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The Rutgers Geology Museum: America's first geology museum and the past 200 years of geoscience education

Lauren Neitzke-Adamo*
Rutgers Geology Museum, Rutgers University, Geology Hall, 85 Somerset Street, New Brunswick, New Jersey 08901, USA, and *Department of Earth and Planetary Sciences, Rutgers University, Wright-Rieman Laboratories, 610 Taylor Road, Piscataway, New Jersey 08854, USA*

A.J. Blandford
Department of History, Rutgers University, 111 Van Dyck Hall, 16 Seminary Place, New Brunswick, New Jersey 08901, USA

Julia Criscione
Rutgers Geology Museum, Rutgers University, Geology Hall, 85 Somerset Street, New Brunswick, New Jersey 08901, USA, and *Department of Earth and Planetary Sciences, Rutgers University, Wright-Rieman Laboratories, 610 Taylor Road, Piscataway, New Jersey 08854, USA*

Richard K. Olsson
Department of Earth and Planetary Sciences, Rutgers University, Wright-Rieman Laboratories, 610 Taylor Road, Piscataway, New Jersey 08854, USA

Erika Gorder
Special Collections and University Archives, Rutgers University Libraries, Alexander Library, 169 College Avenue, New Brunswick, New Jersey 08901, USA

ABSTRACT

The Rutgers Geology Museum is America's first geology museum. Rocks, fossils, and minerals had been collected into "cabinets of curiosities" since first contact between Europeans and Native Americans, and beginning in the late eighteenth century, many of these small personal cabinets were expanded, organized, and made available to the public at natural history and philosophical societies in Philadelphia and Boston. In the first decades of the nineteenth century, geology was widely recognized as an important new science that influenced the organization of collections on display at the growing number of colleges, academies, societies, lyceums, and museums that began popping up all over the United States, but it was not until 1872 that the first museum dedicated specifically to geology was built at Rutgers College. Rutgers University, known as Rutgers College until 1924, is itself one of the oldest colleges in America. Originally chartered as Queens College in the British colony of New

**Corresponding author:* lauren.adamo@rutgers.edu.

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Jersey in 1766, Rutgers, along with Harvard (1636), William and Mary (1693), Yale (1701), University of Pennsylvania (1740), Columbia (1754), Princeton (1755), Brown (1764), and Dartmouth College (1769), was among the nine colonial colleges founded before the American Revolution.

Since its inception, the Rutgers Geology Museum's primary mission has been to educate the public on natural history–related topics. How this was accomplished has varied greatly through the years and originated with the "cabinet" of minerals that was displayed to students, alumni, and professors in the days of Dr. Lewis Beck, the first geology professor at Rutgers College. Through the efforts of Dr. George Cook, professor and vice president of Rutgers College, Geology Hall was erected in 1872 as the permanent home for the collections, and the museum and its collections became the focal point of the natural history courses taught at the time. The many professors and curators who tended to the museum and its collections over the next half century helped shape and dictate the future of science and geology education at the university, and with the creation of the Department of Geology in 1931, the museum became a center of leading geologic research and the outlet to present the results to the community. Today, the museum strives to connect with the local K–12 and university communities to inspire the next generation of geoscientists to continue building upon the legacy that the many Rutgers University geologists worked so hard to build.

INTRODUCTION

The study of geology developed in Europe during the late eighteenth century and involved the uniting of three historically distinct fields: long-debated theoretical ideas about the history of the Earth—natural philosophy; the collection and classification of minerals, fossils, and other curiosities from underground—natural history; and the management of mines—practical mining (Porter, 1977; Laudan, 1987; Rudwick, 2007). Although a largely speculative mineralogical map of North America was presented in Paris in the 1750s, it wasn't until the end of the American Revolution that the first deliberately "geological" surveys were conducted and published in the 1780s (Merrill, 1964; Cailleux, 1972; Eyles, 1972). While Americans had always been extremely curious about their mountains and soils, these first geological reports were not widely available, and the spread of specifically "geological" knowledge and practices was initially limited to a handful of individuals who had received training in Europe (Hindle, 1956; Merrill, 1964; Greene, 1984; Newell, 1993; Parrish, 2006).

In 1787, Samuel Latham Mitchill, a Long Island native, published his *Geological Remarks on the Maritime Parts of the State of New-York* in a pamphlet primarily concerned with anatomy (Mitchill, 1787). Mitchill had just returned from completing a medical degree at the University of Edinburgh, and he had been a member of the recently formed Natural History Society where James Hutton's new geological theories were avidly discussed (Hall, 1934). Mitchill became one of the most influential early American geologists and naturalists, and his pamphlet is probably the first time the term "geological" was printed in America. That same year, naturalist Johann David Schoepf included numerous geological descriptions of America in his German language travel narrative, *Travels in the Confederation, 1783–1784* (Merrill, 1964; Schoepf and Morrison, 1968; Greene, 1984). Schoepf was a German physician and surgeon who had been stationed with Hessian and British troops during the Revolutionary War. He sailed to America with specific instructions to observe the mountains and soils of America, which previous travelers, such as the itinerant Linnaean naturalist, Peter Kalm (author of a 1755 travel account), had overlooked (Kremers, 1907; Merrill, 1964; Spieker, 1971). Although this work was not fully translated into English until the twentieth century, the sections on mining in New Jersey and Pennsylvania were published by a Philadelphia periodical in 1790, reflecting both the awareness of Schoepf's work among Pennsylvania naturalists (many of whom were literate in German) and the growing interest in mineralogical and geological subjects (Hoffman, 1901; Bates, 1965; Baatz, 1985; Reid-Maroney, 2001).

This small community gradually increased in size until it could support the publication of the foundational texts of American geology: William Maclure's *Geological Map of the United States,* in 1809; the release of the first American geological textbook, Parker Cleaveland's *Elementary Treatise on Mineralogy and Geology* in 1816; and the national distribution of geological articles in the *American Journal of Science and Arts,* commonly referred to as Silliman's Journal, beginning in 1818. These publications helped to extend and promote interest in geological surveying so that by the 1830s, geology was considered one of the most important and popular sciences in the country (Merrill, 1964; Kohlstedt, 1976; Greene, 1984; Daniels, 1994).

In the decades that followed, the number of geological texts and images, including those for children, multiplied. Attendance at geological lectures became so numerous that colleges began to integrate geology into their curriculum, and state legislatures began allocating thousands of dollars for the production of geological surveys and maps. These state geological survey projects represent the first examples of publicly funded scientific research in the United States. Because every state underwrote some measure of geological surveying, the surveys collectively helped to create an informal and decentralized corps of paid scientists. Eager to compare notes and formulate a national picture of American strata that could compete with and be related to European formations, these survey geologists created the first truly national scientific society, the Association of American Geologists and Naturalists. The society continues today as the American Association for the Advancement of Science and still holds their annual meeting in a different city each year. American geology finally received a national direction in 1879 with the creation of the United States Geological Survey (Merrill, 1964; Kohlstedt, 1976; Greene, 1982; Greene, 1984; Newell, 1993, Daniels, 1994; Gerstner, 1994; Lucier, 2008; Lewis, 2011; Spanagel, 2014).

The rapid expansion of the geological public during the nineteenth century was a global phenomenon that was driven by innovations in theory and practice developed in European centers and through the footwork and formulations of local observers from all over the world. Geology both fueled and was fueled by the global expansion of industrialization and its attendant thirst for coals, iron, and other ores. In America, the study of geology and the extraction of these resources was integrated with the nation's unique political structure of federal and state governments and the activism of local associations, which one foreign observer described as ubiquitous, "Everywhere that, at the head of a new undertaking, you see the government in France and a great lord in England, count on it that you will perceive an association in the United States" (de Tocqueville, 2002, p. 489–490). America did not have a large class of independently wealthy gentlemen scientists as in Europe or state-funded mining schools like those of France and Germany; therefore, the growth of geology during the first half of the nineteenth century was instead a mixture of the top-down lobbying efforts of early industrialists and the bottom-up interests of local groups of "citizen scientists" (Greene, 1982; Newell, 1993; Larson, 2001; Lucier, 2008; Lewis, 2011; Spanagel, 2014). College students, farmers, doctors, postal officers, judges, and teachers all wanted to understand their local soils, minerals, and artifacts, which led to a demand for lectures by experts, public "cabinets" to share and display collections, and initiatives to fund local and regional geological surveying. In the second half of the nineteenth century, geological work became professionalized, and specialized scientific instruction was more widely available at the new land-grant colleges and through scientific schools developed within many of the older schools, many of which also developed their own institutional museums (Hendrickson, 1961; Guralnick, 1975; Kuritz, 1981; Dupree, 1986; Kohlstedt, 1988; Daniels, 1994; Lewis, 2011).

The development of geology at Rutgers closely follows this larger national pattern, and the Rutgers Geology Hall and Museum are among the few remaining architectural legacies of this history. The still largely original and intact spaces of the museum display not only the historical collections but provide us a way of seeing nineteenth-century geology in its native habitat. Here, the preservation of the physical spaces where geological and natural historical specimens were collected, organized, displayed, and chemically and instrumentally analyzed also embodies the social organization of the human and financial capital—the students, professors, schools, states, and companies—that produced and paid for geological knowledge in the nineteenth century (Alpers, 1991).

EARLY AMERICAN GEOLOGY AS GEOLOGICAL EDUCATION

While Samuel Latham Mitchill published his geological remarks as early as 1787 (Mitchill, 1787), it was not until he had become integrated into community institutions such as Columbia College in New York City, the New York Society for the Promotion of Agriculture, Arts, and Manufactures, and the short-lived American Mineralogical Society (1798) that Mitchill's interest in geology found a wider audience. Mitchill began teaching natural history, chemistry, and geology at Columbia College in 1792, and many of these lectures were open to subscription by the public (Hall, 1934; Spieker, 1971; Greene, 1984). Similarly, Benjamin Silliman's first lectures on geology and natural history at Yale, beginning in 1807, extended beyond the school itself to include what he referred to as "volunteer amateurs" and inspired a new cohort of native-trained geologists such as Amos Eaton and Edward Hitchcock (Hall, 1934; Greene, 1984; Brown, 1989; Herbert, 2012; Spanagel, 2014).

Crucial to Silliman's success in New Haven specifically, and geological instruction in America everywhere, was access to a chemical laboratory for mineralogical analysis and the availability of comprehensive collections of European minerals, rocks, and fossils that were so essential for learning how to "read the rocks." Americans could make their own local collections, but mineral classification was based on European specimens, and without access to material examples, it was impossible to determine "even *the names* of the most common stones and minerals" (Silliman, 1818, p. 36). At the turn of the century, there were only a handful of collections available—Adam Seybert's in Philadelphia, Samuel Mitchill's in New York, and a collection David Hosack had donated to Princeton. As these collections increased, they also became more available to the public because some were donated to large institutions. Seybert, for example, transferred his collection to the Academy of Natural Sciences in Philadelphia, and the independently wealthy Rhode Island Colonel George Gibb eventually donated his famously "huge" collection to Yale, where it was available to any curious traveler. However, a collection alone was not sufficient. These immutable rocks needed to be enlivened by

inspiring instruction and their meanings made mobile through networks of exchange. Although Harvard College had a well-catalogued collection of hundreds of specimens from around the world, they did not have a Silliman like Yale or a Parker Cleaveland like Bowdoin College in Maine (Greene and Burke, 1978; Latour, 1987; Brown, 1989).

During the 1820s, geology grew in popularity as it became increasingly associated with the successful pursuit of internal improvements, such as the Erie Canal, the excavation of which unearthed exciting new fossil evidence about the vastness of Earth's history and the extinct creatures that had lived in these "former worlds" (Guralnick, 1972; Rudwick, 1992; Newell, 1993; Larson, 2001; Spanagel, 2014). However, there were still relatively few places where one could receive experienced training in subjects that would soon be thought of as "science," such as natural history, geology, chemistry, and engineering. In 1824, the British ended a restriction on the emigration of "artisans" with mechanical and engineering knowledge, allowing geologically trained surveyors such as Robert C. Taylor and John Finch to supplement the small but growing ranks of geological surveyors in America in the 1820s and 1830s (Torrens, 1990; Spanagel, 2014). The demand for trained surveyors, engineers, mechanics, chemists, and geologists and the popularity of these subjects led to a wave of new institutions such as the Rensselaer Institute, now known as Rensselaer Polytechnic, and educational reforms in older colleges such as Rutgers (Guralnick, 1972; Greene, 1984; Torrens, 1990; Geiger, 2000).

John Finch arrived in America in 1823, almost directly from a debtor's prison in London, and he hoped to benefit from these reforms and to obtain a position as a professor at one of the colleges that were adding natural history, chemistry, and geology to their curriculum (Torrens, 1990). Finch quickly integrated himself into the American geological community by giving lectures at local societies and publishing several articles in Silliman's Journal. In 1829, Finch was given permission to use the College building at Rutgers to deliver a series of 15 geological lectures, the first of its kind at the college. Like those at Columbia and Yale, these lectures took place physically at the College, but they were by subscription and open to the public (Torrens, 1990). What is especially interesting about this lecture series is that it was initiated and organized by a group of students in direct response to the public demand for instruction in geology. This same group of students also petitioned the board of trustees to allow them to form a Natural History Society, and the following year they succeeded in soliciting donations for a specimen cabinet and the purchase of several books. This mineral cabinet, originally displayed in Van Nest Hall (Fig. 1), for which there are very few records, can be considered the origins of the Rutgers Geology Museum (Rutgers College Faculty Minutes, Rutgers University Special Collections and University Archives, 1829–1831). Most likely Finch brought a small collection of his own to illustrate the lectures and spent time helping the residents name and classify their own local finds. In 1830, when the board decided to create a permanent professorship of natural history, they hired an American naturalist and chemist, Lewis C. Beck, instead of Finch (McCormick, 1966; Torrens, 1990).

THE FIRST GEOLOGY PROFESSOR AT RUTGERS COLLEGE, LEWIS CALEB BECK

The first geology professor at Rutgers College, Lewis Caleb Beck (1798–1853; Fig. 2) had institutional and personal ties to both Samuel Latham Mitchill and Amos Eaton, one of the founders of Rensselaer Institute, who helped inspire and shape the members of the first generation of professional American geologists (Kelly and Burrage, 1920; Fenton and Fenton, 1945; Wilkerson, 1963; Spanagel, 2014). Born in Schenectady, New York (1798), Beck graduated from Union College in 1815 and pursued a medical degree at the College of Physicians and Surgeons, the medical department of Columbia University located in New York City, and he began practicing medicine in 1818 (Gross, 1861; Kelly and Burrage, 1920). His older brother, T. Romeyn Beck, had assisted Eaton in the publication of *A Geological Survey of the County of Albany* in 1818 as part of a geological survey of Albany and Rensselaer County, New York, commissioned by the owner of one of the last remaining Dutch patroonships, Stephen Van Rensselaer. In 1821, Beck himself assisted Eaton in his next survey, *A Geological and Agricultural Survey of Rensselaer County, in the State of New-York,* and the results of these surveys became the standard for subsequent geological surveys (Spanagel, 2014). When the Rensselaer Institute opened in 1824, Eaton hired Beck as a junior professor of botany, mineralogy, and zoology (Gross, 1861; Kelly and Burrage, 1920; Wilkerson, 1963; Aldrich, 2000).

Like many of the other well-known geologists of the time who started out as lawyers, clergymen, surveyors, zoologists, and chemists, for Beck, geology was one pronounced aspect of a career as a "naturalist" that included publications in botany, chemistry, and mineralogy as well as a *Gazetteer of Illinois and Missouri*. There were few paying jobs for geologists, and those that existed did not pay well. While some geologists, such as Benjamin Silliman, had permanent positions, most early geology instructors, like Beck, had to piece together a living through multiple appointments. Even permanent professorships, like Silliman's, paid less than similar positions in the traditional fields that we now refer to as the humanities, and teaching work was often supplemented by private consulting work for wealthy individuals, mining companies, or the government geological surveys. Beck found teaching jobs in Vermont, New York, and New Jersey, and in 1836, he was hired as the mineralogist for the New York Natural History Survey. Later on, he received an appointment at the Patent Office to carry out some of the first chemical analyses of agricultural products as part of what would eventually become the Food and Drug Administration (Wilkerson, 1963; Newell, 1993; Aldrich, 2000; Lucier, 2008).

At Rutgers College, Beck taught geology and mineralogy as part of the natural history and chemistry courses and was heavily involved in studying and publishing on the local geology and

Figure 1. View of Van Nest Hall with students gathered in front, ca. 1850. Van Nest Hall was originally used to house and display the mineral and fossil "cabinet" during the days of Lewis C. Beck's tenure before the Rutgers College Geology Museum was built. Photograph courtesy of the Rutgers University Archives.

mineralogy of New Jersey and New York (Beck, 1842; Gross, 1861; Wilkerson, 1963). During his travels on foot and horseback over the years, Beck took copious notes and collected local geologic, mineralogical, and botanical specimens. These journeys, along with his chemistry background, fostered a lifelong pursuit into the examination and understanding of the chemical composition of minerals. Beck conveyed these practices and his extensive knowledge of chemistry to his students by combining field observations with chemical analyses performed in the laboratory. He amassed an extensive personal collection in tandem with the nearly 3000 mineral specimens gathered for the people of the State of New York (Gross, 1861). The Rutgers Geology Museum did not have a permanent building during the tenure of Lewis Caleb Beck, and Beck most likely used his own personal collection to supplement the mineral "cabinet" for instructional purposes. Shortly after his death, his collection was purchased by friends of Rutgers College and placed in the custody of the student Natural History Society. This collection would serve as a key component of the museum's mineralogical and teaching collections in subsequent years, and the Beck collection remains the oldest scientific collection still on display today at Rutgers University (Wilkerson, 1963).

GEORGE HAMMELL COOK, THE MORRILL ACT, AND THE FOUNDING OF THE GEOLOGY MUSEUM

In 1853, George Hammell Cook (Fig. 3), one of Rutgers University's most revered and well-known figures in its 250-year history, was hired by Rutgers President Theodore Frelinghuysen and the Board of Trustees to replace Beck as full-time professor of chemistry and natural science. Cook was urged to pay an informal and secret visit to discuss this position. With the promise of a higher salary, less arduous duties, the chance to do more advanced scientific research, and US$2000 to purchase laboratory equipment, he decided to accept the position at Rutgers College (Sidar, 1976). His appointment and accomplishments at the college led to the building of Geology Hall, the permanent home of the Rutgers Geology Museum, and the significant improvement of Rutgers College through the attainment of land grant status (McCormick, 1966; Sidar, 1976).

Figure 2. Portrait of Lewis Caleb Beck, professor of chemistry and natural science (1830–1853) and first professor of geology at Rutgers College. Photograph courtesy of the Rutgers University Archives.

Figure 3. Portrait of George Hammell Cook, professor of chemistry, geology, agriculture (1853–1889), vice president (1864–1889), and founder of the Geology Museum (1872) at Rutgers College. Photograph courtesy of the Rutgers University Archives.

Cook was born in 1818, raised in Hanover, New Jersey, and later moved to Troy, New York, to attend college at Rensselaer Polytechnic Institute between the years of 1838 and 1840 (Wilkerson, 1963; Sidar, 1976). He enrolled at Rensselaer with a keen interest in engineering but quickly changed his focus to geology and natural history due to the influence, once again, of Professor Amos Eaton, whose energy and enthusiasm, despite his declining health, continued to exert as strong an influence on his students as always (Sidar, 1976). Like Beck before him, Cook was also offered a position at Rensselaer Polytechnic Institute and strung together a series of tutoring and teaching jobs to support himself (Wilkerson, 1963; Sidar, 1976).

In 1846, he left teaching to try to pursue his fortunes in the glass-making business, but after a series of financial issues and the folding of the company (Sidar, 1976), he returned to education in 1848 as a teacher of mathematics and natural philosophy at Albany Academy (Wilkerson, 1963). Cook was unhappy teaching at a school with so few students; so he began lecturing at Albany Medical College in 1852, where he co-taught several courses in chemistry with Dr. Lewis Beck (Sidar, 1976). In 1854, shortly after Cook arrived at Rutgers College, he was named the State Geologist by the New Jersey Geological Survey and retained this title until his death in 1889 (Wilkerson, 1963; Sidar, 1976). In 1856, Cook was granted an honorary Ph.D. from New York University, a measure of his academic distinction during this period because there were no earned doctorates in the country until 1863 (Brubacher and Rudy, 1976; Sidar, 1976; Sheets-Pyenson, 1987; Bruce, 1988; Angulo, 2009). Over the years at Rutgers College, Cook's position was altered from professor of chemistry and natural history to include agriculture in 1867, and it was finally changed to professor of geology and agriculture in 1882. Additionally, he was named vice president of Rutgers College in 1864 and remained in this position until his death (Sidar, 1976).

Cook's simultaneous activities at Rutgers and with the government-run New Jersey Geological Survey during this time exemplify the dual appointments that many state geological survey geologists held (Merrill, 1978; Newell, 1993). As a professor at Rutgers, he helped establish the Bachelor of Science program and one of the first experimental agricultural stations in the country, and as the State Geologist of New Jersey, his research efforts encouraged the economic development of the clays, soils, iron, zinc, and water supplies throughout the state (Wilkerson, 1963; Sidar, 1976). The Morrill Land Grant Act, signed by President

Abraham Lincoln on 2 July 1862, allowed for the funds raised by the sale of public lands to be applied to the endowment and support of colleges in the study of military tactics, agriculture, and engineering (Vesey, 1965; Geiger, 2000). In the early 1860s, the college was struggling with low student enrollments and lack of funds for professors' salaries; therefore, Cook along with Professor David Murray, presented a proposal to the Board of Trustees in December 1863 to obtain funds from the Federal government under the Morrill Act. The board immediately accepted this proposal and embarked on an intensive campaign to secure the grant from the state legislators (McCormick, 1966; Sidar, 1976).

Cook himself undertook a majority of this task, personally seeking out legislators and other important and influential men of the time (McCormick, 1966; Sidar, 1976). Events culminated when the state legislators voted against Princeton University and the State Normal School at Trenton and voted in favor of Rutgers College (McCormick, 1966). In order to comply with the terms of the grant, the College needed to make some improvements to their facilities without the use of state funds. A run-down farm that would eventually become the experimental agricultural station was purchased, and a well-equipped observatory was built, largely through the gift of Daniel S. Schanck (Fig. 4). After a year-long fundraising campaign that brought in over US$121,000, it was decided that half of these funds would be designated to "build a geological hall" (McCormick, 1966). Henry Janeway Hardenbergh, great-great-grandson of the first Rutgers College president and the architect of the Kirkpatrick Chapel and Van Nest Hall on campus (Fig. 1) and the Waldorf-Astoria Hotel and Dakota building in New York City, was hired to build the large brownstone building. Construction on Geology Hall was completed in 1872, with an armory in the basement, a lecture hall and facilities for the physical sciences on the first floor, and the two-story geology museum with its large windows and open gallery occupying the central floors of the building (Fig. 5; McCormick, 1966).

The Rutgers Geology Museum within Geology Hall opened at this time with the purpose of displaying and making the ever-growing mineral and fossil collections compiled by Beck, Cook, and others more accessible to the public and for use in the instruction of geology and natural history classes (McCormick, 1966). The construction and opening of a permanent home for the Rutgers Geology Museum represented the culmination of work Cook had been pursuing since 1853 when he took over from Lewis Beck, and it represents both Cook's outsized influence within the College and the role that geology played in this period as one of the most preeminent and popular sciences.

Figure 4. View of the Schanck Observatory sometime in the l890s. This facility, built in 1866, was made possible with the funds donated by Daniel S. Schanck, for whom the Observatory is named. Photograph courtesy of the Rutgers University Archives.

Figure 5. Exterior view of Rutgers College Geology Hall sometime in the late 1800s. Geology Hall was built by Henry Janeway Hardenbergh and completed in 1872. The basement of the building was used as an armory, while the first floor contained a sizable lecture hall that was used to hold physical sciences classes. The Rutgers Geology Museum was built on the second and third floors of this building and resides here to this day. Photograph courtesy of the Rutgers University Archives.

In 1857, Cook reinstated the Natural History Society to stimulate and satisfy interest in natural history. The objective of the society was to expand the "cabinet" or museum of minerals that was started by Beck, and originally on display in Van Nest Hall on campus (Fig. 1), with Cook himself serving as president.

This collection was the most visible indicator of the entire sciences program at Rutgers College, and it was proudly displayed and toured by students, faculty, and alumni. Cook kept up extensive correspondence with colleagues around the world, even throughout the Civil War, to acquire and exchange mineral, fossil, and other natural history specimens to expand the collection (Sidar, 1976). By the end of his career at Rutgers College, Cook had collected and organized more than 4000 mineral and fossil specimens and acquired several other important artifacts, such as a mastodon skeleton from Mannington, New Jersey (Fig. 6) and several large slabs of Triassic sandstone from Morris County, New Jersey; these sandstone slabs contained footprints from seven different species of ancient reptiles including dinosaurs (Fig. 7; Wilkerson, 1963).

The origins of the Rutgers Geology Museum can be traced back to the antebellum era, when the student-led Society for Natural History organized the very first "cabinet" of minerals, just one of many of the numerous mineralogical and geological collections held by local colleges and academies, agricultural and natural history societies, and lyceums all over the country. Some of the most notable examples include the collection of the American Philosophical Society—which Charles Willson Peale displayed as part of his American Museum (1790), Yale College's mineral gallery (1811), the cabinet at Philadelphia's Academy of Natural Sciences (1812), and the Lyceum of Natural History of New York (1817). However, as geological collecting and observation increasingly shifted from the hands of "citizen scientists" to paid labor done by state surveyors, many of these smaller local societies sold off or transferred their collections to new institutional homes dedicated to natural history, as was the case with the many collections transferred to the Boston Museum of Natural History in 1830 (Bates, 1965; Greene, 1984; Preston, 1986; Conn, 1998; Yanni, 1999).

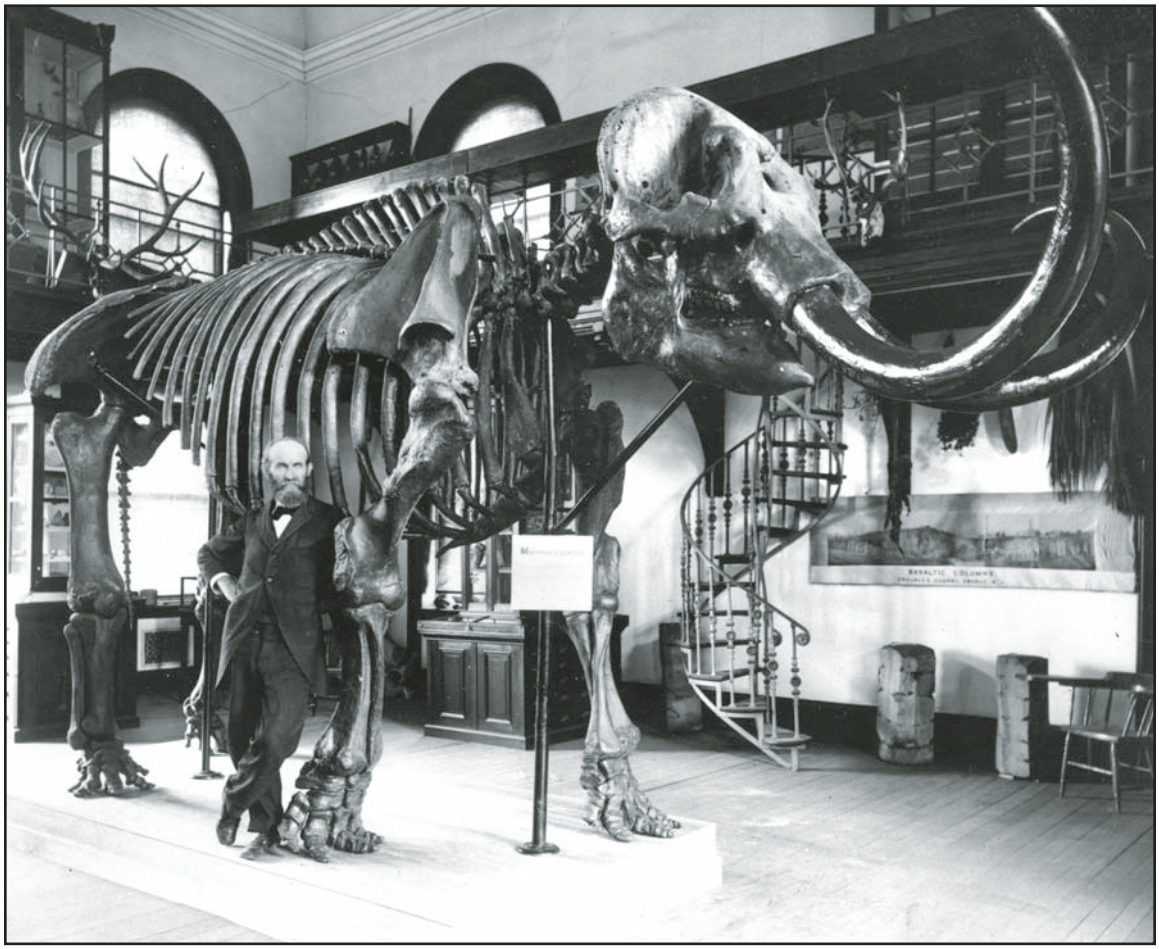

Figure 6. View of the mastodon skeleton from Mannington, New Jersey, on display in the Rutgers Geology Museum with William S. Valiant. Valiant was the assistant curator of the museum from 1893 to 1903 and the curator from 1903 to 1923. Photograph courtesy of the Rutgers University Archives.

Figure 7. View of the large slabs of Triassic sandstone from Morris County, New Jersey, acquired by George H. Cook. These slabs contain the trackways of seven different species of dinosaurs and reptiles. Photograph courtesy of the Rutgers University Archives.

Scientific research became more specialized during the middle decades of the nineteenth century, and the work of collecting, displaying, and explaining natural historical phenomena became the domain of larger government and university museums, such as the New York "State Cabinet of Natural History" (1845), the Smithsonian Institution (1846), Harvard's Museum of Comparative Zoology (1859), Yale's Peabody Museum (1866), and the American Museum of Natural History in New York City (1869). All of these museums had exhibits and collections featuring rocks, minerals, and fossils; however, the Rutgers Geology Museum is unique in that when it opened in 1872, it was the first museum dedicated exclusively to geology and can be considered America's first geology museum (Preston, 1986; Sheets-Pyenson, 1987; Winsor, 1991; Conn, 1998; Yanni, 1999; Chaplin, 2001; Miller and Buhay, 2007).

Shortly thereafter, several other geology museums opened up around the country, including the Colorado School of Mines Geology Museum (1874; Colorado School of Mines, 2017), the Arizona Mining and Mineral Museum (1884; Arizona Mining and Mineral Museum, 2015), the Orton Geological Museum at Ohio State University (1893; Ohio State University, 2017), the University of Wisconsin–Madison Geology Museum (~1877; University of Wisconsin Geology Museum, 2017), the South Dakota School of Mines and Technology Geology Museum (1885; South Dakota Mines, 2017), and the Fryxell Geology Museum in Illinois (ca. late 1880s; Augustana College, 2017).

CHESTER, VALIANT, AND THE FIRST MUSEUM CURATORS

In 1891, two years after Cook's death, Albert Huntington Chester was hired as a professor of general and applied chemistry, and then reappointed as a professor of chemistry and mineralogy and as the first official curator of the Rutgers Geology Museum in 1892 (Fig. 8; Rutgers College, 1916). Chester was born in 1843 in Saratoga Springs, New York, and began his career in mineralogy when he graduated with a degree in Mining Engineering from Columbia School of Mines in 1868, an M.A. from Union College in 1872, and a Ph.D. from Columbia University in 1878. He then went on to teach chemistry, mineralogy, and natural history at Hamilton College as a professor of mining and metallurgy from 1870 to 1891 (Paine, 1924; Aiken, 1945; Wilkerson, 1963). During his tenure at Hamilton College, not only was Chester a well-respected lecturer, but he also oversaw the Department of Chemistry and Mineralogy as the department head (Aiken, 1945). He also obtained, examined, and classified thousands of mineral specimens from type localities around the world, without the help of modern mineral identification techniques, in order to publish a comprehensive catalogue of mineral names and compositions (Chester, 1886). Chester also undertook the rearranging and relabeling of the State of New York's large mineral collection, a large portion of which was collected by Lewis Beck during his time at the New York Geological Survey, as it had fallen into disrepair with nearly all the labels misplaced or lost (Chester Collection Hamilton College, retrieved 2017). Chester worked diligently to restore order to this collection, and this experience curating and classifying mineral collections is most likely one of the reasons he was offered the position at Rutgers College and the Geology Museum.

When Chester arrived at Rutgers College, the Geology Museum already possessed a large collection of items that covered many topics within geology, including a collection of rock samples from across Europe and North America, a broad range of paleontological samples that covered the major topics in the field but with special emphasis on New Jersey, a large collection of shells, many stone tools and artifacts, thousands of mineral specimens, and the recently mounted mastodon skeleton (Fig. 6). He continued to personally accumulate mineral specimens as more samples were sent to him for analysis, and this ~4800-piece collection, later donated to Rutgers after Chester's death, remained a valuable research and teaching set at Rutgers University. Despite Chester's strong interest in mineralogy, little time was spent putting the Geology Museum's vast collections in order prior to the mid-1890s, a daunting task because of the many different systems of mineralogical and geological classification the nineteenth-century labels would have reflected (Greene, 1982; Newell, 1993;

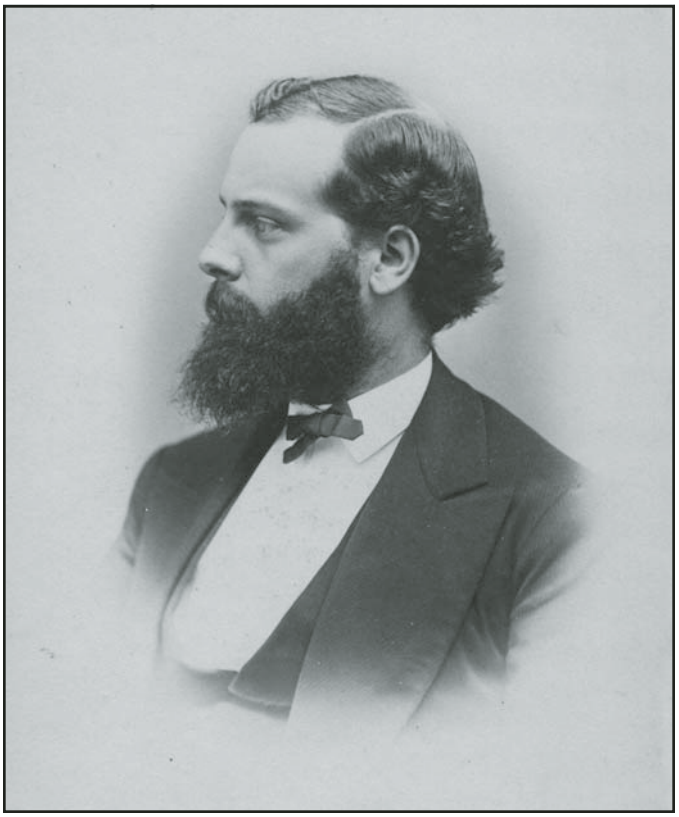

Figure 8. Portrait of Albert H. Chester, ca. 1880s, courtesy of the Hamilton College Archives. Chester became the first official curator of the Rutgers Geology Museum in 1892 and retained that title until his death in 1903.

Gerstner; 1994; Aldrich, 2000; Lucier, 2008). William S. Valiant was hired in 1893 to help Chester undertake the task of reorganizing the museum's collection as the assistant curator and held this position until Chester's death in 1903 (Figs. 6 and 9; Wilkerson, 1963). Valiant was then named museum curator and continued in this capacity until 1923, when his health would no longer allow him to complete his duties (Hayes, 1927).

Valiant was born in Rome, New York, in 1845, and he developed an interest in geology, fossils, and minerals at a very early age. He started exploring the local geology and fossil hunting around the age of 13 and educated himself by studying geologic reports and corresponding with State Geologist, James Hall (Hayes, 1927; Wilkerson, 1963). Valiant developed a keen eye for observation and became an expert at classifying minerals despite having no university training, and he actually helped catalogue minerals for the Rome Academy in 1875 (Wilkerson, 1963). He is also responsible for one of the most important paleontological finds of the century when he discovered a new species of trilobite, *Triarthrus becki,* which was the first specimen recovered with preserved antennae and appendages intact (Hayes, 1927). Later on in his life, he worked closely with the state geologists as a contributor to the Annual Reports of the New Jersey Geological Survey (Kümmel, 1909).

Under the guidance of Chester and Valiant, much progress was made in cleaning up the Geology Museum's collections and making improvements to the physical space. They continued to acquire more natural history specimens from around the world, including a giant Japanese spider crab exoskeleton and a right whale skeleton, which were both mounted in 1899 (Figs. 9 and 10, respectively; Wilkerson, 1963). Contrary to what one might assume about the limited scope of responsibility for an assistant curator, Museum records show that Valiant actually did the majority of the work organizing, re-labeling, and recording the thousands of fossil and mineral specimens in the collection. As Chester's health declined, Valiant took on more of the responsibilities of the museum and was performing the majority of the curator duties long before Chester's death (Chester Collection, Rutgers University Special Collections and University Archives, 1871–1903; Valiant, 1899). Valiant kept diligent records of the museum visitors and encouraged all the visitors to ask questions

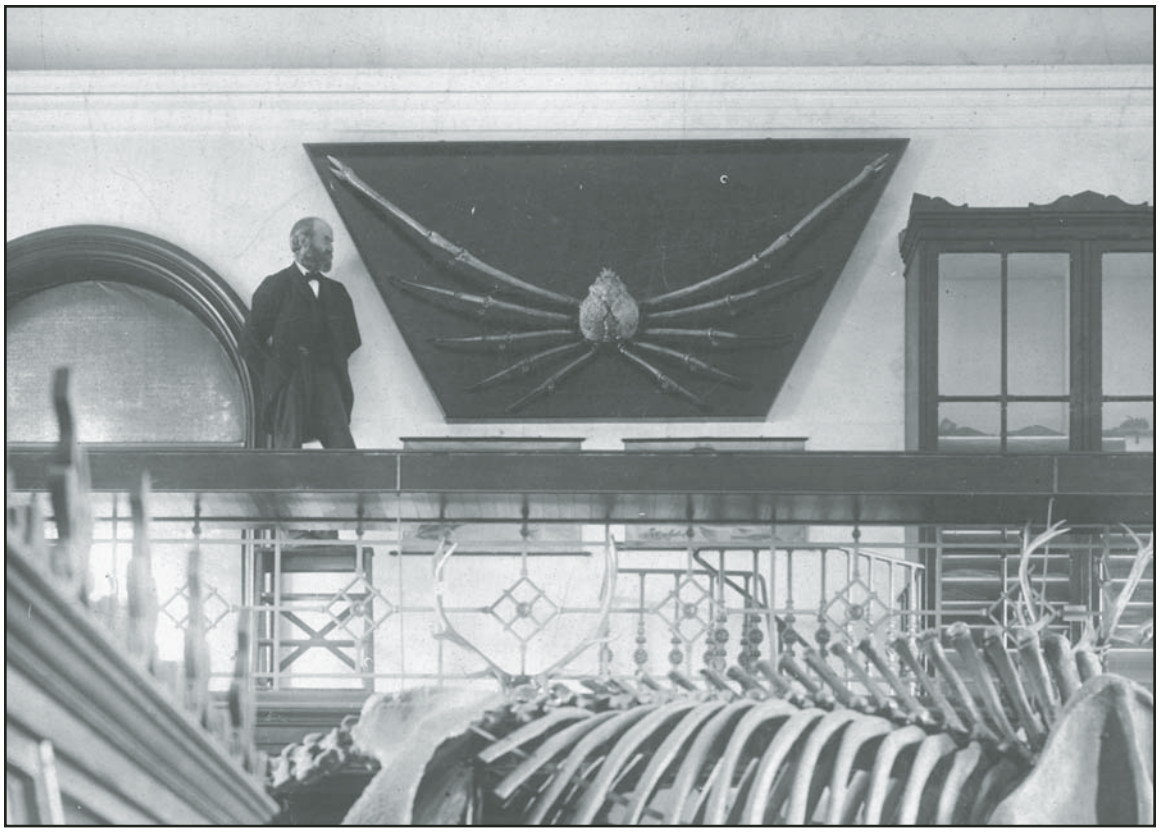

Figure 9. View of a giant Japanese spider crab with William S. Valiant. This spider crab was gifted to Rutgers College from the Japanese government as a gesture of good will for accepting many Japanese students at the College in the late 1800s. It was originally mounted in 1899 and remained on the walls until the 1980s, when it started to fall into disrepair. This giant spider crab specimen was returned to its historic location in the Rutgers Geology Museum in 2015 after a three-year restoration project. Photograph courtesy of the Rutgers University Archives.

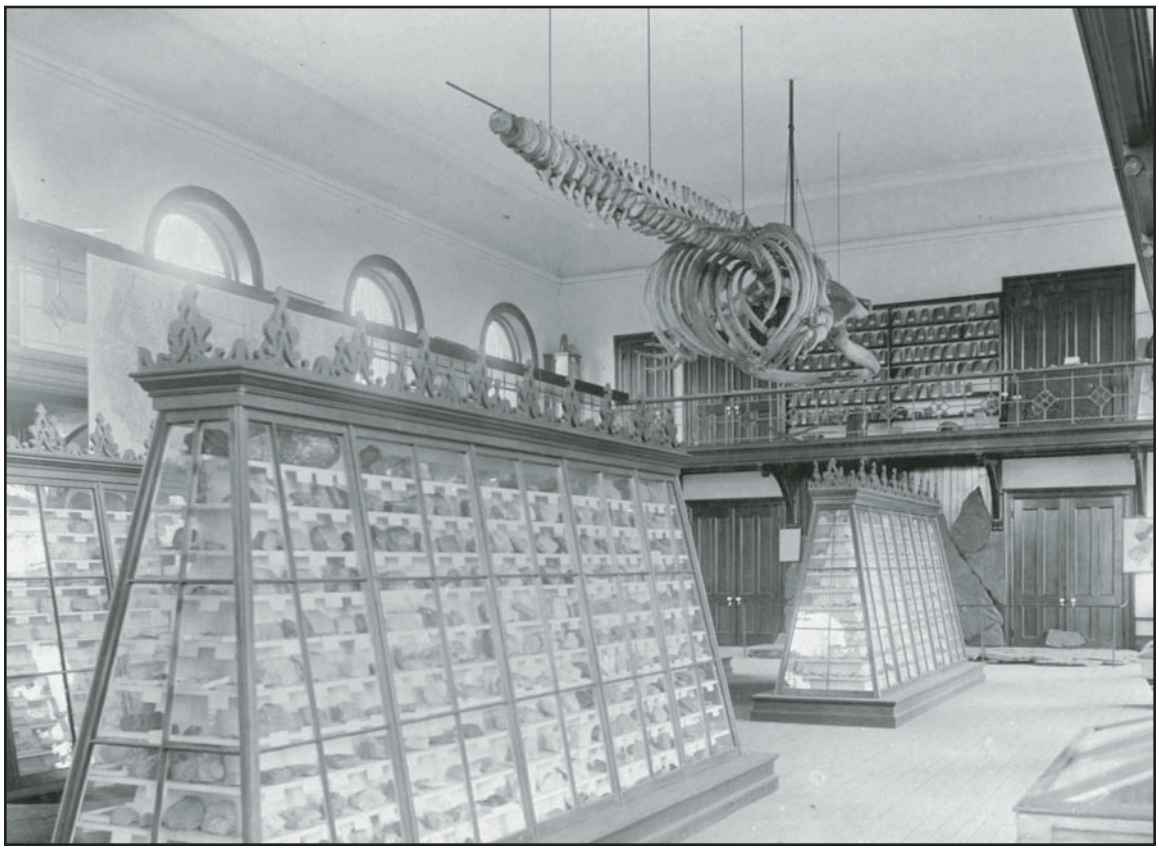

Figure 10. Interior of the Rutgers Geology Museum with a view of the right whale, mounted in 1899, hanging from the ceiling. The whale bones were later given to Yale University where they were discarded. The floor of the museum is covered with cabinets filled with mineral and fossil specimens that would be visually inspected by students taking mineralogy and natural history courses at Rutgers College during the late 1800s. Photograph courtesy of the Rutgers University Archives.

about the exhibits. He took great pride in the educational value of the museum, and he was constantly looking for ways to increase its impact to the general public (Rutgers College Geology Museum Records, 1860–1919; Valiant, 1899).

MODERN MUSEUM ERA

Geology Courses and the Creation of the Geology Department

Many other prominent geologists stepped into the role of Museum Director during the next several decades, including Dr. Joseph Volney Lewis from 1911 to 1927 (Curator from 1904 to 1911), Dr. Albert Orion Hayes from 1927 to 1944, Dr. Helgi Johnson from 1944 to 1961, Dr. James H.C. Martens from 1961 to 1967, and Dr. Raymond C. Murray from 1967 to 1977 (Wilkerson, 1963). Until the 1920s, much of Geology Hall was occupied by the Department of Physics, and the geology and mineralogy professors taught courses in the dedicated classroom, mineralogy laboratory, and museum space within the building. From the early 1900s until the late 1920s, the activity amongst the geology professors was largely centered around classroom instruction and working on cataloging and displaying the vast rock, mineral, and fossil collections of Beck, Cook, Chester, and others (R.K. Olsson, 2016, personal commun.).

Geology at Rutgers began to take on its more modern form when Albert Orion Hayes (Fig. 11) was hired in 1926. This same year, the Department of Physics vacated the premises in Geology Hall, allowing the geology professors to completely take over all four floors of the building, with the museum and offices on the second and third floors and classrooms, laboratories, and faculty lounges in the basement and first floor (R.K. Olsson, 2016, personal commun.). At this time, Rutgers College received a considerable donation willed by Mr. Fred Canfield to be used toward the furtherance of geology at the college (Wilkerson, 1963). This donation helped geology to officially become a major department when the first B.S. degree in geology was awarded in 1931. The first earned doctorate and master's degrees in geology followed shortly after in 1938 and 1939, respectively (R.K. Olsson, 2016, personal commun.).

The Rutgers College Geology Museum and Geology Department continued to grow through the mid-1900s as new faculty

were hired and more collections were acquired. Many new courses in geology were offered between 1926 and 1945, including paleontology, geomorphology, human origins, sedimentology, stratigraphy, and crystallography (Wilkerson, 1963). As the focus of geological research and instruction shifted increasingly to these new sub-fields, the historic mineral collections were less and less frequently used in lectures and coursework. Despite this, the museum's collections continued to grow as additional acquisitions were made, most significant of which was the Rowe collection donated in 1940 (R.K. Olsson, 2016, personal commun.). George Rowe was the mining captain for the New Jersey Zinc Company in Franklin, New Jersey, from 1906 to 1934, and the ~2400-piece collection contains an array of minerals from around the world but prominently features fluorescent minerals from New Jersey (Wilkerson, 1963; Rowe, 1999). Many of these and other historic minerals remain on display today at the Geology Museum, and the collection remains a valuable reference collection with many samples from all over the world and from some localities in New Jersey and New York that are no longer accessible (Fig. 12; Beck Papers, Rutgers University Special Collections and University Archives, 1839).

Figure 11. Professor Albert Orion Hayes (standing; 1926–1951) and Professor Alfred C. Hawkins (squatting; 1927–1933) examining a dinosaur footprint that was discovered in the clay pits in Woodbridge, New Jersey, in 1930. Photograph courtesy of the Rutgers University Archives.

In 1977, the Geology Department moved from the Geology Museum within Geology Hall to renovated quarters in a building on another campus, thus completing the relocation of all Rutgers College science departments across the Raritan River to Busch Campus (Wilkerson, 1963; R.K. Olsson, 2016, personal commun.). Under the direction of Dr. Richard K. Olsson (Fig. 13), hired in 1957 and department chairman from 1977 to 1996, the Geology Department increased its research focus by hiring many new faculty members and laying the groundwork for the strong geologic research institution it is today (R.K. Olsson, 2016, personal commun.). This move marked the end of active research activities within the museum and the expansion of the museum's education and outreach mission despite the commencement of the annual open house program prior to this time.

Outreach and Public Education

The Geology Museum first expanded its public outreach initiative with the establishment of its annual open house at the end of January in 1968 (Fig. 14). This event, first suggested by museum technician, Al Bliss, and supported by Dr. Murray, entailed a series of faculty-organized lectures, exhibits, rock and mineral identifications, and movies in Geology Hall for Rutgers students, the public, high school teachers, and students. The sale of various mineral collections to fundraise for the museum began in 1975 and has since been a major activity of the open house. In the early years of the open house, Rutgers faculty performed most of the lectures, and, in subsequent years, invited speakers from other universities, research centers, government departments, and academies all over the country. The annual open house has been host to several major scientific discoveries; for example, the Moon rocks collected during the Apollo 11 lunar landing (1969) were exhibited in 1971, and the first public presentation of the rediscovery of the *Titanic* was presented by Dr. Robert Ballard of Woods Hole Oceanographic Institute in 1986 (R.K. Olsson, 2016, personal commun.). The lecture program included the latest research results from various fields of geology, paleontology, mineralogy, archeology, oceanography, evolution, extinction, glaciology, seismology, physics and astronomy, meteorites, etc., from around the world. Records of attendance were not kept prior to 2010, but with an average of well over 2000 people in attendance every year, this event remains the largest and most well-attended public event of the year, and 2018 marked the 50th anniversary of the first open house.

From 1977 until 2009, the head of the Department of Earth and Planetary Sciences, known as the Geology Department until 2007, also served as the director of the Geology Museum. The Geology Department heads who also filled the role of museum director include Dr. Richard K. Olsson (1977–1996), Dr. Michael J. Carr (1996–1999), and Dr. Kenneth G. Miller (2000–2009). In 1978, Dr. Olsson appointed William Selden (Fig. 15) as curator of the museum, a position he held until his

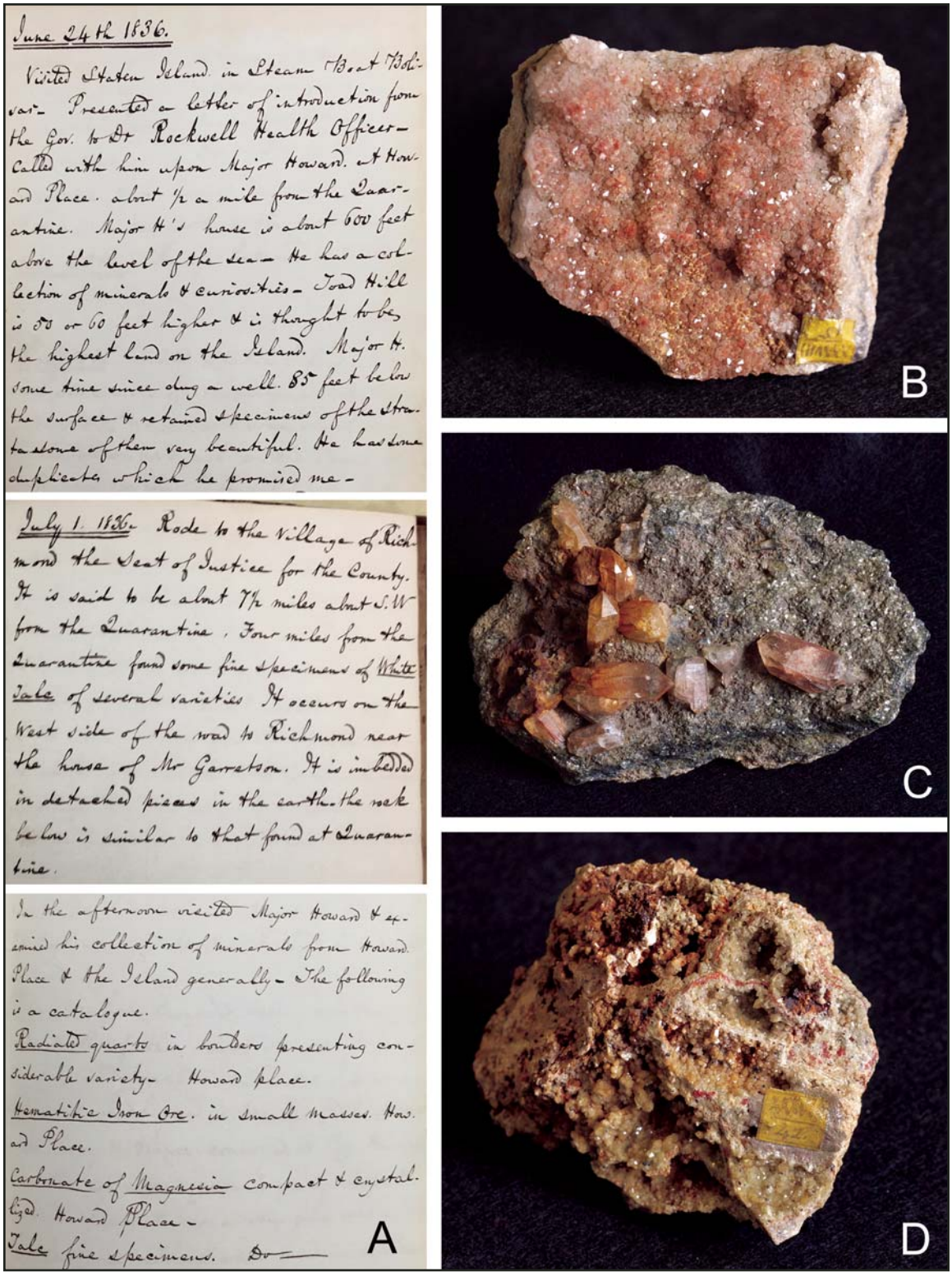

Figure 12. Specimens and historic documents from the mineral and archive collection of Dr. Lewis Beck. (A) Notes from Beck's original journal describing some of the minerals still in the collections today. Images courtesy of the Rutgers University Archives. (B, C) Quartz specimens from Diana, Lewis County, New York. (D) Quartz specimen with talc collected near the "Quarantine" Hospital in Tompkinsville, Staten Island, New York. Stephenson (2004) had previously stated that this mineral locality, which was once small farmland, is now built-up and no longer accessible. This study was able to match the historic mineral specimens and journal entries to this locality that is no longer a viable collection site.

Figure 13. Professor Richard K. Olsson (left; 1957–present), Professor Raymond Murray (1973–1977), and John Beardsloe III (right) of the New Brunswick Theological Seminary; they are examining the remains of Egyptian priestess Iset-Ha on display at the Rutgers Geology Museum, ca. 1969 (photograph courtesy of the Rutgers University Archives).

retirement in 2009. Under his guidance, new exhibits were created, and the annual open house continued to grow. A significant effort was made by Selden and a few dedicated volunteers to inventory the many thousands of rock, mineral, and fossil specimens in the historic Rowe, Chester, Cook, and Beck collections, which had been moved out of Geology Hall in the 1960s due to the growing geology faculty (R.K. Olsson, 2016, personal commun.). However, hundreds of these historic minerals can still be seen on display within the museum today. In the 1990s, the Friends of the Geology Museum was established to create a stronger connection between the museum and its patrons with the purpose of sponsoring museum activities that enhance the services to the public and enrich the educational environment of the community. Selden was also responsible for first introducing guided tours of the museum for K–12 school and special interest groups, a program that is still in effect today and brings thousands of children to the museum each year (Fig. 16; R.K. Olsson, 2016, personal commun.).

During a Rutgers University transition in 2009, control of the Geology Museum was transferred from the Department of Earth and Planetary Sciences, to the unit of Undergraduate Academic Affairs under the dual directorship of Dr. Kathleen Scott from Biological Sciences and Dr. Carl Swisher from Earth and Planetary Sciences. The museum's outreach programs were greatly expanded during this time to include new interactive family-friendly programs on weekends and week nights, guided field trips to local geologic sites, and increased programming to facilitate K–12 interaction at the annual open house event (Fig. 16). Faculty and staff with science and educational backgrounds enhanced the guided tour programs with hands-on learning activities that addressed the Core Curriculum Standards, now called Next Generation Science Standards, and they started offering a wider variety of tours, such as bilingual tours for the English as a Secondary Language classrooms, Boy Scout and Girl Scout groups, etc. Today these programs reach an average of 8000–10,000 people a year and more than

Figure 14. Photographs from the first Rutgers Geology Museum open house in 1968. (A and B) The mineral sale; (C) Professor Steven Knowlton Fox (1948–1981) talking with visitors and volunteers; and (D) a view of the interior of the museum. Photographs courtesy of Richard K. Olsson.

100 different schools and groups within the Rutgers University and New Jersey communities.

In 2015, oversight of the Rutgers University Geology Museum was moved back to the School of Arts and Sciences, and Dr. Lauren Neitzke-Adamo and Dr. Patricia Irizarry-Barrato were named co-directors. An advisory committee, consisting of museum and university staff, undergraduate and graduate students, faculty members, and active museum members, was created with the hope of developing a mission for the museum that will further cement the commitment to enhance the Geology Museum's impact on Rutgers University and its surrounding communities. The museum continues to be committed to providing varied, dynamic, and scientifically relevant exhibits and offering stimulating K–12 outreach opportunities while preserving the historic aesthetics and cultural integrity of the museum. New efforts will be made to expand the role of the museum in Rutgers University education, and additional internship and place-based learning opportunities will be created and offered to university students to enhance their learning and professional experiences. Significant improvements have been made to the types and quality of the programs offered at the Rutgers Geology Museum in recent years, and the museum staff hopes that these new efforts will help establish the museum as a leading outreach and education center at Rutgers University and throughout New Jersey.

THE MUSEUM AS A RUTGERS RESOURCE AND CONCLUSIONS

With the increase in fiscal constraints in recent years to state and university natural history museums, many museums have been forced to shutter their doors, and the priceless collections have been forcibly relocated to other institutions, dismantled, or sold for profit (Allmon, 1994; Dalton, 2003; Froelich, 2003; Gropp, 2003; Conniff, 2016). The value of natural history museums and their collections as resources for research and public education is commonly misunderstood by the general public (Allmon, 1994). Even though active research is no longer conducted at the Rutgers Geology Museum, it still provides value to the research community as a means to document the past, a repository of reference material, and as a center for disseminating current research to the public through hands-on education (Allmon, 1994; Suarez and Tsutsui, 2004). Throughout the museum's history, members of the Rutgers University faculty have taken an active role in the creation of new and exciting exhibits

Figure 15. Museum Curator William Selden giving a tour to a group of schoolchildren at the Rutgers University Geology Museum. Photograph courtesy of the Rutgers University Archives.

based on the latest natural history–related discoveries. In the days of Cook, Chester, Valiant, etc., the professors took the lead in this endeavor; whereas, today, the museum directors, staff, and educational specialists oversee the majority of the exhibit renovations and consult with university professors to ensure the scientific accuracy and relevance of the new displays. Furthermore, many Rutgers University undergraduate and graduate students assist the museum staff with exhibit design and other museum activities, through internships and place-based course requirements, providing valuable professional development experience for the next generation of educators and researchers.

In addition to the immense historic value of the museum and the building, the Rutgers Geology Museum remains a valuable resource as a place of learning. The popularity of science museums has significantly increased over the past 50 years (Friedman, 2007), and research has shown that people of all ages learn from museum visits through the memories they create and transformative experiences (Ramey-Gassert et al., 1994; Rennie and McClafferty, 1995; Weil, 1995; Rennie and Johnston, 2004; Soren, 2009; and others). Visitors can be transformed by gaining new appreciation of a topic they knew little about, having their previous views or beliefs challenged, or when they are provided with opportunities to explore new ideas and concepts (Soren, 2009). These experiences may have profound life-long effects; for example, a museum visitor might decide to become a paleontologist after watching scientists work on excavating fossils at a museum. Change can also be as seemingly insignificant as when a student correctly recalls a concept or answer based on a visit to a museum (Rennie and McClafferty, 1995). Thousands of school-aged children from all over New Jersey and the surrounding states visit the Rutgers Geology Museum each year, and in some cases, these visits might be their only exposure to science topics outside of the classroom. As a free museum, the Rutgers Geology Museum serves many underprivileged areas including New Brunswick, New Jersey, the town in which the museum is located. Courses across a broad range of subjects, including geology, ecology, evolution, anthropology, history, art history, creative writing, art, American studies, education, etc. bring hundreds of Rutgers University students to the Geology Museum each year to utilize the resources and exhibits available in order to enhance the university students' learning experiences.

Figure 16. The Rutgers Geology Museum today. (A) A view of the inside of the museum in 2017 showing the Mannington mastodon and the newly restored spider crab that was remounted in 2015. (B) Visitors participate in activity stations during an annual open house. (C) Visitors collect fossils on a field trip to Big Brook Preserve in Colts Neck, New Jersey. (D) A group of Girl Scouts pose in front of the mastodon as they explore the exhibits at a "Late Night at the Museum" event.

Much more time and effort would need to be invested to transform the museum into one of the leading outreach and educational centers in New Jersey; however, the Rutgers Geology Museum remains a treasure within the Rutgers University and New Jersey communities. As the first geology museum in America, the long geologic, architectural, mineralogical, and educational history surrounding the Rutgers Geology Museum deserves to be preserved so that many future generations can experience this museum first hand. The museum staff is embarking on a new chapter in the history of the Rutgers Geology Museum, and as part of this effort, they hope to enhance the many exhibits, tours, and programming available to the public. By forging new relationships across New Jersey, the museum hopes to expand its mission and to continue to meet the changing educational needs of the times, while keeping the Rutgers and New Jersey communities, which were so pivotal in demanding the need for a public space for geologic education in the first place, as its top priority.

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