BOOK REVIEWS

Edited by Vic Baker

THE LANGUAGE OF MINERALOGY: JOHN WALKER, CHEMISTRY AND THE EDINBURGH MEDICAL SCHOOL 1750–1800. Matthew D. Eddy, 2008. Farnham, United Kingdom and Burlington, USA: Ashgate Publishing. 332 pp. Hardcover, £60.00.

THE WORLD IN A CRUCIBLE: LABORATORY PRACTICE AND GEOLOGICAL THEORY AT THE BEGINNING OF GEOLOGY. Sally Newcomb, 2009. Geological Society of America, Special Paper No. 449. 204 pp. Soft cover, $60.00.

Most earth-science historians have long neglected the role of chemical and mineralogical knowledge and the uses of experimental methods in the early years of modern geology. Statements like this are not new; rather, they refer to a frequently deplored gap in the history of geology. The observation applies particularly to Anglo-Saxon history of geology. For while the chemical and mineralogical background of Continental geology (mainly German, Scandinavian and Russian) has frequently been emphasised, until recently there seems to have been no corresponding approach for British geology where an emphasis on stratigraphy and fieldwork has predominated. Moreover, the classical history of geology, and in particular the history of controversies as exemplified by the 'Neptunism–Plutonism' debate, is often implicitly presented as a kind of schism between chemically and mineralogically trained naturalists on the one hand, and 'travelling field-workers' on the other.

Now, in just the last couple of years, two—and, to say in advance, wonderful—books have appeared that fill this gap in the history of geology. New books by Matthew D. Eddy and Sally Newcomb both cross the line between chemical and experimental practices on the one hand and fieldwork on the other. Both *The Language of Mineralogy* and *The World in a Crucible* focus on the second half of the eighteenth century and the first decades of the nineteenth century, and both focus, as Eddy (p. 1) puts it, on the "day-to-day practice of science". Furthermore, the books share other themes, including the work of the Scottish chemist and (experimental) geologist James Hall (1761–1832), who is given prominence in both works. Nevertheless, Eddy and Newcomb adopt quite different—but complementary not contradictory—points of view. Applying Eddy's notion of the 'language of mineralogy' for its chemically-oriented vocabulary and the characteristics of minerals and rocks (cf. the section in his Introduction on the 'Language of Systematics', pp. 9–15), one might contrast the viewpoints of the two books as follows: Eddy discusses the words of this language, while Newcomb highlights its grammar. And continuing with this approach, the essential question for both books is the extent to which they reveal the language's semantics.

A first observation is that both books deliver much more than their titles might suggest. According to its subtitle, *The Language of Mineralogy* is concerned with the mineralogical work of one of Scotland's most influential naturalists (Eddy, p. 3), John Walker (1731–1803), with chemistry, and with the Edinburgh Medical School. Actually, however, Eddy's book provides a broad discussion of the scientific (*i.e.*, in his case, the chemical) background of the Scottish Enlightenment, which is more usually portrayed as a matter of economics and philosophy. More precisely, *The Language of Mineralogy* presents a critique of a historiographical approach that treats the Scottish Enlightenment in terms of an overtly philosophical agenda, thereby marginalising men like Walker (Eddy, p. 7). In two chapters, focusing on the question of "how a naturalist actually became a naturalist during the Enlightenment" (Eddy, p. 3), and using numerous printed and manuscript sources, Eddy presents his protagonist in a variety of contexts: Walker as traveller, as cleric, as author, and as adviser to powerful aristocratic and government patrons, as well as teacher to hundreds of students, some of whom became influential industrialists, scientists, physicians, and politicians. (One of the most valuable features of Eddy's book is a complete list of Walker's recorded students: 'Appendix VII: The University of Edinburgh Natural History Course Attendances Lists 1782–1800'.)

Regarding the main subject of the book, Walker's natural history, Eddy concentrates on the different types of language and nomenclature that were used to describe and categorise natural objects in a fashion that was relevant to a local population. This means that he does not primarily analyse the influence on local scientific practice by authorities and leading concepts. Rather, he investigates the pathway from a peculiar local practice to leading concepts. It is this "bottom up" approach (Eddy, p. 185), I think, which may give his book status as a role model. Thus, according to Eddy, it is the emphasis on local practice that sheds most light on the first 'geologists', who used chemistry and mineralogy to create a new field of enquiry (p. 185). Moreover, by focusing on chemistry, it becomes easier to judge the larger impact of the Edinburgh medical school upon Scottish conceptions of the earth's form (Eddy, pp. 185–187, see also pp. 3–4).

In this way, *The Language of Mineralogy*—and this is the essential issue of the book—explicitly connects eighteenth-century Scottish (and British) geology to the chemistry being taught in medical settings. Eddy shows that Walker's conception of geology was based upon the methods of definition and division that he inherited from chemistry and mineralogy (Eddy, p. 185). Due to the prevailing scholarly emphasis on the development of stratigraphy, however, approaches like Walker's have usually been sidelined (p. 185). To emphasise, it is not Eddy's thesis of a chemically-based geology that is most novel in *The Language of Mineralogy*. Rather, it is that Eddy states this thesis for Scottish and British geology, for which these connections have generally been omitted in other writings about their histories.

For the author of this review, *The Language of Mineralogy* opens the door to a new perspective. Late eighteenth-century Edinburgh is indeed a unique place for the study of the various economical, philosophical, social, and—as Eddy has now shown in his book—also the chemical contexts of early geology. Nevertheless, it might be asked whether Eddy's themes will be taken up by many other historians of geology, particularly in regard to British geology. Given that a chemically-based geology was the particular product of the Scottish Enlightenment, or more precisely of the Edinburgh Medical School, it might be asked whether this theme can be transferred, for example, to the early Geological Society. One can even consider the question more generally. Given that the strong part of Eddy's book is his discussion of the particular local (chemical) practices of the Edinburgh Enlightenment, one is led to question the extent to which the thesis of a chemical foundation to early geology might be applied to other 'spaces'. To be sure, this will include the question, if not the place, of a chemically-based geology that might be applied outside Britain. Eddy raises the question of whether the mineralogy/geognosy of the German mineralogist Abraham Gottlob Werner (1749–1817) might also be based in the context of (chemical) 'language of mineralogy', *i.e.*, in the works of eighteenth-century Swedish chemists (Eddy, p. 127). The answer to this question is a definite 'yes', for the restriction of Wernerian mineralogy to the external characteristics of minerals and rocks, and also the oft-claimed Wernerian neglect of chemistry, seem to have been products of political bias in nineteenth-century historiography. In truth, Werner was quite familiar with chemistry and he gave it a strong (implicit) role in his geognosy. This chemical theme might unite Walker and Werner conceptually, but apparently they were not united personally. In describing Walker's reception outside Scotland and England, Eddy notes that apart from his immediate students Walker did not seek any connection with Werner, which may have been due to the fact that he was nearly twenty years older than his German colleague (Eddy, p. 130). More significantly, in this respect, it seems that, so far as is known, Werner did not make any contact with Walker.

There is a further question, consideration of which several readers may think to be the essential one concerning Eddy's theses; and it leads directly to the themes of Sally Newcomb's *The World in a Crucible*. It is the question of how chemical practice in Edinburgh actually modified geological theory. According to Eddy, there seems to have been a considerable gap in this regard. Although Walker must have been aware of James Hutton's (1726–1797) theory of the earth, he probably ignored it in his lectures, perhaps because "Hutton was simply too theoretical" (Eddy, p. 165). In turn, there also seems to be no evidence that Walker's practical chemistry was significant for Hutton. Eddy (p. 31) names Hutton as one of Walker's students. Curiously, however, in the list of Walker's students (Eddy, Appendix VII), Hutton's name is missing. Thus, it seems not unlikely that Walker was one of those naturalists who were derided by Hutton for judging of the great operations of the mineral kingdom by looking into the bottom of a little crucible.

Of course, the relation of experimental methods to geological theory is an intricate one, and there will be no simple answer. Thus, it has to be noted in advance that Newcomb also does not claim to have a definite answer to this question, notwithstanding the subtitle of her book. *The World in a Crucible* considers the place of chemical and experimental methods in the building of early geological theories. However, the book is not so much a theoretical discussion of the relation of experiment to theory, or of laboratory practice and fieldwork in the particular case of geology. Rather, it is a comprehensive and detailed discussion of a multitude of tools and methods applied by naturalists in the eighteenth and early nineteenth centuries used to study the earth's structure and its physical processes and complementing the study of the external characteristics of minerals and rocks, and field methods. (In this sense alone, Newcomb's table of contents would have been worth publishing as a systematic, and, as far I know, the first 'classification' of these tools and methods.)

Relying primarily on printed sources, Newcomb orders her 'classification' in four chapters. Chapter 1 ('The Components of Geology') is an account of the constituents of the empirical basis for geology, including alchemy, observation, technology, and economics, as well as social needs and connections. In the second part ('The Experimental Tradition: Tools and Methods'), she first discusses the various methods for the determination of the classical characteristics of minerals (such as hardness, streak, colour, transparency, specific gravity, form, cleavage, and also magnetism and electricity), and then what she calls "heat matters", *i.e.* the tools related to the study of fusion (various furnaces, in particular industrial furnaces, and glass-furnaces), fuels, and burning lenses. Thereafter, she discusses the various chemical 'tools' used (such as reagents for acids and bases) and, finally, the investigative methods for the determination of gravity, magnetic and electrical properties, and also seismic activity. Chapter 3 ('Geological Implications') presents the classical topics of experimental geology (the fusion of granite, limestone and marble, and, of course, the overall question of the formation of basalt), which leads into a discussion of measurements of the Earth's temperature, *i.e*. its increase towards the interior (temperature gradients).

Indeed, the multitude of tools, methods, and individual procedures described in Newcomb's book may well be confusing to some readers. They might repeatedly ask if they are still reading a book on geological theories or one on chemical methods of the eighteenth century (see also, in this respect, David Oldroyd's review of *The World in a Crucible*, which appeared in *Episodes*, Vol. 32, No. 4, pp. 285–286, 2009). Nevertheless, and here one might recall Eddy's book, it was these tools and methods which made up—though often more implicitly than explicitly—the basis for geological reasoning, at least in regard to the origins of minerals and rocks. And in her fourth chapter Newcomb explicitly raises the question: “How did geology change?” (*i.e.*, through the laboratory practice of the time).

As mentioned, the reader may sometimes get the impression that Newcomb herself does not fully place trust in the importance of experimental methods for geology, as for example when she states that history of science gives ample examples that pure investigation conveys enormous benefit (Newcomb, p. 176), or that experiments have many uses apart from supporting or refuting knowledge claims, including “active observation”, and “invention” (Newcomb, p. 174). In this sense, she also emphasises that the word ‘experiment’ in her book has mainly been employed to refer to what might be called “regulated observations” (Newcomb, p. 171). Readers will, I think, know what she means. Nevertheless, they may well ask whether field observations are not also “regulated observations”. Perhaps it would have been better to focus on the ‘constructive moment’ of laboratory work, as opposed to the ‘phenomenological moment’ of field observations.

Be that as it may, a problem for experimental methods in early geology seems to have been that they rarely generated definitive results; or better one might say that when they did yield definite results these were still open to different interpretations. James Hall’s comments on his generally unsuccessful granite fusion and crystallisation (Newcomb, p. 166) provide one well-known example and his experiments on the fusion of basalt provide another. The latter showed that successful experiments (or experiments thought to be successful) were not necessarily accepted as a definite proof of a particular theory.

These remarks are not intended to be criticisms of Newcomb’s book. Rather, they indicate that the meaning of chemical and experimental methods in geology, the ‘language of mineralogy’, and the ‘semantics’ of this language, remain an open question. But this leads to Newcomb’s general conclusion that experimentation has been “far more part of the overall fabric of geology than historians of that science have previously recognized” (Newcomb, p. 176).

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EXPLORING DESERT STONE: JOHN N. MACOMB’S 1859 EXPEDITION TO THE CANYONLANDS OF THE COLORADO. Steven K. Madsen. Logan: Utah State University Press. 273 pp. Hardcover, $34.95.

A number of framed lithographs from the report of the 1859 Macomb expedition hang in the headquarters of the Geological Society of America in Boulder, Colorado. Some of these illustrations depicting landscapes and rocks include diminutive figures in the foreground, one of them with a long black beard. It is likely that the hirsute figure is John Strong Newberry (1822–1892), the expedition geologist who provided the sketches upon which these lithographs are based and was one of the founding members of the Geological Society of America. This inclusion of an artist in illustrations follows a longstanding artistic convention—and, of course, provides a scale.

The Macomb expedition of 1859 had set out to explore a region of the United States that had been taken from Mexico as a result of the 1846–1848 war between Mexico and the United States. The expedition into this newly conquered domain was intended to find a route between Santa Fé and the junction of the Grand and Green rivers, in part as a contingency in case war broke out between the U. S. and Mormon settlements in Utah. It would also fill in a large lacuna (*terra incognita*) in the map of the western part of the country. The leader was John N. Macomb, Jr (1811–1889), a career officer in the U. S. Army. Newberry was a Cleveland geologist, naturalist, and medical doctor on his third western expedition. Previously, he had been a member of the 1855 Williamson Expedition and the 1857–1858 Ives expedition. Newberry would interpret the geology of this region. Charles H. Dimmock (1831–1873), assistant engineer and topographer of the expedition, took sightings and measurements for use in mapping.

The Macomb expedition produced two major products: a detailed map (Egloffstein, 1864) of the region and a report (United States Army, Corps of Engineers, 1876), consisting mostly of a detailed geological and paleontological report, mainly by Newberry. The map was first published separately in 1864, but the report of the Macomb expedition of 1859 was published only in 1876 because of the late submission of Newberry's geological report. The Civil War (which began in April 1861) was the initial cause of this delay. Newberry, who had trained as a medical doctor, became involved with the U. S. Sanitary Commission during the War, becoming Secretary of the Western Department of the Commission in 1861. This work, of course, took precedence, and his report of the Commission was published in 1871. Newberry's manuscript of the Macomb expedition had apparently been mostly completed years before, except for some key parts, including the plates illustrating fossils (coordinating plates and text seemed to have been a major problem in the nineteenth century) and a geologic map. Newberry's other responsibilities, including his position at Columbia beginning in 1866 and his simultaneous position as head of the Ohio Geological Survey (1869–1872), may have further delayed the Macomb expedition report, and the seventy-five publications that Newberry authored from 1860 through 1875 may also have played an additional role in the delay. The final book did include the paleontological plates and was accompanied by the previously published map showing locations and topography. But a geological map was not included.

Because of the late date of publication, the discoveries of the Macomb expedition were eclipsed by the later, more expeditiously published, discoveries of the expeditions of Ferdinand Hayden (1828–1887), Clarence King (1842–1901), George Wheeler (1842–1905), and John Wesley Powell (1834–1902). Indeed, Powell's popular *Exploration of the Colorado River of the West* was published in 1875, a few years before the report of the Macomb expedition. As readers of this journal are likely to know, Powell's book is still in print under the title *Canyons of the Colorado*.

Steven Madsen's new book, *Exploring Desert Stone*, is a welcome supplement to the original report of the Macomb expedition. His new book is divided into two approximately equal parts. The first half provides a fresh recounting of the expedition, its organisation, and its aftermath, based on numerous published and unpublished sources as well as Madsen's personal observations. Highlights include an account of Newberry's important early discovery of a dinosaur (the first such discovery in Utah), the description of Mesa Verde, the expedition's visit to Pagosa Spring (today's Pagosa Springs, Colorado), and the expedition's complex interactions with the Native Americans. The coverage of the subsequent history of the major participants (Macomb, Newberry, and Dimmock) and of the report and Egglofstein's map complement the story of the expedition. The account of Dimmock's participation in the expedition is of special note, as his contribution is noted on the map (Egloffstein, 1864) and in the original report, but Madsen notes (p. 196) that some of his contributions seem to have been ignored in the final report. Madsen hypothesises with good reason that this may have been due to Dimmock's service as a Confederate officer during the Civil War. (Dimmock is perhaps best known today as architect of the Dimmock Line of earthwork defenses that protected Petersburg, Virginia, during the Civil War.)

The second half of the book consists of a series of documents, including expedition diaries by Dimmock and Newberry, letters that Macomb wrote home, letters that Newberry wrote to Spencer Baird at the Smithsonian, and letters that von Egloffstein wrote to Macomb. Newberry's expedition diary is disappointingly terse but, as noted in the book, Newberry's field notes appear to be lost. The expedition diary of Charles Dimmock is more extensive. The correspondence adds information about and gives a human dimension to the expedition. Madsen has obviously gone through a great amount of archival material, in the process unearthing much fascinating unpublished material, now made readily available. And though mostly written in a telegraphic style, these documents still make for fascinating reading.

The book includes previously unpublished illustrations by Dimmock, many juxtaposed with modern photographs showing the same or a similar view. The book also contains a facsimile of the 1864 map, which was one of the key achievements of the expedition as well as color lithographs from the expedition report. The map is an especially welcome addition to the book, as the extant original copies are very fragile. The map is very useful to have spread out as one reads the book as this allows one to follow along the numbered camps of the expedition. The camp numbers are depicted on the map (though the original map key does not note this, so neither does the facsimile) and these same numbers are referred to in various parts of the book's text.

Like most books, this one contains a number of errors, some of which a geological editor would have ferreted out upon a first reading. These include calling what is probably the extant crustacean *Apus* (that is, *Triops*) a fossil (p. 25); giving (p. 25) 'quartzose' as a type of rock rather than an adjective used to describe a rock (thus misinterpreting Lucas and Hunt, 1987, p. 97, who noted a "quartzose sandstone" at the locality being discussed); and not capitalising "Carboniferous" and "Cretaceous" (p. 111). The book is also light in its coverage of the treatment of the Macomb report (and Newberry's geological work) by nineteenth-century and subsequent geologists, noting in a footnote (p. xxi) only two references, including Şengör (2003), but overlooking more recent comments on Newberry's work such as those in Lucas *et al*.'s (2005) volume on the Chama Basin. The printing of the book is also 'suboptimal'. I found the type of the text generally too light, and the text on some pages is lighter than on others. There are also smudges.

The legibility of the map is generally very good, but the reprint reflects the discoloration pattern present on the map copy used for reproduction and the higher-contrast publication of the facsimile has lost the delicacy of the original. The map is also reproduced slightly larger than the original, so the scale is off somewhat, as an inch on the map scale bar does not exactly represent an actual inch on the map. (That said, the original printed map included with the Macomb report was not exact either.)

Exploring Desert Stone succeeds well in calling attention to this important early expedition and adding to our knowledge of how it was carried out. It complements the information in the original report as well as more recent reports on the geology and history of geology of the greater four-corners region. It also adds to the ever-growing body of literature addressing the mapping and exploration of the western United States in the middle decades of the nineteenth century.

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THE MOUNTAINS OF SAINT FRANCIS: DISCOVERING THE GEOLOGIC EVENTS THAT SHAPED OUR EARTH. Walter Alvarez, 2009. New York: W. W. Norton and Co. 304 pp. Hardcover, $25.95.

Assisi

In which we visit the little medieval city of Saint Francis and encounter the three great questions of the book: How can we discover the strange early worlds that once existed on Earth? How can we learn the age of rocks and of the events in Earth history that the rocks record? And how have the mountains and valleys of Earth's present landscape come to be?
Walter Alvarez, *The Mountains of Saint Francis* (2009, p. 1)

To be a geologist doing fieldwork, and to be doing it in Italy, is to be a fortunate person. The food is delicious, the wine as fine as French wine, the people vibrant and friendly, the geology wondrous. Off and on for nearly four decades professor Walter Alvarez has been one of the lucky ones. He speaks the language fluently and has become an honorary citizen of the Italian towns of Piobbico and Gubio. Here he tells in detail what it was like for him to be doing geology in Italy and what it meant to him. He hopes, he says, "to bring to life both the historical worlds that geologists have uncovered, and the geologists who have made these discoveries". He dedicates The *Mountains of Saint Francis* to the geologists of Italy, who "have extended their welcome and friendship to me as together we have made wonderful discoveries".

Dr Alvarez, Professor of Geology at the University of California, Berkeley, wrote the first-rate book *T. Rex and the Crater of Doom*, which I recently reread and was struck by how much I had missed the first time. He contends in it that the "KT mass extinction was the result of a huge comet or asteroid that hit Mexico's Yucatán Peninsula". In June 1980, Alvarez was the second co-author, with his father Luis, Frank Asaro, and Helen Michel of the article 'Extraterrestrial Cause for the Cretaceous–Tertiary Extinction', which appeared in the prestigious journal *Science*. Surprisingly, they reported exceptionally high relative concentrations of iridium (thirty times normal) and other aberrant elements in marine claystone deposited "exactly at the end of the Cretaceous period" about sixty-five million years ago. Further, they suggested that a large (about 10 km in diameter) asteroid collided with Earth at 90,000 km per hour (about 56,000 mi/hr). This led, they said, to massive extinctions of life at the Cretaceous–Tertiary boundary. Details of the hypothesis became a cover story of *Time* magazine.

The paper's senior author Luis Alvarez, an '*über*-physicist', was the discoverer of numerous resonance particles. In recognition of these achievements, he was awarded a Nobel Prize. His collaboration gave heft to the article in *Science*.

Some paleontologists, but far from all, were enthusiastic about the extinction thesis. Geophysicists were less enamored. Stratigraphers in regions where either the lithologic or paleontologic boundary is difficult to place—if they differ—were reluctant at first to embrace the theory. Some geologists and astronomers favored a comet rather than an asteroid, and Walter Alvarez now says in this book that either a comet or an asteroid was the destroyer.

The research professor Charles Officer and the writer Jake Page, in their 1996 book *The Great Dinosaur Extinction Controversy*, questioned much of the postulation to the point of wondering if it was not "some kind of scam". They offered an alternative explanation for mass extinctions at the Cretaceous–Tertiary boundary, stressing volcanism and continued retreat of the world's oceans. Later on, Gerta Keller of Princeton University, a foraminifera authority and former chairperson at Princeton, but not when Walter Alvarez was a student, challenged the Mexican evidence in almost every particular. However, by the time *T. Rex and the Crater of Doom* appeared, catastrophists had made significant inroads into the once faithful ranks of gradualists. Debate about boundaries between geologic periods, mass extinctions, and considerations of the histories of the organisms involved are never as simple as first assumed. Discussions soon become heated and interminable. Though it persists, criticism is much less animated now; in the nearly three decades since the hypothesis was advanced, many critics have passed on.

Though Alvarez is best known for his account many years ago of what the *New York Times* in a favorable review of *T. Rex* called "death from above", his new book is a broader, more personal memoir focused on all of his travels and research in Italy. There is some overlap with *T. Rex*. The two books have been put together in much the same way and look about the same, though this one is nearly twice as long.

Fascinated by Earth history, and chilled on a bitterly cold day "after Christmas in 1970", Walter Alvarez and his wife Milly a former graduate student in psychology he met at Princeton, drove from Rome, where so many travelers visiting Italy first set foot, to Assisi, a medieval city precariously perched on the earthquake-prone slopes of Monte Subasio. The city is closely associated with the north Italian, poet and mystic, St Francis of Assisi (1182–1226). An admirer of the saint, Alvarez chooses to call this account of Earth history *The Mountains of Saint Francis*, though the mountains are known locally as the Umbria–Marche Apennines. This part of the range, the backbone of the Italian Peninsula between Florence and Rome, is the most visited by geologists.

In this book, Alvarez begins in Assisi, "almost thirty-five years after our trip of 1970". There his scientific and cultural adventures in Italy begin: on a lovely day, the beginning of September, he strolls onto the Piazza of Saint Chiara, where the majority of visitors to Assisi soon go.

Three years after that first trip, he and Milly returned with Bill Lawrie to collect limestone samples for paleomagnetic measurements from quarries behind the city. The attractive pink-and-white limestone, called *scaglia rossa* (pronounced scáhl-yah) is a much-prized sedimentary rock, often used for decorative purposes and as a building stone. At Assisi it is pink and hauntingly streaked with white, neither of which are generally considered masculine colors. Rock from the quarry is probably the beautiful stone used to build the Basilica of Saint Francis. The famous cathedral was consecrated in 1253, twenty-seven years after the saint's death.

Saint Francis was a holy person of self-sacrifice and poverty, a preacher to birds, animals, and acolytes. He would have objected to the cathedral's cost, but likely not to its beauty. Later on, many of his followers did protest. During his life, the saint, a diminutive man, was apparently comfortable sleeping on a bed cut into rock outside the present outer wall where he could hear the songs of birds. At or near Asissi, he saw several manifestations of the Virgin and of Christ and he received the stigmata during one such encounter, a lifetime of mystical experience for any saint.

As it does most visitors to Rome, the Roman Forum pulled in Alvarez: "the great archaeological focus of the city". There at the foot of the Palatine Hill, he dug into the bedrock, the deposits of very young volcanoes. Subsequently, he became fascinated with and concentrated his efforts on the Capitoline Hill, a small peanut-shaped prominence west of the Forum. Tuffs had accumulated there from a pair of volcanoes flanking Rome: to the south, the Alban Hills; to the north, the Sabatini volcanic deposits.

In these early chapters, Alvarez introduces the principles of elementary stratigraphy, using the local rock units: *Cappellaccio* mudflow tuff (a lahar); the *Tufo Lionato* (an ignimbrite), and a fluvio-lacustrine (river and lake) unit at the top of the sequence. Above the rocks is a wall, part of Roman construction. Below the volcanic layers are gravels of the ancient Tiber River, layers that occur all around the Roman Forum valley and were aquifers for many springs of importance to early Romans. When the *Tufo Lionato* ash "swept from the Alban Hills, it flowed into the valley of the Tiber, which had cut down through the Capellaccio" and the volcanic layers underlying it. In the early and mid-1970s, Alvarez published several articles on the Pleistocene volcanoes north of Rome, specifically on their eruptive source, stratigraphy, topographic evolution, and geological influences on human settlement.

The second half of the book is about the Apennines, a plate-tectonic primer on the much studied, northwest–southeast, low-lying range that borders on the west the Adriatic Sea. Alvarez wants to be understood by the general public. He will be by the readers he reaches, but a success on the scale of *T. Rex* is unlikely. Evolution of the Apennines is a less catastrophic story played out slowly a few centimeters at a time over thirty million years or more.

Alvarez moved his field operation to Piobbico, "at the foot of a mountain called Monte Nerone", about eleven miles southwest of Urbino, birthplace of the Renaissance painter Raphael. Standing on Monte Nerone, he was struck, as geologists are wont to be, by the fold-and-thrust belt of the Apennines and by the snowy peaks "where previously there were no mountains". He soon strode onto the sedimentary sequence of the northern Apennines, mostly limestone and what he calls "marls", a loose name to be avoided—a lump of a term, often used in Europe and elsewhere for what is likely either limey claystone (shale) or clayey limestone. Readers will not know exactly or even very closely what the rock contains—if indeed it is a rock, rather than a sediment, as the word marl implies. [1]

Briefly, Alvarez reviews the stratigraphic sequence above the Paleozoic, those rocks overlying the Late Paleozoic Hercynian Mountains, exposed in France and Spain and in Italy on the islands Sardinia and Corsica. Mesozoic layers are the building blocks for the Apennine range—evaporites, limestones, and Alvarez's marls. Above the Jurassic shallow-

[1] The word 'marl' would seem to imply a sediment, not a rock (marlstone), but Alvarez here and elsewhere is mostly talking about rocks. However, he frequently uses sediment terms (unconsolidated material)—fucoid marls, Jurassic pelagic sediments, sand beds, grey marls—where he is writing about rocks. Readers familiar with Italian geology will not be confused. Others, however, may prefer rock names rather than a mix of rock and sediment names. My prejudice is that I wish geologists would do a bit more petrography and determine the composition well enough to say what these marls (marlstones) consist of.

water limestone of the Massiccio sequence are deeper-water and much more slowly deposited pelagic fossils (forams, coccoliths, and radiolarians), in layers much studied throughout the sedimentary world. “The north-pointing spur of African continental crust (‘Adria’)” extended far out into the Tethyan Ocean, far from the rivers draining Africa, concludes Alvarez. This protuberance provided the conditions for the slow accumulation of the thick pelagic limestones—free of clastics—shaping “the sediments and the mountains that were to come”.

At the beginning of the Eocene (about 56 Ma), when the African and European continents collided, Adria overrode Europe, resulting in the folding and faulting of the Alps. Alvarez sketches this history and his journey to the Alps, seeing a need at the time to live the story on the ground. Those who wouldn’t grasp such an opportunity would benefit from counseling! He was accompanied by his wife Milly, a student, and Alberto Castellarin, an authority on the Alps who has written on the geology of the Dolomites. This chapter of the book, called ‘Distant thunder from the Alps’, introduces the ideas of sea-floor spreading, thrust faults, nappes, and plate tectonics, all necessary background for talking about the Apennines. One of Alvarez’s least successful photographs, of the Marmolada Massif (the highest peak in the Dolomite Alps), appears in this chapter.

Apennine turbidites provide critical evidence necessary to understand the formation of the mountains. Seizing the opportunity to explain graded beds and turbidity currents, Alvarez discusses the influx of sand toward the southeast into the northern Apennines, including from oldest (Oligocene) to youngest (Late Miocene), the sand-sheets Cervarola, Marnoso-arenacea, and Laga. The “sea-floor trough in which the sand was deposited gradually migrated toward the east”. One of the many fine photographs of Italian geologists is that of Carlo Migliorini, pioneer on the study of graded beds as turbidites in the Apennines. Six decades have swept by since Kuenen’s and Migliorini’s classic article in the *Journal of Geology*. At the risk of dating the present writer, I may mention that I heard one of Kuenen’s early presentations.

Fold after fold, propagating thrust faults that formed anticlines in the northern Apennines, slowly advanced toward the northeast. Sheet by sheet, turbidity currents deposited sand in basins at the thrust front. Later, an extensional front formed normal faults about a hundred kilometers behind the compressional (thrust-fault) front. Relentlessly, the compressional and extensional fronts migrated “lockstep across Italy” exclaims Alvarez—”a surprising combination of compression and extension”. Folds were generated and then torn apart.

The Mediterranean salt crisis is given a short chapter. The last stage of the Miocene (the Messinian)—seven to five million years ago—is represented by substantial evaporites, halite (NaCl) and gypsum ($CaSO_4.2H_2O$). Present evidence suggests a partial lowering of sea level, leading to deposition of the evaporites as brines in the sea became more and more concentrated. Later, the sea level fell still farther, yielding the “evaporites in the deep Mediterranean” and allowing enormous deep canyons, now filled with sediment, to be cut on surrounding continents—the Nile Canyon about 4,500 meters below present sea level, for example.

In a grand finale, and by way of summing up, Alvarez maneuvers microplates. Poring over maps, sliding microplates on paper, he moves Corsica and Sardinia up against France. It looks like a fit. Corsica and Sardinia rotate “about forty-five degrees, opening up the triangular Ligurian Sea”. A Calabrian microplate moves southeast about five hundred kilometers (three hundred miles), opening up the Tyrrhenian Sea. The oceanic crust of the Ionian Sea falls into the mantle. The upper part of the continental crust floats; the lower part peels off and sinks (he call this process “delamination”). Though slow in pace, beyond easy understanding, the formation of the present Italian geography was a wild ride. As the book begins, so it ends with a photograph of the Basilica of San Francisco, the setting orange sun entwined with the church.

For English-speaking lovers of Italy and its geology, and they include just about all who have ever been there, *Mountains* is a 'must read', though not always an easy one. It should also attract many Italians. For ease of reading, the volume contains numerous figures and photographs (mostly good to excellent), a small glossary, a two-page list of additional readings, an index, and detailed notes to the text, which are especially useful. We see in *Mountains* a further real contribution to geology by Walter Alvarez, which follows by twelve years the hard-to-put-down *T. Rex*. The passages that only he could have perpetrated are full of detail but simply composed.

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GEOLOGY AND RELIGION: A HISTORY OF HARMONY AND HOSTILITY, edited by Martina Kölbl-Ebert. 2009. Geological Society of London, Special Publication 310, 357 pp. Hardcover, £95.00/$190.

Perhaps more than any other science, geology has had an ambivalent relationship with religion. Especially in the nineteenth century, many theologians made important contributions to geology and found immense pleasure in their dual passions of geology and theology. In some cases, this harmoniously productive relationship continued into the twentieth and twenty-first centuries, but, as geologists began to explore the depths of geologic time, and to document the evolution of life as recorded in the fossil record, most religious fundamentalists parted ways with mainstream geology. The book being reviewed is a collection of case studies of this alternately harmonious and hostile relationship. Many of its thirty-two chapters are expansions of papers presented at a 2007 conference on the history of the relationship between geology and religion that was organised in Eichstätt, Germany, by the International Commission on the History of Geology.

The editor has organised the chapters into seven clusters: (1) 'From mythological approaches towards the European Enlightenment'; (2) 'The Flood and the age of the Earth'; (3) 'Geology within 'religious' organizations'; (4) 'Geological clerics and Christian geologists'; (5) 'Evolution'; (6) 'History of creationism'; and (7) 'Theology and creationism'. In the early chapters, there are many accounts of individual theologian-geologists. Indeed, the book contains many more examples of harmony than hostility. To choose one particularly interesting example, a chapter by Paulo Barbaro ('Explanations of the Earth's features and origin in pre-Meiji Japan') examines aspects of the history of the relationship between mythological and scientific explanations of earthquakes, volcanoes, and other geological phenomena in Japan. This chapter, which is broader in scope than the title suggests, also examines aspects of the relationship between geology and religion in modern Japanese culture. Japanese culture has apparently found a way for modern science to harmoniously coexist with ancient tradition. Perhaps there is a lesson here for those of us in the West. Barbaro's chapter is highly recommended for any Western scientist traveling to Japan.

Among the most innovative chapters is one by David Oldroyd, which addresses the question of how a historian's personal religious convictions influence his or her treatment of a religiously inspired geologist. Oldroyd examines three accounts of the work of Genevan naturalist Jean-André de Luc (1727–1817). One account is by a historian who describes himself as a freethinker (Charles Gillispie), another is by an Anglican (Martin Rudwick), and the third is by a pair of co-authors: a Calvinist (François Ellenberger) and an atheist (Gabriel Gohau). Oldroyd found that each historian paid particular attention to aspects of de Luc's work that were most compatible with his own religious beliefs.

Speaking of Martin Rudwick, he has a chapter in the book titled 'Biblical flood and geological deluge: the amicable dissociation of geology and Genesis'. Rudwick explores the contrasting interpretations of diluvial deposits among early nineteenth-century European naturalists. "By the early nineteenth century", he tells us, "educated people in most European countries, including those who would now be called 'scientists,' were coming to recognise that biblical literalism was no longer tenable, and that it had not been characteristic of Christian thinking in the earlier history of the Church". He makes the case that the Earth sciences were originally ahistorical. By the late eighteenth century, however, Earth scientists were beginning to realise that the Earth can't be understood solely in terms of unchanging 'laws of nature.' This was a radical new outlook on the natural world, and it put Earth scientists on a collision course with biblical literalists.

Having been published in the 150th anniversary year of *On the Origin of Species*, the book appropriately contains a chapter that chronicles the life of a little-known scientist who played a role in the support of Darwin's arguments, and whose own career was dramatically affected—in a negative way—by the controversy that followed publication of the *Origin*. This chapter, by Hugh Torrens, is titled 'James Buckman (1814–1884): the scientific career of an English Darwinian thwarted by religious prejudice'. It is a delight to read and a model of scholarship in the history of nineteenth-century science. As Professor of Geology, Botany and Zoology at the new Royal Agriculture College in Cirencester, England in 1848, Buckman conducted botanical experiments with grasses to "solve the problem of the identity of species". In the first edition of the *Origin*, Darwin cited Buckman's work in support of his own conclusions about the mutability of species. Then, at the 1860 meeting of the British Association for the Advancement of Science (famous for a heated and witty verbal exchange between T. H. Huxley and Bishop Samuel ('Soapy Sam') Wilberforce concerning Huxley's ancestry), Buckman presented a paper that further supported the Darwinian position. The Anglican Principal of the Royal Agricultural College was incensed that one of his staff would support Darwin's heretical views, and he ordered the destruction of Buckman's research garden. Buckman left the College shortly thereafter, a victim of the perceived incompatibility of orthodox Christianity and the mutability of species.

Another chapter examines a situation in which geology has surprisingly found a way to thrive within the curriculum of an evangelical Christian college. Wheaton College, Illinois, is one of a very few evangelical colleges that offer a degree in geology. More than thirty of Wheaton's approximately 250 geology graduates have gone on to earn doctorates in the geosciences, and several have had very distinguished careers. In a fascinating chapter titled 'From the beginning: faith and geology at evangelical Wheaton College', S. O. Moshier, D. E. Mass and J. K. Greenberg review the history of the college's geology curriculum and the tensions it has weathered as creation issues have waxed and waned within the evangelical subculture in which the college exists. The key to maintaining a viable, not-too-far-out-of-the-mainstream geology curriculum at an evangelical Christian college in a time of galloping fundamentalism has been the rejection of Flood geology and young-Earth creationism. Wheaton geologists are old-Earth creationists.

The chapter about Wheaton College reminds us that creationists come in many varieties. Richard Peters' chapter, 'Theodocic creationism: its membership and motivations', concerns the other extreme on the creationist spectrum. Peters himself is a former fundamentalist Christian. His conversion from radical creationism to a more science-friendly worldview gives him a rare perspective on the tension between geology and religion. Furthermore, he writes with a clarity and passion that makes the reader sit up and pay attention. If this book contains a 'must read' chapter for non-creationists who are trying to understand the creationist mindset, this is the one. Peters first classifies creationists into three camps: (1) intelligent designers; (2) theistic evolutionists; and (3) radical (or, Peters' own new term, 'theodicic') creationists. He then proceeds to explore the motivations of the third camp. His term 'theodicic' comes from 'theodicy', which refers to the theological problem of the existence of evil and suffering in the world. If God is the personal, loving, omniscient and omnipotent Creator that some creationists *need* to believe in, why would He permit the existence of evil and suffering? The theological struggle to answer this question is termed 'theodicy'. According to Peters, the single most powerful factor that motivates radical creationists (*i.e.*, biblical literalists/young-Earth creationists) is the "desire to clear God of the charge of creating a world full of suffering and death". Within their worldview, the only conceivable explanation for suffering, and the death of any of God's creatures, is the sins of Adam and Eve, as described in the book of Genesis. No animals or plants could have died before the existence of Adam and Eve, so it follows that the fossil-rich strata of the Earth must post-date the creation of humans. There is no possibility for reconciliation between this theodicic perspective and the mainstream scientific worldview.

The book concludes with an insightful chapter by Michael Roberts, an Anglican priest with expertise in the history of geology. He provides an interesting and useful taxonomy of believers with respect to creation and Earth history, and discusses the alarming spread of Christian fundamentalism within the Church of England and throughout the world.

In spite of the fact that many of the authors' first language is not English, the book is very well edited, well illustrated, and free of typographical errors. In her introductory chapter, editor Martina Kölbl-Ebert writes that "[b]oth geology and religion have evolved through time, often intensely entwined, and mutually influencing one another". This book provides an excellent sampling of the history of that relationship.

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FOR THE ROCK RECORD: GEOLOGISTS ON INTELLIGENT DESIGN, edited by Jill S. Schneiderman and Warren D. Allmon. 2009. Berkeley: University of California Press. 261 pp. Softcover, $21.95.

As geologists we explore Earth's magnificent past, which we interpret as signifying nature's actualisations. The latter fit together in patterns no less remarkable for their exquisite organised complexity than for what seems to be a miracle: that we humans are actually capable of making sense of it all. It is as if this vast abundance of Earth's geological past were the epic plot of a wonderful story, written by a highly gifted novelist, or, alternatively, the symphony of a great composer. Such metaphors inspire us to search for underlying truths, but, as scientists, we know that even the most useful of metaphors cannot be the truths that we seek. Scientific truths must be the focus of continuing inquiry; they do not reside in some absolute belief in which that inquiry can come to rest. For these reasons most geologists either are or will be alarmed by an on-going skirmish in the current culture wars. This confrontation is made even more disturbing by the newly effective networking of like-minded fundamentalist ideologues and its sensationalising via irresponsible elements of the public media. It is a conflict that pits science in general, and geology specifically, against a view that Earth's natural facts can marshaled in evidence for the actions and existence of a supernatural entity who is the designer for their obvious pattern and complexity. Intellectual historians will, of course, recognise that this latter argument, currently labeled 'Intelligent Design' (ID), has been around for a long, long time. The resurrection of this 'design in nature' theme has come to the fore of the culture wars in large part because of ID's superficial appearance of scientific objectivity, which conveys more opportunity for swaying opinion among a gullible and ill-informed public than does the closely related doctrine of creationism based in absolute biblical literalism.

For the Rock Record brings together ten thoughtful essays by Earth scientists, nearly all of them researchers and/or educators with backgrounds in paleontology. The book provides a valuable resource for geologists engaged with the broader meaning of their science as it relates to the social, political, and religious issues of our times. Section 1, entitled 'Rocks and bones', compares the claims arising from mainstream scientific understanding to counterclaims made by advocates of creationism of all types, including ID. Chapters by professors Jill Schneiderman (a co-editor), Tim Heaton, Don Prothero, and Allison Tumarkin-Deratzian lay out excellent examples from the innumerable geological facts that fail to accord with various creationist theories. These are all worthy observations, but, as observed in 1996 by an ardent and articulate advocate of creationism, Berkeley law professor Phillip Johnson (quoted in Prothero's essay): "[t]his isn't really, and never has been, about science. . . . It's about religion and philosophy". Unfortunately, some of the ID advocates are sufficiently well versed in clever sophisms (and geologists sufficiently innocent of philosophy) that, to the great frustration of dedicated scientists, the debate can often appear to a public audience as favoring the creationists.

Science is best defined in terms of the attitudes that need to be held by its practitioners as a matter of normative logic. This is the definition that was posed by geophysicist Charles Sanders Peirce (1839–1914), who was also America's greatest philosopher. The relevant normative attitudes for science involve how one correctly reasons, *i.e.*, logic, a subject for which Peirce has now become internationally famous. In his 1898 lectures on 'Reasoning and the logic of things', Peirce held there to be one single, overriding 'First Rule of Reason': "in order to learn you must desire to learn and in so desiring not be satisfied with what you already are inclined to think". Following Peirce's ideas, the modern logician Susan Haack, in her 1998 book *Manifesto of a Passionate Moderate*, describes examples of pseudo-reasoning that commonly masquerade as the real thing. Much of what is claimed to be 'science' by ID creationism clearly fits the category of sham reasoning, in which the inquirer is not interested in how things truly are, but rather wishes only to support as true a cherished prior proposition that is both evidence- and argument-proof. Among the more egregious forms of sham inquiry employed by ID creationists is the 'argument from ignorance' that has been discredited as a mode of rational thought since at least the time of Aristotle (384–322 BC). In this argument, employed by Michael Behe in *Darwin's Black Box*, the fact that one theory, in this case, evolution by natural selection acting on random genetic variations, does not fully explain some fact (here, the complexity bacterial cilia and flagella) is taken as evidence that a totally different theory (ID which is presumed erroneously to be the only possible alternative) must be correct. Sherlock Holmes would be appalled!

The view that ID creationism is not science is also argued effectively in the section of the book entitled 'Education, politics, and philosophy'. In his essay 'Pangloss, Paley, and the privileged planet', Terry Miller, a long-time educator in public and independent schools, writes literally from the front lines of the culture wars. A well-funded ID think tank, the Discovery Institute, established its headquarters just few blocks from his Seattle school. Miller's essay shows how the 1999 'Wedge Document' serves as the manifesto for the Discovery Institute's strategy to progressively insert religious beliefs (disguised as science) into the nation's classrooms. This goal qualifies some of the ID pseudoscience as fake reasoning, according to criteria established by Peirce and Haack. The fake reasoner has no genuine desire to work toward scientific truth; instead the appearances of scientific reasoning are used in support of some other goal, in this case a political and social agenda that is only masquerading as science.

In his essay ‘It’s not about the evidence’ geology professor Charles Mitchell takes on a number of philosophical issues, including a reinforcement of the long-known insight that scientific facts can neither prove nor disprove metaphysical propositions, which include both the presumptions: (1) ‘God exists’, held by those who think they can mix ID-ideology with science, and (2) ‘God does not exist’, held by those who try to mix atheist ideology with their science. In a conclusion reminiscent of the pluralism advocated by the psychologist and pragmatist philosopher William James (1842–1910), Mitchell calls for a resolution of the supposed conflict between science and religion via a recognition that, given the varieties of human needs both to understand the world and to find meaning in human existence, an approach is needed, along with some humility, such that, “there is no single correct way that works for every human concern or in every context”.

William James, who was a good friend of Peirce, pointed out the spiritual poverty of the overly simplistic argument from design in his 1906 Lowell Institute lectures on ‘Pragmatism’. Think here from the viewpoint of a theologian, not a scientist, but be informed in your theology about the amazing discoveries of science. Religion is not simply about some particular creation story; it is much more about human wonder at the universe and the moral law that brings human beings to salvation. To merely envision a god-designer as an old man-like deity who makes men and then saves them is to impoverish one’s appreciation for that deity. To the degree that anyone can rationally conceive of God’s role as designer, then one must rationally conclude, as James did, “that science has clearly shown that the complexities, beauty, and wonder of those designs are immensely more overwhelming than what can be implied by attachment of the word ‘design’ to their magnificence”. As James put it: “[t]he *what* of them so overwhelms us that to establish the mere *that* of a designer for them becomes of little consequence in comparison”. How can mere humans, James added, “comprehend the *character* of a cosmic mind whose purposes are fully revealed by the strange mixture of goods and evils that we find in this actual world’s particulars”.

Keith Miller’s essay deals with ‘methodological naturalism’ (MN)—the conventional view that holds scientific investigation to be confined to natural entities, seeking explanations in natural cause-and-effect processes. This view is portrayed as materialistic atheism by creationists of all stripes, who feel that it denies a role for God in the world. As Miller correctly points out, however, this portrayal by the creationists confuses methodological naturalism (a fruitful way of inquiring scientifically into the natural world) with a belief in ontological naturalism (which Miller calls philosophical naturalism). It is only ontological naturalism (ON), not MN, that makes the materialist/physicalist claims that are so anathema to the Christian fundamentalists.

This matter is more than one of arcane metaphysics. The public promotion of the false claim that scientific methodology is inherently atheistic contributes to the warfare image so commonly and naively applied in regard to science and religion. The warfare metaphor plays on an ill-informed public by perpetuating the myth that a single monolithic entity, science, is in continuing cultural conflict with one other single monolithic entity, religion, the latter being championed, of course, by advocates of the impoverished theology underlying both creationism and ID. However, it is a matter of simple logic that ON cannot be a part of genuine science, and this is for much the same reason that ID cannot. By Peirce’s criteria, noted above, ON is non-scientific in that it violates the First Rule of Reason by claiming *a priori* how the world actually is; that there is only a totally material/physical universe—absolutely nothing more. Though it possible ON could be true (the amount of scientific inquiry necessary to prove this boggles the mind), and many atheists would probably claim ON to be true on philosophical grounds, the making of any truth claim in advance cuts off all inquiry into the matter, thereby excluding it from being a part of science.

It would probably surprise both ID creationists (though they seem to care little about such things) and scientists that methodological naturalism was first espoused as a matter of Christian theology. It was the monk Abelard of Bath (*ca* 1180–*ca* 1152) who in his *Quaestiones naturales* recognised that the biblical story of God's creating the rainbow after the Noachian deluge brought to mind an important issue needed for reconciling faith and reason. To say "God did it" provides no rational explanation at all for understanding the operation of the rainbow. Thus, it is necessary to distinguish matters of faith, which do not contribute scientific methodology, from matters of inquiry and reason, the latter being obviously necessary for fully understanding what Abelard termed "the amazing rational beauty of the universe".

Miller's essay is followed by David Goldsmith's comparison of the scientific reasoning employed in Darwin's *On the Origin of Species* to that applied in the ID literature, such as in Michael Behe's book *Darwin's Black Box*. For Behe and other ID advocates the claim of a designer is presumed to follow from the unbiased accumulation of facts that show a baffling degree of complexity in nature. The inability to account for this complexity leads to the conclusion that the explanation must lie outside nature, *i.e.*, in the supernatural existence of a designer. Besides this being an example of the "argument from ignorance", there is also confusion, as Goldsmith notes, concerning whether this reasoning is inductive, inferring from the particular facts (complexity) to a general conclusion (God did it), or deductive (God is assumed from the start, and that presumption is then used to explain the facts).

Something that Goldsmith does not note is that Behe's argument can also be interpreted as an inappropriate use of abduction, which is a mode of inference from effects to a specific probable cause that Charles Sanders Peirce also termed 'retroduction', and which he recognised to be critical in scientific reasoning. The problem with Behe's ID argument is that abduction merely presents a potentially interesting hypothesis: it comes at the beginning of a scientific inquiry, not at the end. Abduction does not provide a final scientific explanation. Instead it initiates further inquiry by asking a potentially fruitful scientific question. Thus, it is a feature of abduction that it will lead to further experimentation, more investigation, or even to an entire research program. Behe's ID inference kills inquiry by the totality of its singular conclusion: design by some unspecified supernatural entity. Compare this to Darwin's *Origin*, in which he abductively inferred for evolution the mechanism of natural selection acting upon random variations—an insight that has generated nearly the entire research program of modern biology. The contrast could not be more extreme.

For the Rock Record finishes with two essays in a section 'On religion'. In the first of these, Professor Patricia Kelley, a former President of the Paleontological Society, explains how she reconciles her "double life": researching and teaching during the week on the evolution of fossil mollusks, and then on Sunday teaching an adult Bible study class at her Presbyterian church. As with anyone seriously interested in the Bible's meaning, in contrast to those who seek to invoke its authority for ideological or selfish ends, Kelley finds that truly literal interpretation of the Bible is a logical impossibility. How remarkable that the fallacy of biblical literalism, which has been theologically resolved since at least the time of St Augustine (354–430), can continue to propel the dogma of fundamentalist ideologues!

Co-editor Warren Allmon ends the book with a wide-ranging, insightful, and lengthy essay 'The 'God spectrum' and the uneven search for a consistent view of the natural world'. Like many scholars, Allmon rejects the separate-but-equal thesis of Stephen Jay Gould (1941–2002) that sharply demarcates science and religion as "non-overlapping magisteria" (NOMA). Instead, he provides a 'God spectrum' in which views can be classified along a line that runs from the more religious (a God designed, created, and maintained universe that includes the supernatural and nonmaterial, is subject to miracles, *etc*.) to the less religious (the physical universe of matter and energy is all that exists, *i.e*., ON). Allmon's wide-ranging and very useful essay ultimately comes down to four major conclusions for those who teach about historical geology and evolution. That his analysis is rather balanced on the contentious issues of science and religion is corroborated by reviewers of his paper: one, an atheist scientist criticises him for being too easy on religious scientists, and another, a religious scientist, accuses him of being "way too sympathetic to the Dawkins/Dennett camp". Allmon concludes that the relationship of science and religion must not be limited to concern by readers of *For the Rock Record* alone. Nor is the issue merely a matter for sermons and philosophy classes. "It is perhaps the single most important problem facing humanity today". Whatever your views on the religion/science issue, this debate has immense consequences for how humankind will collectively face critical issues for the continued habitability of the planet.

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NOTES ON CONTRIBUTORS

Willemjan Barzilay graduated from the university of Utrecht in 2008 with a thesis on the reception of Wegener's theory by Dutch geologists. His research interests concern the development of the geological sciences in the Netherlands in the nineteenth and twentieth centuries. He is currently focusing on the self-image of Dutch geologists as geologists in the first half of the twentieth century and the importance of Vening Meinesz in the development of Dutch geology in the same period.

David Branagan is an Honorary Research Associate, School of Geosciences, Sydney University, where he taught for thirty years, following ten years in government and the mining industry. In recent years he has concentrated largely on the history of Australian geology and mining, publishing, *inter alia*, a biography of the geologist Sir T. W. Edgeworth David. He is a foundation and Honorary Life Member of the Geological Society of Australia and a former President of the International Commission on the History of Geological Sciences. In 2007, he was awarded an Honorary DSc by Sydney University.

Noah Heringman is Associate Professor of English at the University of Missouri. His publications include *Romantic Rocks, Aesthetic Geology* (2004) and an edited collection, *Romantic Science: The Literary Forms of Natural History* (2003). His articles include historical contributions to volumes published by the GSA and the GSL. He is currently completing a book on the relationship between writing and fieldwork in the disciplines that emerged from eighteenth-century antiquarianism and natural history.

Donald Hogarth has had a long-standing interest in uranium niobate minerals, starting with a PhD thesis (McGill 1959) concerning the structure and chemical composition of betafite. From 1952 to 1954 he was employed by the Geological Survey of Canada (Radioactive Minerals Division), investigating uranium deposits in northern Saskatchewan and Alberta. From 1959 to the present he has been on the staff at the University of Ottawa, with teaching duties including a postgraduate course on 'Radioactive occurrences and minerals'. Historical research has included the Frobisher mines on Baffin Island, Charles Campbell's 1827 exploration of Château Bay (Labrador), and abandoned mines in the Ottawa area.

Martina Kölbl-Ebert received her degrees in geology and palaeontology from the University of Tübingen, Germany. After working at the Museum of Natural History in Karlsruhe, the GEOMAR-research center in Kiel and the geological collection and museum of the Bavarian Natural History Collections, she is now Director of the Jura-Museum Eichstätt and Curator of the natural history collections of the Bishop's Seminary in Eichstätt, Germany. Her principal research interests are in the history of geosciences.

Barbara Mohr completed her university education at Bonn, with a PhD on Tertiary pollen floras from the Cologne area. As a post-doc she worked in West Berlin as a palynologist in cooperation with vertebrate palaeontologists. She then spent ten years as an assistant professor at the ETH Zurich, studying Mesozoic and Tertiary Antarctic pollen floras in order to understand southern high-latitude past vegetation and climate change. Since 1996 she has been a curator of the Mesophytic plant collections of the Museum of Natural History, Berlin, where her primary research area is the early evolution of angiosperms. She is interested in the history of palaeontological collections and also the role of women in the earth sciences and their popularisation.

Leonard Wilson is Professor Emeritus of the History of Medicine at the University of Minnesota. He has spent many years studying the work of Sir Charles Lyell. In 1970 he edited Sir Charles Lyell's *Scientific Journals on the Species Question.* In 1972 he published *Charles Lyell, the Years to 1841: The Revolution in Geology* and in 1998 *Lyell in America: Transatlantic Geology, 1841–1853.* He is preparing a third volume on Lyell's life from 1853 until his death in 1875. Wilson has also published several papers on controversies involving Lyell during the 1850s and 1860s.

Davis Young is a Professor of Geology, Emeritus, Calvin College, Grand Rapids, MI, USA. His most recent books are *Mind over Magma: The Story of Igneous Petrology*, and *John Calvin and the Natural World*. A forthcoming book co-authored with paleontologist Ralph Stearley, *The Bible, Rocks and Time*, is addressed primarily to Christian readers. This work presents much of the geological evidence for Earth's antiquity and includes chapters that summarise the history of ideas about geologic time.

GUIDELINES FOR AUTHORS (abbreviated)

1. Contact with the Editor or a Member of the Editorial Board prior to submission is welcomed.
2. Articles should be submitted to the Editor at his home address as a Word (.doc) document, preferably by email attachment (or, if that is not possible, on a CD).
3. The text should be prepared in Times New Roman (10pt), but using 9pt for indented quotations. The title should be centered and in bold, 12pt. **Please do not use auto-numbering, auto-'bullet-points', or any form of auto-formatting other than for automated footnoting and 'smart' quotes**. The text should be single spaced and justified left and right.
4. Figures are welcome. Digital submission is required, on a CD for large files or by email attachment if transmission is possible. Half-tones should be scanned at 600 dpi and black and white documents at 1,200 dpi. The use of colour is possible, but authors will be charged for this. A cost estimate will be provided in advance for each case.
5. Tables and figures should be sent in files separate from the main text.
6. Figure numbers and captions (italicised) should be situated where you would like them to be printed in the final version, but the figures themselves should be sent separately (see Point 5). All figures or tables must be referred to in the body of the text (for example, 'see Figure 10'). Please write 'Figure', not 'Fig.'.
7. The article should be divided into numbered sections (with headings centered, bold, upper case). Subsections (numbered) should be headed in italics, not bold, lower case, and left-justified.
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Bullen, K. E. and Bolt, Bruce A. 1985. *Introduction to the Theory of Seismology*. 4th edn. Cambridge: Cambridge University Press.

Good, Gregory A. (ed.). 1998. S*ciences of the Earth: An Encyclopedia of Events, People, and Phenomena*. 2 vols. New York and London: Garland Publishing Inc.

Suess, Eduard, 1904–1924. *The Face of the Earth (Das Antliz der Erde)*, translated by Hertha B. C. Sollas. 5 vols. Oxford: Clarendon Press.

Articles in journals

Jago, J. B., Pharaoh, M. D. and Wilson-Roberts, C. L. 2005. Douglas Mawson's first major geological expedition: the New Hebrides, 1903. *Earth Sciences History* 24: 93–111.

Articles or chapters in books

Branagan, D. F. 1998. Geological periodization. In: S*ciences of the Earth: An Encyclopedia of Events, People, and Phenomena*, edited by Gregory A. Good, Vol. 2, 306–314. New York and London: Garland Publishing Inc.

Unpublished thesis or dissertation

Wolter, John A. 1975. The Emerging Discipline of Cartography. PhD dissertation, University of Minnesota.

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