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Book Review
From Hooke and Leibniz to Rouelle and Lavoisier, the eventful world of early geologists. A review of "Studies on Eighteenth-Century Geology, a Selection of Papers by Rhoda Rappaport"

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Kenneth L. Taylor and Martin J. S. Rudwick (Eds.): From Hooke and Leibniz to Rouelle and Lavoisier, the eventful world of early geologists. A review of Studies on Eighteenth-Century Geology, a Selection of Papers by Rhoda Rappaport, Ashgate Variorum, 366 pp., ISBN-13: 978-1-4094-2959-3, EUR 118.00, 2011

Geophysicists can boast that some branches of their discipline date back from the earliest stages of science; they can even claim as theirs some of the most illustrious scientists. Geodesy, for instance, was certainly born in the early 5th century BC when the spherical figure of the Earth was recognized by Parmenides. The physics of the atmosphere quickly followed suit with Anaxagoras (500?–428? BC) who stated that water freezes "*when a cloud is pushed into the upper region, which is colder because there the reflections of the rays of the sun from the Earth cease*" — this was why "*hailstorms occur more often in summer and in hot places, because the greater heat pushes the clouds higher up from the Earth*". Seismology then got a start when Posidonius (~135–~51 BC) observed that there were two kinds of earthquakes: "*one is succusio* [jolt from underneath], *when the Earth is shaken by an up-and-down movement. The other is inclinatio* [tilting], *whereby the earth leans to one side or the other like a ship*". Later, geomagnetism was clearly at the roots of the well-conducted experimental investigation of the magnetic needle made by Petrus Peregrinus in the 13th century. And gravimetry took on a firm stand with the pendulum observations performed by Pierre Bouguer (1698–1758) during the long expedition in Southern America made from 1735 to 1744 to determine the length of a degree of meridian.

For those geophysicists unfamiliar with the history of Earth Sciences, it could come as a surprise to learn that the discipline that we now call *geology* was just beginning to emerge at the time of Bouguer. Not only was it much more difficult to understand the Earth's activity as a whole than to investigate some particular geophysical phenomena, but the real problem was originating in the *time* variable: no place had actually been left for *history* in a world that had first been thought eternal in Antiquity and then, with the advent of Christianity, only a few thousand years old. The idea that the Earth had a history and that this history could be deciphered thus had a very slow gestation. That Nature is replete with traces of past episodes was eventually recognized as a result of a slow dialectical process whereby observations of strata, *fossils*, mountain building and dismantling, or sedimentation led astute naturalists to enlarge considerably the time frames relevant to the Earth's activity. The key period in this respect was the years 1775–1825, the "heroic period" when geology at last took its name and grouped under the same umbrella various pieces of the natural sciences that were turned toward a common historical goal.

This long formative period of geology has been the main theme investigated throughout the years by the late Rhoda Rappaport (1935–2009), a noted historian of science who taught at Vassar College during her whole career. Her best-known work is *When Geologists Were Historians, 1665–1750*, a book published in 1997 that describes the interplay of civil, natural and sacred history that led to the progressive realization that Nature itself was historical, and even enticed a few savants to guess "*the possibility that the Earth's history might be correlated with a history of life*". The present review

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deals with a valuable complement to this book, namely, sixteen essays of a more specialized nature that have been selected as a fitting tribute to Rappaport's endeavors by two other leading historians of geology, Martin Rudwick and Ken Taylor. As they summarize in their introduction, "*much of Rappaport's research addressed two problems prevalent within 18th-century earth science: the proper understanding of petrifactions, or fossil objects; and struggles to establish reliable knowledge of the earth's past*". These two features were in fact so intimately related that they would eventually result, at the beginning of the 19th century, in the use of fossils as the basis of a relative chronological scale of truly fundamental importance. But, as revealed by the five sections into which the selected papers have been split, Rappaport's research was of such a breadth as to include a great variety of other topics.

There are many ways to sift through such a rich material. In the first two sections a common feature is how personal inclinations and interactions, combined with careful observations and smart interpretations, resulted in the making of a discipline. Here, an interesting character is Guillaume Rouelle (1703–1770), a chemist whose fame mostly rested on his vivid teaching before rapidly fading away afterward because of the scarcity of his published work. In relation to the vegetal and animal realms, Rouelle aimed at a comprehensive understanding of the mineral realm which led him to distinguish two, and then three general kinds of strata depending on their relative antiquity. Among his listeners was Nicolas Desmarest (1725–1815), who would discard the sedimentary nature of basalt to demonstrate instead its volcanic origin in 1763. And there was also Antoine-Laurent Lavoisier (1743–1794) who attended Rouelle's lectures at the time he was beginning important geological observations with Jean-Etienne Guettard (1715–1786), the discoverer of extinct volcanism in 1751. First known as a talented field geologist, Lavoisier was hired by Guettard to help him prepare a detailed Mineralogical map of France. This project was much too ambitious to be completed, and it would also be a source of controversy between Lavoisier and another member of the team, but it launched the effort that resulted early in the 19th century in the first geological maps. Even when he was busying himself with quite different investigations Lavoisier never lost his interest for the Earth. He long toyed with the idea of writing his own *Theory of the Earth* based on the conceptions of his time about a single era of deposition of sediments in stationary seas until his own field observations in the Paris basin led him to formulate "*the revolutionary idea*", as Rappaport put it, of "*a succession of ages characterized by a cyclically advancing and subsiding ocean*". And whereas Rouelle had been in chemistry a strong proponent of the phlogiston theory, which was supposed to account for combustion, ironically it was Lavoisier who brought against it a decisive blow with his balance.

The third section, *Understanding the Earth and Its History*, deals with themes addressed in the preceding century by famous savants whose interest for matters geological is not generally known. The first is Robert Hooke (1635–1703), the physicist, who was among the earliest defenders of the thesis that what we call today *fossils* were the remains of formerly living organisms and not the products of elusive mineral forces, as many were still claiming. But how were these remains buried and thereafter uplifted? Hooke needed a mechanism for these purposes, but he met with a skeptic audience when he claimed that earthquakes were the source of all geological transformations. What sense could be made of new observations that were accumulating at a high rate? No one was in a better place than Fontenelle (1657–1757) not only to ask this question, because he was for decades in charge of the transactions of the Paris Academy of Science, but also to answer it in terms of the new notion of history. Gottfried Wilhelm Leibnitz (1646–1716) was another luminary who took interest in the Earth. Following René Descartes (1596–1650), he assumed in his *Protogaea* that the Earth had initially been molten, an idea somewhat akin to that of our current Magma ocean. And he also defended the organic origin of fossils in a 1706 short communication, which has long been sought after and was finally unearthed in the archives of the Paris Academy of Sciences by Rappaport. As for the Flood, its role as a major geological agent was highly debated. Within the then prevailing view that the Earth was about 6000 yr old, the discussion was not limited to the origin of fossils or the formation of mountains; it represented a lively illustration of the interactions between the Book of nature and the Book of Scripture that was an important ingredient in the emergence of a geological science.

The two papers of the fourth section might seem to address mainly matters of nomenclature. The fondness of geologists for new words had implications that went well beyond philology, however, at a time when the new discipline was taking shape. As a matter of fact, geology was early on prone to controversy because, in spite of painstakingly acquired observations, field evidence was too often ambiguous. Rappaport thus termed "*dangerous words*" those terms, such as diluvialism, catastrophism, or Neptunism, which have been used indiscriminately as weapons in the fierce polemics in which geologists entered, without regard to the fact that their usefulness was restricted to much more narrowly defined contexts.

The last section has also some sociological flavor because it investigates how science was done either by individuals or within institutions. Even though she focused on France, the main scientific power of the age, Rappaport took interest in some noted foreign scientists such as the "Italian gentleman" Antonio Vallisneri (1661–1730) and the German-born baron d'Holbach (1723–1789), yet another Rouelle's student who was a major contributor to Diderot *Encyclopédie* where he made heavy use of German and Swedish science, especially in fields such as mining and mineralogy, with the claim that a reformed chemistry was a prerequisite to understand the Earth's history. Besides, that funding of science is not a recent issue is illustrated by a contribution on the

various kinds of motivations for Government support in 18th-century France. As a study of the inner workings of a scientific institution, the last essay will also sound familiar to today's readers: it investigates the relative importance of scientific competence, political influence, philosophical sympathies and other factors on the selection and promotion of the Parisian academicians.

In summary, this series of papers nicely illustrates the diversity as well as the careful nature of Rappaport's studies. These glimpses at the multifarious activity that was taking place in the 17th and 18th centuries are representative of the questions raised by the best minds of these periods. The variety of lively characters and themes dealt with nicely depicts not only the state of Earth investigations at these periods, but also a complex web of personal and institutional relationships at a time where there were no clear-cut boundaries between disciplines. Lavoisier began as a smart field geologist and ended up as a truly outstanding chemist, making it unlikely fortuitous that the Chemical Revolution took place at the same time as geology was born. Throughout the five sections of the book, the papers might seem to have been arranged in logical order, whereas this arrangement actually reflects the chronological order of Rappaport's publications. In other words, this volume provides one with rich insights on how the thought of an innovative historian of science evolves, turns to unexpected facts, broadens its scope and eventually addresses a variety of initially unforeseen questions along with their diverse ramifications.

Finally, a word might be proper about the Variorum books published by Ashgate. This series is probably not well known among geophysicists, but it has proven very helpful in fields where a significant fraction of the literature appears as chapters in books, *festschrifts* or other publications that can be difficult to consult. This review thus gives the opportunity to call the readers' attention to two other Variorum volumes of particular interest to Earth scientists. They gather papers by M. Rudwick and K. Taylor themselves, which are devoted to a great many aspects of geological research around the 18th century. Along with Rappaport's these fine volumes should be on the shelves of any decent Earth Sciences library.

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