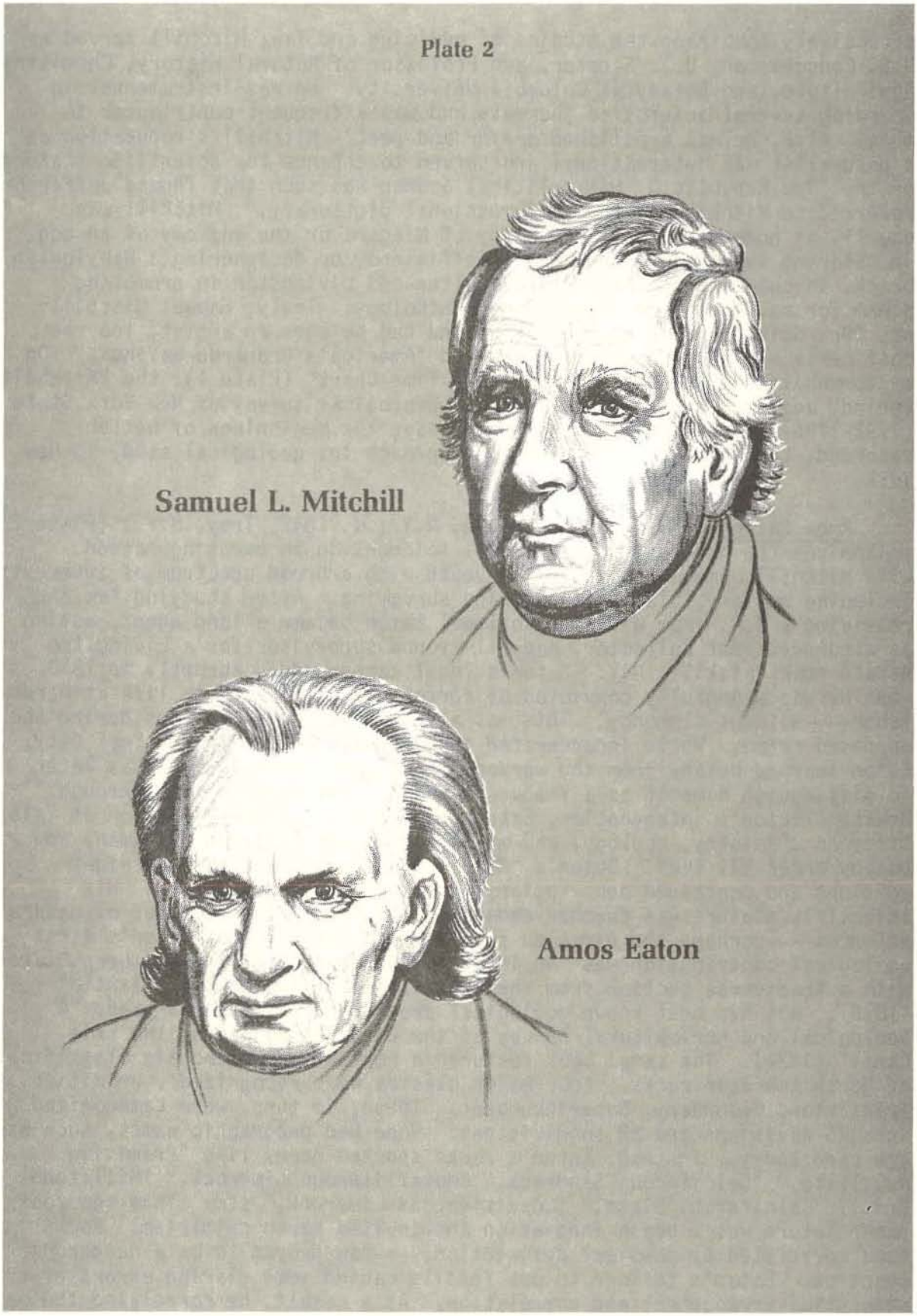


Plate 1. Paleontological time scale for New York State.

Effectively combining the studies of medicine and law, Mitchill served as U.S. Congressman, U.S. Senator, and Professor of Natural History, Chemistry, Agriculture, and Botany at Columbia University. He was instrumental in founding several scientific journals and was a frequent contributor to them. Also, he was a polished orator and poet. Mitchill's reputation as a naturalist was international and served to enhance the scientific stature of the "New Republic." His political acumen was such that Thomas Jefferson referred to Mitchill as the "congressional dictionary." Mitchill was equally at home studying the geology of Niagara or the anatomy of an egg, in offering suggestions on windmill efficiency or deciphering a Babylonian brick, in championing the cause of Fulton and Livingston in promoting steam for navigation or in studying conchology. Truly, Samuel Mitchill was "Mr. Scientist" in young America and had he been an artist, too, he most certainly would have been labelled "America's Leonardo daVinci." On my somewhat whimsical "Paleontological Time Chart" (Plate 1), the "Mitchill Period" begins with the first informal geological survey of New York State (1793-1796)---by Mitchill---and encompasses the beginnings of better recorded, though still a "curiosity" approach to, geological study in New York.

Amos Eaton (b. 1776, New Concord, N.Y.; d. 1842, Troy, N.Y.) (Plate 2) epitomizes the budding of the natural sciences in an emerging nation. Like Mitchill, Amos was a talented youth with a broad spectrum of interests including oratory, blacksmithing, and surveying. After studying law and receiving a B.A. from Williams College, Eaton became a land agent, acting as attorney, rent collector, and all-around supervisor for a Livingston estate near Catskill, N.Y. Eaton's legal career ended abruptly in 1810 when he was wrongfully convicted of forgery and sentenced to life at hard labor----without clemency. This was a most severe penalty considering the supposed crime. While incarcerated in Greenwich Prison in New York City, Eaton learned botany from the warden's son, John Torrey----who was later to distinguish himself as a famous botanist. Pardoned in 1815 through DeWitt Clinton's intervention, Eaton resumed his college education at Yale, studying chemistry, geology, and mineralogy under Benjamin Silliman, and botany under Eli Ives. Eaton's "Manual of Botany" went through eight editions and contained descriptions of 5,267 species of plants. His scientific stature was further enhanced as a travelling lecturer of natural sciences----perhaps the first on such a broad scale. Amos Eaton's first geological contribution was "An index to the geology of the Northern States, with a transverse section from the Catskill Mountains to the Atlantic" (1818). But his best known geological production was the 163-page, "A Geological and Agricultural Survey of the District adjoining the Erie Canal" (1824). The canal book featured a revised and elaborate classification of North American rocks. Four major classes were recognized: Primitive, Transition, Secondary, Superincumbent. These, in turn, were categorized into 25 divisions and 28 subdivisions. None had geographic names, such as are used today. Instead, Eaton's rocks sported names like "Primitive Argillite," "Calciferous Sandrock," "Metalliferous Limerock," "Millstone Grit," "Calciferous Slate," "Cornitiferous Limerock," etc. This new rock nomenclature was a brash innovation and invited harsh criticism. Rocks were correlated by physical description,----now proven to be a dangerous practice. Eaton's failure to use fossils caused some glaring errors of sequential arrangement and correlation. As a result, he correlated the

Plate 2



Catskill redbeds (Middle and Late Devonian) with the Queenston redbeds (Late Ordovician) and placed the salt-bearing strata (Late Silurian) above both! Seemingly, he was ignorant of William Smith's classic work on stratigraphy in the British Isles. With T. Romeyn Beck and Lewis C. Beck, Eaton conducted geological surveys of Albany (1820) and Rensselaer (1822) Counties,---the first such detailed county studies in North America. The multitalented Eaton was selected by the patroon Stephen Van Rensselaer as first senior professor at the Rensselaer School (later the Rensselaer Polytechnic Institute). Eaton's highly innovative teaching techniques included students learning by doing via laboratory experiments, field collecting, and practice teaching. All this was a bold departure from the boring, stereotyped method of that day which saw professors formally reading from prepared notes and calling on students to recite from memory. The spirit of camaraderie between Eaton and his students was one not previously developed in the scientific community and was no small point of professional jealousy among the well-known universities of that period. The Rensselaer School, together with a School of Industry operated by William Maclure at New Harmony, Indiana, attracted the best would-be geologists of the early 19th century, and between them produced most of the outstanding geologists of that period. Amos Eaton was also a pioneer in women's rights, openly encouraging young ladies who possessed a scientific bent. Among these were his daughter, Sarah Cady Eaton, his sister-in-law Laura Johnson, Almira Lincoln Phelps (sister of Emma Willard who founded the famous school for girls in Troy), and Mary Lyon, the emancipator. Eaton prepared the first "Geological Textbook" (1830) which sold for $1.50 and included the first colored geological map of New York State. As an educator, he introduced the Bachelor of Natural Science and Bachelor of Civil Engineering degrees. Amos Eaton, this zealot of science, attained the rare achievement of becoming a colossus in two sciences----geology and botany. Between 1817 and 1841, his passionate peddling of science, through more than 4,000 lectures, 12,000 chemistry experiments, and over 17,000 miles of "field-tripping," provided an impetus in natural science at a time when scientific artifacts became more than curiosities of nature. Appropriately, the 1818-1836 interval is termed the "Eatonian Period" in the evolution of geology in New York State (Plate 1).

April 15 is both an infamous and famous day. Infamous because, annually, it is the deadline for payment of Federal and State income taxes. Famous, for April 15, 1836 was a turning point in the development of geological undertaking in New York State because it marked the initiation of state-sponsored geologic study. On that momentous day, Governor William Marcy, an ardent proponent of conservation of the State's poorly known but presumably vast natural resources, signed into law the establishment of the Natural History Surveys of New York. Geologists should be especially indebted to the then-Secretary of State John A. Dix. It was he who so convincingly argued in favor of a geological survey, before the skeptical legislature succumbed to his enthusiasm and appropriated $104,000 for that purpose.

Upon the advice of Eaton and Edward Hitchcock (Professor of Geology at Amherst College, and respected New England geologist), the state was apportioned into four geological districts. Not one, but four State Geologists were appointed with equal authority (and, it was hoped, equal

competency!). U.S. Army engineer William W(illiams) Mather (b. 1804, Brooklyn, Conn.; d. 1859, Columbus, Ohio) (Plate 4) was given charge of the First or Eastern District. Rensselaer School Professor of Chemistry (and Albany Medical College Doctor of Obstetrics) Ebenezer Emmons, Sr. (b. 1799, Middlefield, Mass.; d. 1863, Brunswick County, N.C.) (Plate 4) headed the Second or Northern District. Conchologist Timothy A(bbott) Conrad (b. 1803, Trenton, N.J.; d. 1877, Trenton, N.J.) (Plate 4) became chief of the Third or Central District. Paris-trained geologist Lardner Vanuxem (b. 1792, Philadelphia, Penn.; d. 1848, Bristol, Penn.) (Plate 4), the only one with formal training in geology, headed the Fourth or Southern District. Physician and Professor of Chemistry, Botany, Mineralogy, and Zoology Lewis C(aleb) Beck (b. 1798, Schenectady, N.Y.; d. 1853, Albany, N.Y.) (Plate 4) was appointed State Mineralogist. Because the 1836 season's work yielded such a prodigious array of unidentified fossils, and Conrad and Vanuxem were displeased with the boundaries of their respective districts, the survey was reorganized in 1837 with an adjustment in the boundaries of the Third and Fourth Districts (Plate 3) and the appointment of Conrad as Paleontologist. This suited Conrad as he was none-too-fond of field work anyway and he could remain closeted in Albany, studying fossils. Vanuxem was transferred to the Third District, which now had agreeable boundaries, and the young 25-year old James Hall, assistant to Emmons the previous year, was placed in charge of the new Fourth or Western District,---considered a geological "no-man's-land" by the elder staff members. Hall chose his fellow Rensselaer classmates, George Boyd, Ezra Carr, and Eben Horsford, as his field assistants. Together, this quartet of relatively "green" geologists demonstrated to their somewhat condescending colleagues that it was the "wasteland" that would yield the "pearl-in-the-oyster." Each chief geologist had from one to five assistants. The resulting five year foot and horseback fieldwork yielded much unsuspected new information which was summarized in five annual reports and four final, quarto-size, District Reports (1842-1843). These four classics in early American 19th century geology are obligatory reading for all those engaged in geological research in New York State. Beck prepared a final report, "Mineralogy of New York," a methodical and exemplary monograph of 536 pages and 533 woodcuts----all of this accomplished while simultaneously serving as Professor of Medicine at Albany Medical College and Rutgers University. But, alas, there was no final report of the descriptions of the fossils of the State; this was a bitter disappointment. Although "married" to New York's Paleozoic fossils by contract, Conrad had carried on "extramarital affairs" with Tertiary fossils from the Atlantic Coast. Apparently, the task of preparing over 100 plates and describing scores of fossils overwhelmed Conrad. Thus, when Governor Bouck abolished the Survey in 1842, a representative collection of New York's fossils was in hand, but undescribed. Conrad hastily departed without bothering to resign. Mather became active with the growing Ohio Survey. Vanuxem retired to his farm in Pennsylvania. Beck continued research on mineralogy and in medicine and gained an international reputation for his work on pure foods and drugs. This left Emmons and Hall, who remained in Albany, competing to persuade the Legislature to set up funds to collect, study, describe, and publish on the untapped wealth of fossils that occurred in New York strata.

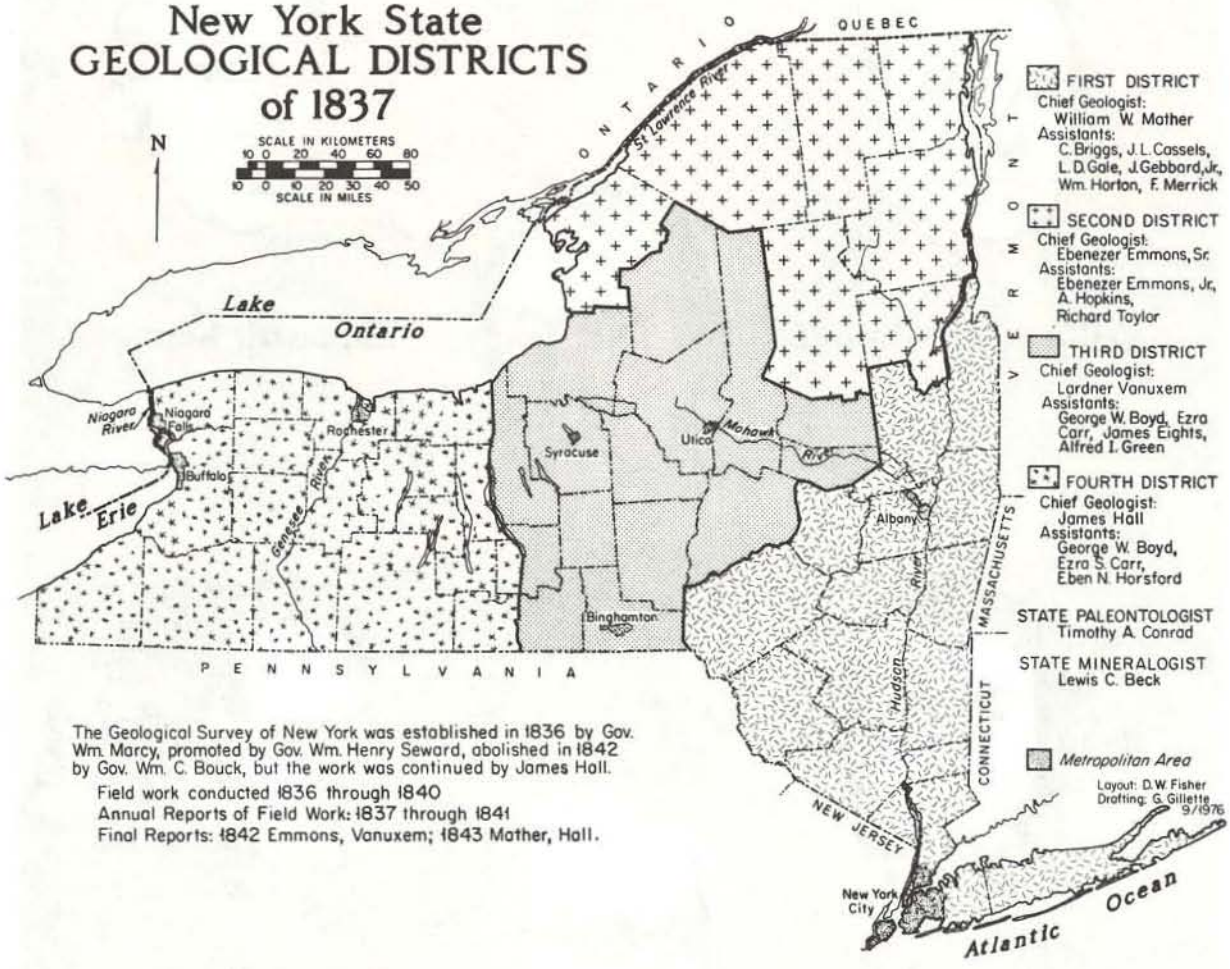


Plate 3. New York State geological districts of 1837.

Plate 4

Principal Staff of the New York Geological Survey of 1837

William W. Mather

Ebenezer Emmons

Lewis C. Beck

James Hall

Lardner Vanuxem

Timothy A. Conrad

The "New York System," the sequence of rocks developed by the District Geologists, would not endure and receive national and international acceptance if it were not fortified by detailed study of its fossils. Either through superior competence, relative youth, or political chicanery, Hall was appointed State Paleontologist by Governor Bouck in 1843. As a conciliatory measure, Emmons was made State Agriculturist but he made the most of this apparently demeaning appointment. He produced five monographs on the Agriculture of New York (soils, fruits, insects, etc.) in which he surreptitiously included his novel notions on the Taconic System of rocks in eastern New York, -- views which were anathema to Hall. Briefly, Emmons believed that the Taconic rocks were older fossil-bearing rocks than any others that were then known in New York (Potsdam). Hall, supported by Mather (who had mapped all of these rocks), the influential James Dwight Dana, and Louis Agassiz (personal friend of Hall) argued that these deformed rocks were nothing more than equivalents of the rocks to the west. The Hall-Emmons discord was widened. In the 1870's and 1880's, discoveries of diagnostic fossils by S(ilas) W(atson) Ford, Troy jeweler and amateur geologist, and William B(uck) Dwight, Professor of Geology at Vassar College, proved that both antagonists were right and wrong! Some rocks in the Taconics are, indeed, older than the Potsdam whereas others are equivalents of those further west. In its original guise, the Taconic Controversy "died a lingering death"; within the last three decades it has been resurrected in a new form in that some geologists have offered different non-conforming structural interpretations for these complexly deformed rocks.

The New York State Geological Survey of 1836-1842, or the Seward Survey (so named because William Henry Seward, later Secretary of State under President Abraham Lincoln, was Governor of New York during most of the Survey's years) left a more impressionable legacy upon American geology than any that preceded or succeeded it. Besides supplying American geology with a nomenclature largely its own (New York System), it demonstrated unequivocally the value of invertebrate fossils for purposes of correlation. The published results (the "Geology of New York") of the Seward Survey attests to the dedication and prodigious efforts of those pioneer geologists (staff of the Survey), ---- traits which modern geologists often fail to appreciate. Within the time span of the history of New York geology, the "Conradian Period" (Plate 1) marks the shortest duration but with the greatest consequence.

The omnipotent reign of James Hall (b. 1811, Hingham, Mass.; d. 1898, Bethlehem, N.H.) spanned 63 years of public service, a tenure that is unmatchable owing to the current mandatory retirement age of 70 under New York State retirement regulations. No other single person exerted as influential a role in the development of paleontology in North America during the 19th century than James Hall. Surely, no one before or since, has been so thoroughly involved with the inception of geologic organizations and government-sponsored geological surveys, nor has exercised such a persuasive influence on his fellow colleagues than did this patriarch of American invertebrate paleontology. Hall's attributes as an astute observer, sagacious scientist, and prolific writer (he authored 302 scientific articles), coupled with his inflexibility of purpose and dynamic personality, made Albany, New York, the "mecca" for aspiring young

Plate 5

State Paleontologists of New York

John M. Clarke
1898 - 1925

Rudolf Ruedemann
1926 - 1937

James Hall
1843 - 1898

Winifred Goldring
1938 - 1954

Donald W. Fisher
1955 -

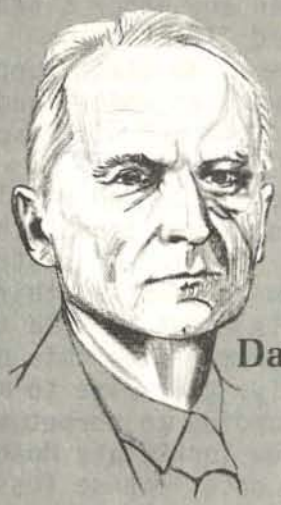
Plate 6

State Geologists of New York

Frederick J. H. Merrill
1899 - 1904

John M. Clarke
1904 - 1925

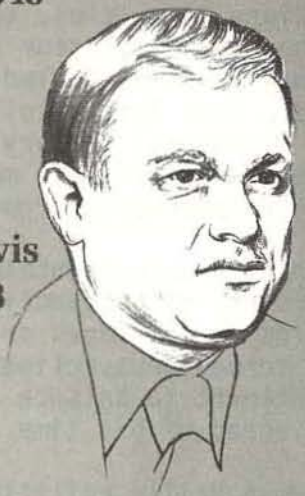
James Hall
1837 - 1898



David H. Newland
1927 - 1940

Chris A. Hartnagel
1941 - 1946

John G. Broughton
1949 - 1968



James F. Davis
1970 - 1978

paleontologists. In 1857, Hall had constructed (at his own expense) a large brick building (still standing in Lincoln Park, within a "fossils-throw" of the new N.Y. State Museum). To this apprentice school, would-be paleontologists, artists, draftsmen, and collectors migrated in order to learn and labor in the shadow of Hall's growing fame. To have been hired by Hall was an honor and this employment carried credentials unmatched among 19th century American paleontologists. The experience they gained under Hall's watchful diligence, mimicking their teacher's study methods, and receiving free and frequent criticism produced extraordinarily competent scientists. However, one's employment was certain to be a tempestuous tenure because Hall never compromised his high ideals and purposes in favor of a tranquil environment. Amid this continuing atmosphere of anxiety there was produced some of the finest paleontological research in North America. Among Hall's "graduates" were: Charles E(merson) Beecher, John M(ason) Clarke, Orville Derby, Fielding B(radford) Meek, Charles Rominger, Charles Schuchert, Charles D(oolittle) Walcott, Charles A(bithair) White, and Robert P(arr) Whitfield. Collaborating with these students, James Hall produced the 13-quarto volume series, "Palaeontology of New York," consisting of 4,305 pages, and 869 plates of drawings of fossils. This encyclopedic reference exerted a greater influence on succeeding American invertebrate paleontologists than any other single work until the issuance of the current multi-authored "Treatise on Invertebrate Paleontology," more than a century later. No state-supported paleontological research has contributed as much toward an understanding of ancient invertebrate life than has that of James Hall and his disciples.

From time to time, however, the State reduced or suspended Hall's salary and/or expenses. Undaunted, the wily Hall would not forsake his original commitment to describe New York's fossils. In lieu of sustenance, Hall cajoled the State legislature into allowing him to keep two-thirds of his collections. He did so in order that the fossils might be sold to provide an equity to carry on his Palaeontology Program. With this capital, he shrewdly employed more collectors which, naturally, gave rise to more collections which, after sale, yielded additional funding to perpetuate his Palaeontology Project. Unfortunately for the New York State Museum (which Hall founded), and for later workers, Hall's once immense fossil collections were, thus, scattered. The largest recipients of Hall's sales were the American Museum of Natural History in New York City, the University of Pennsylvania at Philadelphia, and the Walker Museum of the University of Chicago. This latter collection has now been transferred to the Field Museum of Natural History in Chicago. What Hall did to promulgate his research was within his mandate, and absolutely necessary for the continuance of his "Palaeontology Program." In this case, "The end justified the means."

Apart from paleontology, Hall formulated two basic ideas of geology, the concepts of geosynclines and isostasy. Outlining his idea of crustal downfolds at the edges of continents in areas of thick sediment accumulation (later termed geosynclines by Dana) and then compensating responses within the continent to balance these downfoldings (isostasy), Hall showed that he was ahead of his time in these areas of thinking.

James Hall's abilities, accomplishments, and adventures rank him as the foremost and most colorful paleontologist that America has produced.

Truly, he was the main catalyst and activator for biostratigraphy, taxonomic paleontology, and paleoecology, fields that he was privileged to observe wax from unpretentious beginnings to assertive sciences.

Although G(rove) K(arl) Gilbert (b. 1843, Rochester, N.Y.; d. 1918, Jackson, Mich.) is best known for his meticulous and sound work with the federal Wheeler and Powell Surveys, his brief career in New York deserves mention. Receiving his bachelor's degree from the University of Rochester at 19, Gilbert associated himself with Henry A. Ward, not only professor at Rochester but founder of the unique institution known as Cosmos Hall,--- later to evolve into Ward's Natural Science Establishment, supplier of geological and biological specimens and equipment (and some outstanding zoologists!). Gilbert was responsible for the measurements and comparisons of the famous Cohoes Mastodon skeleton and for its erection in Geological Hall in the old State House in Albany in 1867. This exhibit did much to focus attention and to attract scientists to "Hall's Community" in Albany.

"....he stands today, alone and pre-eminent, the acknowledged master of field technique, the greatest reconnaissance geologist of our time," spoke Douglas Johnson in 1940, then president of the Geological Society of America, when awarding the Penrose Medal, the Society's highest honor, to N(elson) H(oratio) Darton (b. 1865, Brooklyn, N.Y.; d. 1948, Chevy Chase, Md.) (Plate 7). Fifty four years earlier, one month beyond his 21st birthday, Darton was hired by the U.S. Geological Survey as the direct result of his card catalog of references on the geology of New York and vicinity. G.K. Gilbert, then head of the Appalachian Division of the Federal Survey, suggested that Darton expand his card catalog to include the entire Appalachian District. Eventually, 13,330 cards were prepared, covering the area from Maine to Alabama; this later evolved into the exceedingly useful "Bibliography of North American Geology." In 1892, W.J. McGee, chief of the Atlantic Coastal Plain Division of the Survey, sent Darton to New York State to trace the Oneonta strata. While there, it was arranged that young Darton should work with the aging James Hall on a new geologic map of New York State. Darton mapped in the Hudson and Mohawk Valleys and supplied information for other areas of the State where knowledge of the bedrock geology was previously vague. Darton's New York mapping covered 9,350 square miles and often necessitated preparing topographic base maps in the process. Practically all of the compilation and drafting of the 1893 Geologic Map of New York was performed by Darton. But when the map was published, it was both shocking and disappointing to Darton to see only Hall's and McGee's names on the new colored map! Despite this travesty of justice, Darton's contributions to geology are preserved in his 15 articles on New York geology (including two U.S.G.S. Atlas Folios covering southeastern New York). His 50-year career netted him over 200 publications. There is scarcely an area from the Dakotas to Texas and Arizona that was not mapped by the most outstanding field geologist that the U.S. Geological Survey has ever employed.

Eminent stratigraphers inherently possess the compulsory attributes of conciseness, perspicacity, and scrupulosity. Vanuxem, of the Seward Survey, had them and so did Charles S(mith) Prosser (b. 1860, Columbus, Chenango County, N.Y.; d. 1916, Columbus, Ohio) (Plate 7). In 1897, as Professor of Geology at Union College, Schenectady, and with his students

Edgar R. Cumings and William L. Fisher, he mapped the bedrock of the Amsterdam 15-minute quadrangle (N.Y. State Museum Bulletin 34, 1900). This was the first N.Y. State 15-minute quadrangle to be published in color. Prosser continued his stratigraphic and paleontologic work by measuring, in great detail, several thick sections of Middle Devonian strata in Chenango County. His works were among the earliest to pinpoint the horizons of fossils within detailed stratigraphic sections. Prosser early identified some of the Lower Devonian Helderberg limestone facies problems.

Following the death of James Hall, the statutory positions of State Geologist and State Paleontologist were assigned to Frederick J(ames) H(amilton) Merrill and John M(ason) Clarke, respectively. The former had been appointed Director of the State Museum in 1894 to relieve the aging Hall from the bulk of increasing administrative duties; the latter had been a protege of Hall's since 1882. Merrill (b. 1861; d. 1916) wrote many articles on sediments and rocks in southeastern New York, particularly on the metropolitan New York City area; he was a co-author of the still authoritative New York City Folio of the U.S. Geological Survey Atlas Series. He resigned in 1904 to do consulting in Mexico and the western United States whereupon Clarke assumed the dual titles of State Geologist and State Paleontologist. The ensuing "Clarkian Period" (Plate 1) was the "Golden Age" of geology and paleontology in New York State. Research, both state and university sponsored, was greatly encouraged and generously supported. The result was a plethora of articles covering a broad spectrum of geological topics. It was a transition period in which detail and specialization began to replace generalized studies. Whereas Hall was often crude and tyrannical in his dealings with others, John M(ason) Clarke (b. 1857, Canandaigua, N.Y.; d. 1925, Albany, N.Y.) (Plate 5) was quite opposite. Clarke's firm and persuasive manner was tempered by politeness, quietness, and compromise. Like Hall, Clarke received many lucrative offers to teach at universities and, like his successor New York State Geologists and State Paleontologists, chose to close his lengthy career at the State Museum in Albany. Elected to about 50 scientific societies, Clarke authored (and co-authored) over 300 scientific papers totalling over 10,000 pages; he named some 135 genera and 870 new species of fossils. His areas of specialization included: brachiopods, eurypterids, trilobites, sponges, Naples Fauna, Guelph Fauna, Devonian stratigraphy. During the "Clarkian Period" topographic mapping by the U.S. Geological Survey in New York State achieved 100% coverage on a 1:62,500 basis. The time was now ripe for an intensified program of mapping bedrock distribution and surficial deposits.

In the field of bedrock geology, two tireless and dedicated mappers stand out. W(illiam) J(ohn) Miller (b. 1880, Red Bluff, Calif.; died. 1965, San Diego, Calif.) (Plate 7) mapped ten 15-minute quadrangles between 1907 and 1920 while Professor of Geology at Hamilton College, Clinton, N.Y. and at Smith College, Mt. Holyoke, Mass. These were published in ten N.Y. State Museum Bulletins (1909-1926). Miller's mapping was in and peripheral to the Adirondack Mountains. Considering the complexity of the geology and the relative inaccessibility of the areas mapped, this was, indeed, a monumental effort. Miller's interpretive articles for the layman and geologist, "Geological History of New York State" (1914, 1924) and "The

Plate 7

Outstanding Mappers of New York Geology

Nelson H. Darton

D. Dana Luther

William J. Miller

James H. Stoller

Adirondack Mountains" (1917) were pioneer efforts to popularize the geology of the Empire State. In 1924, Miller left the east and moved to California where he started the Geology Department at the then new University of California; he remained in California for the remainder of his life.

An even larger area was mapped by D. Dana Luther (b. 1840, Naples, N.Y.; d. 1923, Naples, N.Y.) (Plate 7). Luther, a miller by profession, was a self-taught stratigrapher, who joined the State Geological Survey at the age of 51 and performed field mapping until 70. In 1891 a rare opportunity arose to examine in detail the Upper Silurian and Devonian strata of western New York. An exploratory shaft for salt was to be excavated at Livonia, Livingston County. A prism 18 feet square and 1,400 feet deep was dug. Luther logged this shaft in meticulous detail, and his acute observations have proven of great value to this day. During Luther's state tenure he mapped about 24 15-minute quadrangles, of which 18 were published between 1904 and 1914. This concentrated career of geologic mapping is unsurpassed in New York State. Unlike Miller's mapping, Luther's was done in flat-lying sedimentary rocks of western New York, which are relatively easily distinguished and easily accessible. This is not to take away from Luther's prolific production but to compare the complexity of geology and accessibility to outcrop.

In the field of surficial mapping, James H(ough) Stoller (b. 1857, Johnstown, N.Y.; d. 1955, Bamberg, S.C.) (Plate 7), Professor of Geology at Union College, Schenectady, stands out. His mapping of glacial deposits in the Mohawk and Hudson Valleys resulted in completion of the Schenectady (1911), Saratoga (1916), and Cohoes (1920) quadrangles as N.Y. State Museum Bulletins.

Without challenge, the chief elucidator of New York glacial geology was Herman Leroy Fairchild (b. 1850, Montrose, Penn.; d. 1943, Rochester, N.Y.) (Plate 7). From 1888-1920, Fairchild was Professor of Geology at the University of Rochester. His many publications, 104 on New York, concentrate on central and western New York and are primarily concerned with proglacial lake history and meltwater drainage. Six N.Y. State Museum Bulletins were authored by Fairchild, as well as the popular "Geologic Story of the Genesee Valley and Western New York" (1928).

A(madeus) W(illiam) Grabau (b. 1870, Cedarburgh, Wisc.; d. 1946, Peking, China) is conspicuous as author of two of the finest and most cited publications that the N.Y. State Museum has ever published. These are "Guide to the Geology and Palaeontology of Niagara Falls and Vicinity" (1901) and "Geology and Paleontology of the Schoharie Valley" (1906). These were prepared while Grabau was Professor of Geology at Columbia University. Though long out-of-print, they stand as classics on these geologically vital areas. Grabau's fame rests primarily with his 1,200 page "Principles of Stratigraphy," "North American Index Fossils," "Textbook on Geology," and 4-volume work on the Palaeozoic Pulsation Theory. Interestingly, he also authored 18 articles on New York glacial geology. Together with his Niagara Falls guide (intended to supply geological information to visitors at the 1901 Pan American Exposition in Buffalo), Grabau's first five publications reflect the consummation of subjects in which he had become interested while living in Buffalo. Chief among these

was his concise and precise "Geology and Palaeontology of Eighteenmile Creek and the Lake Shore sections of Erie County, New York" (1898-1899),---- intended as a handbook for students and amateurs. Grabau's contributions to physical and organic stratigraphy and paleogeography spurred his contemporaries and successors to a period of productive thinking and research along these lines.

Since the "Hallian Period," probably no one has made a more thorough probe of the total faunal content of a single group of sedimentary rocks in New York State than did Percy E(dward) Raymond (b. 1879, New Canaan, Conn.; d. 1952, Cambridge, Mass.). As a student of G(ilbert) D(ennison) Harris of Cornell University, he acquired the fine points of field collecting and learned about N.Y. geology on Harris' famous field trips. Later, he was a graduate student of Charles E(merson) Beecher and an assistant to Charles Schuchert at Yale University. Raymond's indoctrination into the realm of invertebrate paleontology was, indeed, impressive and complete. Between 1905 and 1911, Raymond completed 12 articles on several fossil groups of the Chazy limestones; trilobites were his specialization. So thorough were his studies that, today, the Chazy Group is the best known portion of the New York Ordovician from a faunal standpoint.

The first detailed geologic map of a portion of the Adirondack Mountains, "Geology of the Lake Placid Region" (1898) was constructed by James F(urman) Kemp (b. 1859, New York City; d. 1926, Great Neck, N.Y.). During 1892-1902, Kemp, while Professor of Geology at Columbia University, was engaged in studies of the complexly deformed rocks of the eastern Adirondacks; several articles resulted from this work. He is best known for investigations in economic geology and ore deposition and acquired an international reputation in these fields. Kemp also served as consulting geologist for the studies by the New York City Board of Water Supply and was responsible for selecting the sites for the Croton Dams and the Ashokan Reservoir.

H(enry) P(latt) Cushing (b. 1860, Cleveland, Ohio; d. 1921, Cleveland, Ohio), Professor of Geology at Western Reserve University, rendered yeoman work in advancing the knowledge and distribution of New York rocks. He was employed by the N.Y. State Geological Survey from 1893 to 1917, spanning the close of the "Hallian Period" and extending into the heyday of the "Clarkian Period"; World War I terminated his work in New York. Cushing authored or co-authored quadrangle geologic reports on the Little Falls, Thousand Islands, Ogdensburg, Saratoga Springs, and Clinton County regions. In 1896, he proved the existence of pre-Potsdam dikes in the Champlain Valley. Based on his broad knowledge of Adirondack geology, Cushing produced, as early as 1902, a coherent scheme of Adirondack geological history that is still consistent with subsequent observations.

It is seldom, in the lives of geoscientists, to find one who has been a pioneer in a branch of geology. But, in engineering geology, such a pioneer is Charles P(eter) Berkey (b. 1867, Goshen, Ind.; d. 1955, Palisade, N.J.) (Plate 8). Geologic knowledge has been applied intuitively to man-made structures for centuries. Only in recent years, however, has the geologist been accorded his rightful place on a team that plans and constructs dams, aqueducts, bridges, power plants, etc. Berkey was foremost

Plate 8

Outstanding Academicians of New York Geology

Charles S. Prosser

George H. Chadwick

Herman L. Fairchild

Charles P. Berkey

Harold L. Alling

Marshall Kay

among those who proved the value of competent geologic advice in the realm of public works construction. For engineering geology, 1903 was a memorable year. It marked the appointment of Berkey as junior instructor in the Department of Geology at Columbia University (where the aforementioned J.F. Kemp was now senior professor) and it was the year that the Board of Water Supply of New York City was contemplating bringing water from the Catskill watershed to service the fast-growing population of the metropolis. Large tunnels were to pass through mountains; access shafts were to have an aggregate depth of almost 15,000 feet; large dams were needed to be built in order to pond reservoirs; tunneled water was to pass under the Hudson River; and 18 miles of distributing tunnel were to be blasted in a network of rock beneath New York City. Because engineers were unable to answer all of the questions which arose, especially those relating to the rocks, this was a situation made to order for an able, enthusiastic young geologist. Berkey tackled the problems unhesitatingly and the splendid Catskill, Delaware, and Croton hydrology systems today are working evidences of his abilities. Following this successful venture, Berkey's expertise was demanded during the construction of the Holland and Lincoln Tunnels, and the George Washington, Whitestone, and Triborough Bridges. During the ensuing 30 years, hardly a major structure in the United States was built without Berkey's advice and visitation. Numbered among his projects are the Boston, Massachusetts water supply, and the Hoover, Shasta, Hungry Horse, Grand Coulee, and Bonneville Dams, as well as those of the Tennessee Valley Authority. As a sidenote, Berkey was chief geologist for the Dr. Roy Chapman Andrews American Museum of Natural History Expeditions of 1922, 1923, and 1925 into central Mongolia. Here, he was co-discoverer of fossilized dinosaur eggs. Charles P. Berkey's engineering geology influence will affect the lives of generations who will not know his name.

Following J.M. Clarke's death in 1925, Rudolf Ruedemann (b. 1864, Georgenthal, Germany; d. 1956, Albany, N.Y.) (Plate 5) became State Paleontologist. Ruedemann had immigrated to America in 1892 and taught in the high school in Lowville, N.Y. Moving to Dolgeville, northeast of Little Falls, Ruedemann found himself surrounded by some of the richest graptolite-bearing shales in the United States. As a consequence, over the years he patiently studied these enigmatic animals and, concurrently, became a specialist in Ordovician stratigraphy. Eventually, he attained the status of America's premier authority on graptolites demonstrating their value as superb index fossils. Among his 163 scientific articles, Ruedemann's State Museum publications on graptolites, cephalopods, eurypterids, the Lorraine Fauna, the geology of the Thousand Islands region, the Saratoga Springs region, the Capital District, and the Catskill area are frequently consulted. It is noteworthy that Ruedemann's geologic interests were not restricted to paleontology and stratigraphy. Taught by the famous Gustav Steinman, Ernst Kalkowsky, Johannes Walther, and Ernst Haeckel, Ruedemann's Ph.D. thesis at the University of Jena concerned contact metamorphism of the Reuth batholith in the Fichtelgebirge. Years later, he applied his Alpine education to the Taconic Mountains and suggested overthrusting (1909) for the emplacement of the Taconic Allochthon. Although he retired in 1937, he continued his work for many years, culminating in the giant Geological Society of America Memoir, "Graptolites of North America" (1947).

The "Ruedemannian Period" (Plate 1) witnessed great advances in stratigraphic knowledge in New York State. One of the principal workers was George H(alcott) Chadwick (b. 1876, Catskill, N.Y.; d. 1953, Selkirk, N.Y.) (Plate 8). Chadwick was an extremely dedicated, hard-working geologist who early in life, became smitten with a love of nature. His knowledge of plants was equal to that of his geology. As Fairchild's student at the University of Rochester, Chadwick inherited an appreciation for the many facets of geology. His bibliography, therefore, covers topics on glacial geology, stratigraphy, and structural geology. Chadwick's primary contributions are (1) recognition and delineation of the complex facies relations within the Devonian Catskill Delta rocks, (2) clarification of Middle Silurian Clinton Group stratigraphy, (3) bedrock mapping in the Canton and Catskill-Kaaterskill Quadrangles, and (4) discovery of a "Large Fault in western New York." This, later named, "Clarendon-Linden structure" has occupied the time and efforts of many recent geologists who are concerned with underground waste disposal, water supply problems, and earthquake studies. Chadwick authored 35 papers on New York geology, of which 13 were on glacial geology and most of the remainder on the Devonian.

Another Rochesterian, Harold L(attimore) Alling (b. 1888, Rochester, N.Y.; d. 1960, Pittsford, N.Y.) (Plate 8) furnished important geologic data in diverse geologic disciplines. Fairchild's stimulating teaching together with the Alling family's annual vacations in the Adirondack Mountains prompted Harold Alling's first geologic paper to deal with glacial lakes and glacial features in the central Adirondacks. Aware that Professor James F. Kemp was investigating Pre-Cambrian rocks in the eastern Adirondacks, Alling managed to get himself assigned as Kemp's field assistant. This developed into a life-long friendship with mutual interest in problems pertaining to Adirondack rocks. Alling made noteworthy discoveries in the fields of igneous, metamorphic, and sedimentary petrology, specifically addressed to feldspars, graphite, and salt. Seven N.Y. State Museum Bulletins were authored or co-authored by him. He was one of the first to write a special textbook on the petrography of igneous rocks. His enthusiasm for photography was an asset in accumulating hundreds of photomicrographs of rocks. Harold Alling, using graphite horizons, was the first to demonstrate that stratigraphy worked in the highly contorted Adirondack metamorphic rocks.

State Geologists David H(ale) Newland (b. 1872, Vienna, N.Y.; d. 1943, Menands, N.Y.) (Plate 6) and C(hris) A(ndrew) Hartnagel (b. 1874, Newark, N.Y.; d. 1962, Slingerlands, N.Y.) (Plate 6) successively followed John M. Clarke. Their contributions were chiefly in the form of issuing reports on the mineral resources of the State. Newland, as an economic geologist, was well aquainted with mineral deposits both in the United States and in some foreign countries. His bulletin on the Adirondack magnetic iron ores (1908) is a model for thoroughness and accuracy of description and soundness of interpretation. It has proved indispensable to succeeding geologists and engineers in their quest for additional economically feasible mineral deposits within the Adirondacks. Hartnagel's interests in geology unfolded as a result of his student-professor relationship with C.S. Prosser at Union College, listening to lectures on geological subjects by State Geologist F.J.H. Merrill, and collecting fossils for State Paleontologist J.M. Clarke. By his own admission, Hartnagel's most rewarding contribution

to New York geology was his tracing of the Cobleskill Limestone, in 1902, westward to prove that it was not the extension of the caprock of the Niagara cuesta but, rather, that it lay stratigraphically above the Salina Group. Similar field work with the Oneida Conglomerate and the Shawangunk "grit" caused him to believe that much of the Salina passed laterally into the Shawangunk. In his later years with the State Survey, Hartnagel developed a system of record keeping for oil and gas wells within the State. Through his dealing with other State agencies, the State Geological Survey gained a reputation for being a storehouse of vital geologic information. As with most members of the State Survey, Chris Hartnagel's tenure was long, amounting to 44 years.

Upon the retirement of Ruedemann, Winifred Goldring (b. 1888, Kenwood, N.Y.; d. 1971, Slingerlands, N.Y.) (Plate 5) became State Paleontologist. She began her career at the N.Y. State Museum in 1914 and continued productive and significant work until her retirement in 1954. In the United States, it is with great difficulty that a woman accedes to a high position in science. For her sound work in invertebrate paleontology and paleobotany, the Paleontological Society honored her, in 1949, by electing her its first woman president. Noted especially for her studies on Devonian trees (Gilboa Forest), Late Cambrian algae (Cryptozoans), and Devonian crinoids (sea-lilies), her fields of research mirror her botanical training. Forty-four titles, ranging from Pleistocene salinities of the Champlain Sea to Devonian stratigraphy constitute her bibliography. She is best remembered for her (1) popular type publications, especially the "Handbook of Paleontology for Beginners and Amateurs: Part I--The Fossils and Part II--The Formations, and the "Guide to the Geology of Thacher Park"; (2) publications on Devonian crinoids, chief among which is the memoir, "Devonian Crinoids of New York"; and (3) classic quadrangle studies, "Geology of the Berne Quadrangle," and "Geology of the Coxsackie Quadrangle." The "grandame" of New York State paleontology spread her passion for paleontology among innumerable graduate students and hundreds of theses topics which were suggested and implemented during the period 1930-1950. She was avidly interested in museum exhibition, and the famous restoration of the oldest known Devonian Forest in the old N.Y. State Museum, reproduced in many textbooks, has become her exhibit signature.

No one possessed a more intense zeal for Ordovician stratigraphy than did (George) Marshall Kay (b. 1904, Paisley, Ont.; d. 1974, New York City) (Plate 8). Internationally, he was "Mr. Ordovician," and particularly so for the "Three N's" (Newfoundland, New York, Nevada). Kay's ardor for Ordovician stratigraphy was catching and no one who came in contact with him could resist becoming involved (or embroiled!) in fervent discussions on terminology or correlations. His most notable contributions are concerned with descriptions and correlations of Ordovician strata, history and classification of geosynclines, and their bearing on continental drift and plate tectonics. In New York, his efforts toward unraveling the stratigraphy of the Trenton, Black River, and Chazy Groups are especially cogent. For his prolific publications toward a better insight into the problems of the Ordovician Period, he was awarded the Geological Society of America's highest honor, the Penrose Medal.

Amongst the living, enduring and distinguished contributions on New York geology and paleontology have been made by A.F. Buddington and G. Arthur Cooper, respectively.

A(rthur) F(rancis) Buddington (b. 1890, Wilmington, Del.) (Plate 9), Emeritus Professor of Geology (since 1959), Princeton University, and "Mr. Adirondack Geology," ----- for his extensive geologic mapping, his intensive topical studies of complexly deformed and physically complicated metamorphic rocks, iron ore deposits, and origin of anorthosite. Buddington, and a few of the many students whom he inspired, mapped about 3,500 square miles, or about one-third of the Adirondacks. During World War 2, he conducted the first aeromagnetic survey in the western hemisphere. This resulted in the discovery of 70 new magnetite ore bodies, including the large Benson Mines near Tupper Lake; the others are of lower grade and are held in reserve. Buddington also rediscovered the wollastonite deposit near Willsboro,---the only major economic source of that mineral in the world. Since his retirement he has published over a dozen significant articles and two books on Adirondack petrology, metamorphism, and anorthosite petrogenesis and was a major contributor (and dedicatee) at a recent international symposium on the origin of anorthosite. For his many and significant achievements, he was awarded the Penrose Medal by the Geological Society of America.

G(ustav) Arthur Cooper (b. 1902, College Point, N.Y.) (Plate 9), Chief Paleontologist, U.S. National Museum of Natural History, Smithsonian Institution, and "Mr. Brachiopod," ----- for his detailed paleontologic and stratigraphic studies of the Middle Devonian Hamilton Group and Tully Formation, and for his contributions to the knowledge of Chazy brachiopods. While at Yale University, and under the esteemed Charles Schuchert's guidance, Cooper blossomed as the current foremost specialist on fossil brachiopods, especially those of the Ordovician, Devonian, and Permian Periods. Cooper's brachiopod-taxonomy studies, biostratigraphic investigations, and identification of facies relationships brought clarity to Hamilton and Tully rock-unit correlations. For his notable paleontological accomplishments, Cooper was awarded the Paleontological Society Medal for eminence.

Today, the State Geological Survey and faculties and graduate students at universities and colleges have embarked upon sophisticated and specialized avenues of research dealing with New York's geology. Investigations into the realms of geochemistry, geophysics, seismology, oceanography, paleo-ecology, and environmental geology have supplemented the traditional areas of petrology, geomorphology, stratigraphy, sedimentology, economic geology, mineralogy, and paleontology. This has been made possible through fascinating new techniques and time-saving tools and equipment, not the least of which has been the incomparable computer. But, let us pause, and take cognizance of the pioneering and basic work of our predecessors, who labored so fervently without benefit of our modern tools and techniques. It was they who paved the way for our refinements of fact and speculation. We salute our titans of geology and paleontology and appreciate our laudible legacy!

Plate 9

Arthur F. Buddington

G. Arthur Cooper

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