

BAYLOR
UNIVERSITY



GEOLOGY & GENESIS

A Historical Perspective on the Interaction of Two Historical Sciences

Martin Rudwick

University of Cambridge
University of California, San Diego

The Herbert H. Reynolds Lectureship in the History and Philosophy of Science

MARCH 1, 2005

The Herbert H. Reynolds Lectureship in
the History and Philosophy of Science

Geology and Genesis: A Historical
Perspective on the Interaction of Two
Historical Sciences

Martin Rudwick

University of Cambridge and University
of California, San Diego

MARCH 1, 2005

The Herbert H. Reynolds Lectureship
in the History and Philosophy of
Science, established in 1998 by a gift
to the Baylor University Department
of Philosophy from the Herbert H.
and Joy C. Reynolds Endowment
Fund for University Excellence, brings
to the Baylor University campus an
internationally recognized scholar in
the sciences or in the philosophy or
history of science.

The recipient of the Lectureship serves
in residence at Baylor for two weeks,
presents a public lecture, participates
as a co-professor in a philosophy of
science seminar, and is available for
classroom participation in courses in
appropriate disciplines.

A committee composed of faculty
members from the following depart-
ments plans the annual lectureship:
philosophy, biology, chemistry/bio-
chemistry, physics, geology, history
and psychology/neuroscience.

BAYLOR
UNIVERSITY

GEOLOGY AND GENESIS: A HISTORICAL PERSPECTIVE ON THE INTERACTION OF TWO HISTORICAL SCIENCES

MARTIN RUDWICK

UNIVERSITY OF CAMBRIDGE AND UNIVERSITY OF CALIFORNIA, SAN DIEGO

THE IMAGERY OF CONFLICT

While I was teaching in San Diego, I often worked – with a beautiful view out over the Pacific – in the library of the Scripps Institution of Oceanography, one of the world’s leading centers for research in the earth sciences. Many of my colleagues at Scripps were exploring the implications of plate-tectonic theory, the dramatic new understanding of the earth that revolutionized the earth sciences in the 20th century: for example, there had been the sensational discovery of deep-sea hydrothermal vents, with their bizarre and totally unexpected forms of life. But such discoveries, however surprising in themselves, could readily be integrated into a complex story of the earth spread over hundreds and even thousands of millions of years. This was a conception of earth history that I and my colleagues believed was reliably grounded in dozens of independent sources of evidence; and it was reflected as a matter of course in the small public museum at Scripps.

Yet not many miles away, just off the interstate that leads inland towards Texas, was the Institute of Creation Research. Here, in another small museum, there was for example a huge mural photograph of the Grand Canyon – quite an effective substitute for seeing the place at first hand – accompanied by the claim that the mile-thick pile of rocks exposed in its walls had all been deposited, and the canyon then excavated through them, only a few millennia ago and within a geological twinkle of the eye. And in another room was an ingenious reconstruction of the interior of Noah’s Ark, complete with pairs of animals in a receding vista of stalls (including, I was intrigued to see, pairs of dinosaurs), accompanied by sound effects so realistic that we thought for a moment that a violent thunderstorm had started since we ourselves arrived.

We took our graduate students in Science Studies to both these museums, not to admire the first and laugh at the second, and certainly not to revile the first and embrace the second, but to try to

understand how our modern world can contain such radically divergent interpretations of the natural world around us, displayed in discordant institutions only a few miles apart. But there was a further dimension to the contrast. Most of our students unhesitatingly identified the Scripps museum as “Science” and the Creation one as “Religion,” and they took for granted an intrinsic and perennial conflict between the two. But I myself, as an ordinary lay Christian in a mainstream non-fundamentalist tradition, felt acutely uneasy about this polarization. I’d spent the first part of my research career charting the evolutionary history of some humble shellfish on a time scale of several hundred million years; and I certainly hadn’t abandoned that picture of the history of life when, in mid-career, I turned myself into a historian and started charting how and why scientists first developed it. Yet neither my scientific nor my historical research had ever seemed to be incompatible with my religious understanding of the world and of my own life. So I couldn’t place myself unreservedly on either side of this alleged conflict.

My Californian experience of the polarization between “Science” and “Religion” – seeing bumper stickers with the Christian fish symbol parodied by others with the fish inscribed with the name of Darwin – brought home to me in a vivid way the sheer social and historical contingency of this issue. The relation between religious practices and beliefs and scientific practices and beliefs varies widely in the present world, and has varied widely in the past, according to time, place, and, above all, social and cultural location. It can’t be captured in any purely philosophical or theological analysis that leaves out the social, cultural and historical dimensions. For example, what is currently the case in California (and, as I understand it, across much of the southern U.S.) is not the case in my part of the world: in Europe, Christian fundamentalism is politically and culturally marginal, and where it exists at all it’s usually not indigenous but a recent American import. (The down side to this, not unimportantly, is that many Europeans now assume that Islamic fundamentalism is intrinsically Islamic, rather than being one manifestation of a global phenomenon of fundamentalism that affects Islam, Christianity, Judaism and Hinduism in more or less equal measure).

But to return to my main theme: even within a specific social group there can be wide local variations in the sense of conflict between

“Science” and “Religion.” For example, at my present university, Cambridge, there are plenty of ardent atheists. But in practice most of them accept – usually with some puzzlement – that some of their colleagues, without having apparently sacrificed their intellects, nonetheless take their own religious beliefs very seriously. In California, by contrast, my colleagues at UCSD often seemed intolerant of having any religious believers around in the academic community, unless religion could be safely neutered by being tied to ethnicity. Religion to them meant fundamentalism, often for the simple reason that they had never encountered any other kind of religious practice except in an ethnic context.

Such local variations in the perceived relation between scientific beliefs and religious beliefs are quite properly grist to the mills of social and cultural analysts. But being a historian, I’m most concerned to try to understand these variations when they’re plotted against the temporal dimension of history. Historians of the sciences have long recognized that the very imagery of “conflict” between “Science” and “Religion” is a product of specific social and political circumstances in the late 19th century. For example, Andrew Dickson White, the first president of Cornell, wrote his classic book on the “warfare” between science and theology in the context of the professionalization of the sciences in America, and of a struggle to detach higher education from its denominational roots. That context has changed dramatically since White’s time, in both America and Europe; and yet the imagery of conflict or even warfare persists almost unchanged in the mind of the general public, but particularly among television producers and others in the media, and of course in the rhetoric of those propagandizing scientists who are in effect atheistic fundamentalists. Here in America, as I understand it, the context had already changed by the time the term “fundamentalism” was first coined, and even more by the time that creationism came to prominence later in the 20th century. So the apparently perennial appeal of the imagery of conflict needs to be analyzed in relation to changing local contexts. Above all, it can’t be understood without taking into account changes in context over time, in the dimension of history.

THE MEANINGS OF “SCIENCE”

I want to illustrate this historical perspective with a case that has been exemplary, iconic, emblematic or paradigmatic – you can choose your preferred term – ever since the so-called Scientific Revolution some three centuries ago. The case is, of course, the one I’ve chosen as the title of this lecture: geology and Genesis. I want to show how the question of the relation between the opening chapters of the first book of the Pentateuch, and the kind of natural science that came to be called geology, has changed profoundly in the course of history; but also, that it is profoundly misleading to portray this process of change as a relentless “March of Science” against a crumbling “Retreat of Religion.”

But first, I need to subvert the terms in which this alleged conflict is expressed. In the subtitle of my lecture I’ve referred not to two monolithic entities labeled “Science” and “Religion,” but to the interaction of two historical sciences. One of these sciences is of course geology, and I’ll explain later why I put such emphasis on calling it historical. The other side of the interaction is theology, within which I include the scholarly study of the Bible; but I must explain why I call theology another “science.” One of the biggest jolts in my intellectual life came many years ago when I moved from England to the Netherlands, to a teaching position in Amsterdam. In addition to learning the language that famously sounds like a sore throat, I had to adjust to a quite novel concept of what is meant by “science.” But I soon realized that I was the odd one out, and that my colleagues all across mainland Europe represented the historical norm. Only in the last century and a half has the anglophone meaning of “science” deviated from that norm, first in Britain and then here in the U.S. and in other English-speaking countries.

In the rest of the world, all disciplined bodies of systematic knowledge – including, for example, history and, importantly, theology – are regarded as “sciences”: Wissenschaften in German, wetenschappen in Dutch, scienze in Italian, sciences (with an S at the end) in French. But for English-speakers, the word “science” has been narrowed down drastically to mean the physical and biological sciences, and the technologies based on them, excluding everything else. So in our anglophone cultures “scientists” generally distinguish themselves sharply from those they call

“non-scientists,” and they often imply that any knowledge claimed by these outsiders is decidedly inferior to their own. I think it would be a salutary intellectual discipline for us in the English-speaking world to try referring to “sciences” in the plural, as our non-anglophone colleagues around the world do as a matter of course, in place of the singular “Science-with-a-capital-S.” I call it salutary, because it would help us to recognize and value the sheer diversity of the ways in which we try to understand our world, natural and social, human and non-human. And it would put a brake on the tendency to rank our bodies of knowledge according to their approximation to a highly idealized and unrealistic image of a monolithic “scientific method.”

THE SCIENCE OF CHRONOLOGY

Having cleared the ground, I can now tackle my theme of geology and Genesis. We can start in the mid-17th century with James Ussher’s famous date of 4004 B.C. (September 23, to be exact) for the moment of Creation. The scholarly Irish archbishop was not a proto-fundamentalist. He was a practitioner of the science of “chronology,” though not the first or the most distinguished. Chronology was based on rigorous scholarship in ancient history. At the time it was not at the margins of intellectual life but right at its center: Isaac Newton, for example, was one of those who took a deep interest in it. Chronologers tried to correlate the textual records of all the civilizations known to them – not only the ancient Jewish – and to condense them as accurately as possible on to a single timeline of world history. Their primary motive for doing this was usually religious: they wanted to plot the course of salvation history, all the way from Creation to Incarnation and through to the present, from Old Covenant through to New, in its context of total world history. But in doing so they developed very high standards of accurate scholarship.

Chronologers were not naive, and they were acutely aware of the problems of textual evidence. For example, some of them were skeptical about attempts to penetrate as far back as the primal creation, as Ussher claimed to do, because the Roman and Greek records petered out long before that point, and even the biblical evidence was reduced to little more than the bare list in Genesis of who begat whom before the days of Noah. And right at the start, the Creation narrative itself

was controversial, and many scholars doubted whether any dating could properly be derived from it. But anyway, all chronologers, whether or not they agreed with Ussher, were trying to give precision to what was generally taken for granted in their time; namely, that the world had had a brief and finite history, which was almost co-extensive with human history. This assumption was profoundly unmodern, not just in one respect but in two. Not only was the time scale very short, but also it had no place for any pre-human history. As the English writer Sir Thomas Browne (Ussher's younger contemporary) famously put it, "Time we may comprehend, 'tis but five days elder than ourselves." This view of cosmic and human history wasn't imposed by a repressive Church, as the older style of secularist propaganda portrayed it; it didn't need to be, because it was almost everyone's common sense. There was no obvious reason to think otherwise.

Even when rocks and fossils began to be brought into this scholarly debate, later in the 17th century and after Ussher's death, they were integrated naturally and easily into the same picture of a brief and finite history. For example, the Danish scholar Nils Stensen (or Steno, as he was called in the then international language of Latin) found the fossil remains of marine shellfish high above sea level, embedded in layered sediments forming some of the hills in Tuscany, the part of Italy where he was living. It seemed to him that the only recorded historical event adequate to account for them was Noah's Flood. But this inference was not based solely on the biblical text. Many chronologers believed that authentic records of a huge Flood event, however faint or garbled, could also be found in Greek history; and Chinese records were added as soon as European scholars became aware of them. Of course, the scriptural evidence was always regarded as most reliable, because it had a role in salvation history; but the important point is that like the other records the Genesis story was treated as history. The Flood was assumed to have been an event recorded by real human witnesses, which had had natural physical effects (even if its timing had been divine and providential); so it seemed equally natural to find traces of those effects in the form of rocks and fossils. This new kind of natural evidence simply supplemented the older kind of textual evidence: both contributed to an understanding of one-and-the-same brief history of the world.

In the 17th century, then, this picture of a short and finite history of the world was generally taken for granted as obvious and commonsensical. There was indeed a radical alternative, but it was not the modern scientific idea of a far longer yet equally finite history. Instead, it was the quite different notion of a universe that was eternal in all its major features, including the human presence. Unlike other parts of the legacy of the ancient Greeks, the idea of an eternal cosmos with an equally eternal humankind had long been repudiated by the culture of Christendom. Eternalism was regarded as morally and even politically dangerous, and the chronologers' efforts to put a date on the moment of Creation were valued for helping to refute it. It was not just that eternalism contradicted the chronology derived from the Creation story in Genesis. Far more importantly, eternalism was regarded as denying the Christian (and Jewish) doctrine of the createdness of everything in the universe, from atoms to humans, and even time itself. It therefore seemed to call into question all the moral, social and political implications that flowed from that emphasis on God's role as creator: for example, that humans were not free to do whatever they liked, without moral constraint, because they owed their very being to God's creative action, and were therefore ultimately answerable to God.

Arguments for the short and finite history of the world were therefore directed primarily against the threat of eternalism; they were not concerned with defending a literal interpretation of Genesis for its own sake. For example, the English scholar Thomas Burnet published what he called *The Sacred Theory of the Earth*, which was "sacred" because it was partly based on the biblical narratives of Creation and the Flood, and the biblical prophecies of the end of the world. But Burnet also harnessed the latest natural philosophy (or what we would call physics), notably that of Descartes, to argue on physical grounds that the earth must have had a beginning and would necessarily come to an end. Burnet believed that the two sources of evidence – the textual and the natural – combined to prove that the earth's history was doubly finite. In the past there had been a definite starting point in Creation, and then a global catastrophe in the form of the Flood; and in the future there would likewise be a fiery eschatological catastrophe as a prelude to Christ's reign on earth and a final consummation. So scripture and

what would now be called geology combined, in Burnet's view, to refute any kind of uncreated eternity for the earth and humankind.

AN EXPANDING TIME SCALE

During the 18th century this consensual picture of a brief and finite history of the earth, almost co-extensive with human history, unraveled. But it did so in ways that entailed no unsettling crisis of faith. There was no sudden dramatic discovery; but those "naturalists" (as they called themselves) who had seen a lot with their own eyes in the field realized that in some parts of Europe there were many thousands of feet of obviously sedimentary rocks containing lots of obviously marine fossils (they had seen places rather like the as yet unknown Grand Canyon, though somewhat less spectacular). Not surprisingly, their first response was simply to enlarge the scale of the Flood that they assumed had been responsible. An influential example, early in the century, was the London physician and naturalist John Woodward, who later bequeathed his fine fossil collection to Cambridge (and so, indirectly, founded the department where I was trained as a geologist). Woodward suggested that all the varied rock formations had been precipitated in sequence, along with their distinctive fossils, from a thick primordial soup, which he identified as none other than the Flood. But other naturalists were quick to point out that this kind of theorizing put great strain on the story in Genesis: the Flood was indeed envisaged as brief, but not as the kind of relatively tranquil event that Noah and the precious cargo in his Ark could ever have survived.

In fact, the Flood story, as an adequate explanation of rocks and fossils, was soon strained beyond the breaking point. Later in the 18th century, after Woodward's death, naturalists abandoned his and their own earlier assumption that all the rock formations date from the time of the Flood. They became convinced that most of the rocks must have been formed long before any such event. Closer study, both outdoors in the field and indoors in museums, gave them overwhelming evidence that the rocks had not been deposited from any kind of brief and violent Flood, but slowly and quietly, one layer at a time, on the floors of vanished seas; and that the shellfish whose delicate shells were often beautifully preserved as fossils had lived and died in these seas, just like their modern counterparts. So it seemed impossible not to conclude that

the total time scale must have been far longer than Ussher and other chronologers had ever imagined, even if no quantitative figures could be put on it.

These naturalists were not rejecting the traditional short time scale in order to undermine the credibility of the biblical narratives of Creation and the Flood. Most of them were, at the very least, conventionally religious people, and some were much more than that. A hugely expanded time scale was no problem for them, because they were well aware that Ussher's kind of dating was not the only option available. For example, there was a long tradition in biblical exegesis, going right back to the Patristic period, which had questioned whether the "days" of the Creation story could properly be regarded as ordinary days on a calendar, since the sun itself had not been created until well into the symbolic week of divine activity. A better interpretation might be that they were like the "day of the Lord" in prophetic discourse, that is, moments of special divine significance. If so, the story of Creation could be understood as a narrative of divine initiative, spread over a time scale of literally unimaginable magnitude. Alternatively, the primal point of cosmic creation might have been followed by a vast expanse of "deep time" (to use the neat modern phrase), long before the humanly more significant episodes of creative action that began the drama of salvation. Anyway, by the end of the 18th century a hugely expanded time scale for the earth was as much taken for granted among naturalists — whether religious or not — as the short time scale had been a century earlier.

THE IMPACT OF BIBLICAL CRITICISM

As this suggests, the naturalists' growing confidence that the earth must be immensely ancient was encouraged by the parallel growth of another science, that of biblical scholarship. During the 18th century traditional debates about scriptural exegesis were transformed by historical research on the biblical texts, notably in the faculties of Protestant theology at some of the German universities; and this new understanding quickly spread to the educated lay public throughout mainland Europe (my native offshore island, and what were then its colonies across the Atlantic, were slow to catch up in this respect). The origins of biblical criticism are often misdated to the 19th century, and wrongly associated with work that tended — or was even intended — to

undermine religious belief. But in fact its origins lie much further back, and in the 18th century many biblical scholars saw their research as freeing the Bible from the straitjacket of inappropriate literalism; they believed that understanding the historical circumstances in which the texts had first been written would clarify their religious meaning and enhance their religious value.

These scholars studied the comparative philology of ancient languages far more thoroughly than their predecessors, and they delved into ancient history far beyond the traditional limits of Greece and Rome. The biblical documents were analysed in their original contexts in the life of the ancient Middle East, not – or not always – in order to debunk them or empty them of religious significance, but often to facilitate the translation of religious meaning from those culturally remote contexts into the modern world. The older style of literalism, in contrast, was now seen to have embodied false or misleading certainties, because it had unthinkingly imposed on ancient texts a set of hermeneutic assumptions derived from quite different cultural settings. Only a critical historical analysis could reveal the meanings that the texts would have conveyed to their original readers or listeners; and this alone would allow those meanings to be applied reliably to the religious life of the scholars' own time.

The importance of this new kind of rigorous biblical scholarship, newly historical in character, can hardly be over-emphasized, not only for understanding the subsequent history of religious thought and practice in general, but also specifically for understanding the history of the interaction of theology with the natural sciences. For example, it affected profoundly all further discussion of the meaning of the Creation and Flood stories in Genesis, in relation to what was being newly claimed about the history of the earth and its life. It became even clearer than before that the “days” of the Creation narrative could certainly not be treated as calendar days; that the list of who begat whom could not be treated straightforwardly as a quarry for the old style of chronology; that what was inundated by the Flood might have been the part of the globe known to those who recorded it; that the animals saved in the Ark might have been those on which their lives depended; and so on. Yet at the same time this newly historical style

of exegesis, interpreting the texts in the terms of those who first read and received them, did not dilute their religious meaning: the narratives could remain, as before, richly symbolic expressions of what was claimed to be God's self-disclosure within the parameters of human lives and human history.

For example, at the end of the 18th century Josef Haydn's great oratorio *Die Schöpfung (The Creation)*, based mainly on the story in Genesis, was first performed before wildly enthusiastic audiences in Vienna, one of the cultural centers of the Enlightenment. By Haydn's own account he had worked on it with a greater sense of religious commitment than at any other time in his long, productive and pious life. Those of you who are familiar with this work or have sung in it (as I have) will know that it contains one of the most dramatic moments in music of any age: the startling fortissimo on the final word of the saying “God said, ‘Let there be light’, and there was LIGHT!” When Haydn was composing this music, it's inconceivable that he would have been worrying about the number of years, thousands or millions, that had passed since this symbolic creative action took place. Yet among his friends in London a few years earlier had been the naturalist John Hunter, who was then taking part in a lively international debate about fossil animal bones, and was well aware of the growing evidence for an immensely long history of the earth and of life. But this new scientific perspective, however exciting for the naturalist and perhaps also for the composer, was simply irrelevant to the way that Haydn deployed his musical skills to enhance the poetry of the ancient text, and thereby to deepen its religious meaning and its religious impact.

THE EARTH'S OWN HISTORY

The development of critical historical methods in biblical studies was in fact the leading edge of a broader intellectual movement. It was during the 18th century that modern historical scholarship in general first took shape: particularly our modern methods of scrutinizing primary or contemporary sources critically and in detail for their evidence of past events, past lives, past societies, and past ways of thinking; but also, as a product of this research, a new awareness of the sheer strangeness or otherness of earlier periods of history (in the famous later saying, “the past is a foreign country where they do things differently”).

During the 18th century this sense that the human past, however strange and unfamiliar, could be recovered and reliably known, was dramatically strengthened in a way that's directly relevant to my main theme. The Roman cities of Herculaneum and Pompeii, which had been buried in A.D. 79 by the first recorded eruption of the volcano Vesuvius, were discovered by chance and then systematically excavated in what became the first major projects in scientific archaeology. Educated Europeans at this time were all brought up on the Latin classics, and they might well have assumed that such literary sources told them more or less all there was to know about Roman civilization. But these buried cities showed them vastly more about everyday Roman life, ranging from pots and pans to pornographic wall paintings, all of which hugely enriched what had been known from traditional textual sources.

Herculaneum and Pompeii then became the crucial catalyst, as it were, for the transfer of ideas and methods from human history into the history of the earth, from culture into nature. For example, the French naturalist Nicolas Desmarest escorted a young aristocrat on the Grand Tour around Italy, where they saw Vesuvius and the already famous excavations at its foot. Desmarest then transposed that experience on to the extinct prehistoric volcanoes that had recently been discovered in central France. He, and others who followed his example, described ancient volcanoes and lava flows as nature's documents; mountains were nature's monuments or nature's archives, and fossils were nature's coins; and all these physical features could be assembled into nature's annals or nature's chronology. In effect, the whole vocabulary of human historiography was deliberately and explicitly transposed into the natural world as a set of fertile metaphors. This facilitated a quite new sense that the earth could be understood as the product of nature's own history.

One of the most influential examples of this trend was Georges, count Buffon, the director of the royal museum in Paris, which at the time was the world's leading research center for all the natural history sciences. Like Burnet a century earlier, Buffon sketched a conjectural history for the earth itself and for life on earth. He outlined a sequence of the earth's physical states in the deep past, metaphorical "milestones" along the path of its long history. It was no accident that he called his milestones "epochs" and entitled his work *Nature's Epochs*. For "epoch"

was a technical term borrowed from chronologers and other historians. An epoch was a decisive moment in history, a major turning point such as the Exodus or the Incarnation in biblical history, or the founding of Rome, and much later its fall, in secular history. So Buffon, like Desmarest, was claiming that nature, and specifically the earth, had also had a history, and one that could be reconstructed from its own physical evidence.

Buffon's conjectural history for the earth was derived from his cosmological theory that in the remote past the planets had all been spun off from the sun. He outlined how the earth could have been brought from this incandescent (and of course lifeless) beginning all the way to the familiar human present; and how it would continue into a remote future, lifeless once again but this time from extreme cold. He even tried to quantify the time involved, by scaling up the results of experiments in which he timed the cooling of small iron spheres. This gave him a figure of some 75 thousand years for the whole sequence so far. He suspected that this was far too little time to account for the huge pile of rocks that others had found in the field, but he had no concrete evidence to support his private guesstimate of some 3 million years. Obviously, he didn't keep quiet about this higher figure for fear of criticism on religious grounds, because even his published lower estimate was way beyond anything the old chronologers had calculated. Rather, he felt a scientific need for caution; he recognised that the human imagination needed stretching, before any higher figure would look like anything but irresponsible speculation. And it was a sign of the times that the Catholic theologians in Paris made only the most perfunctory attempts to criticize Buffon. Once they recognised that he was not smuggling in a new form of eternalism, they found his reconstruction of the earth's history quite tolerable. Biblical literalism was no longer at issue.

Most significantly, Buffon defined the very last of his milestones or epochs as the point at which humans had first appeared. This made explicit a claim that other naturalists such as Desmarest had long supported implicitly, namely that all the preceding vast spans of the earth's history had been pre-human. In all the huge pile of sedimentary rocks, among all the abundant and diverse fossils that were being collected from them, there was no trace of any human presence, no

human bones or artifacts (or none that was not soon shown to be spurious or at least suspect). In effect, therefore, Buffon's theory signaled explicitly the arrival of the scientific conception of the earth's history. In this perspective it's irrelevant that even Buffon's private time scale of some 3 million years was still peanuts by the standards of modern geologists. What's far more important is that he and his contemporaries established a radically novel picture of earth history, which transcended the antithesis between the two earlier rivals. The naturalists showed, with ever increasing empirical evidence, that earth history has not been short, finite, and almost wholly human, as the old chronologers had assumed. But nor has it been infinitely lengthy and infinitely human, as the old eternalists claimed. Instead, the novel third option – the modern one – was that it has been immensely long but still finite, and totally non-human except in its final phase.

A CONTINGENT EARTH HISTORY

This newly historical way of understanding the earth went against the grain of most scientific work at the time, which was focused instead on a search for the unchanging "laws of nature" that governed all the diverse parts of the natural world. Isaac Newton, for example, was idolized in the 18th century for having formulated the laws of universal gravitation, which made it possible to calculate and predict the motions of planets and comets with uncanny accuracy (famously, Halley's comet returned, and Venus twice crossed the face of the sun, exactly on schedule). But the whole point about nature's laws was that they were not historical: they were assumed to remain unchanged throughout whatever expanses of time there had been or would be, in past or future. Of course, the naturalists who claimed to reconstruct the past history of the earth were not denying the constancy of the laws of nature. But at the same time they were also proposing a quite novel program of scientific research into the history of nature.

The novelty of this concept is highlighted by its contrast to the theorizing of James Hutton, the Scottish philosopher who has often been treated as the creator of the scientific view of the earth's history and therefore as the "father" of modern geology. Hutton's *Theory of the Earth* was first published in the year that Buffon died and on the eve of the French Revolution, but in some ways it was a throwback to a much

earlier intellectual world. Hutton claimed that the earth showed (in his own famous concluding words), "no vestige of a beginning, no prospect of an end." Its sequence of physical states was, in his own favorite analogy, as ahistorical as the apparently endless orbiting of the planets around the sun. Hutton's theory was in fact a late revival of eternalism, and it was interpreted as such by his contemporaries, both his admirers and his critics. It was pervaded by a deistic theology of divine design: the whole physical system he outlined was meaningless without an equally eternal human presence to fulfill its underlying and unchanging purpose. Hutton's theory was profoundly unmodern in many ways, but above all in its denial that the earth has had any true history, and in its implicit claim that the world has always been a human world.

Hutton, like Buffon, assumed that if the true laws of nature were known, it would be possible in principle to predict (or to retrodict) the course of change over time. For Buffon the whole course of earth history, past and future, was ultimately determined by the physics of gradual cooling; for Hutton the unchanging laws of nature determined a steady state of endless cyclic repetition. But both claimed in effect that it was possible in principle to discover what must have happened in the past, and what will necessarily happen in the future, by applying the relevant physical principles. In contrast, the kind of earth history that field naturalists such as Desmarest inferred could only be reconstructed from a detailed study of nature's own documents and archives, the traces of what in fact had happened. And in doing this they were deliberately borrowing from the new style of human history, with its detailed analysis of human documents and archives; and this in turn had been borrowed from the newly critical methods of biblical studies.

This affinity between the newly historical science of the earth and the newly historical science of biblical scholarship was exemplified by Jean-André de Luc, the Genevan naturalist whose patron and employer was George III's highly intelligent German wife Queen Charlotte. De Luc became Hutton's most persistent and formidable critic, not because he doubted Hutton's vast time scale for the earth but because he emphatically rejected Hutton's eternalism. Hutton's theory implied that there had been an endless cyclic repetition of similar events through an infinity of deep time. De Luc insisted instead that the earth had had a

true history, an unrepeated sequence of distinctive events; and this was the hallmark of the new kind of science that came to be known by the word that de Luc proposed for it: "geology."

In the context of the Enlightenment, de Luc described himself as a "Christian philosopher," defending the claims of Christian theism against the more famous array of deistic or atheistic philosophers whom Schleiermacher called "cultured despisers of religion." The impact of de Luc's theistic commitments can be seen in the radical contingency that he attributed to earth history, and which he grounded in God's ultimate role as creator of everything. As de Luc conceived it, earth history at every stage could have taken another course, with a different outcome, without of course abrogating the ordinary laws of nature. It followed that the sequence of events could not, even in principle, be inferred from the ahistorical laws of physics, as both Hutton and Buffon implied: there was too much contingency in earth history, as in human history, for any such determinism. Rather than imposing top-down some grand conclusion of what "must" have happened, based on unchanging laws of nature, it was necessary, in de Luc's view, to assemble bottom-up the evidence of nature's documents and archives, which showed what in fact had happened. So the new way of analyzing the physical traces of earth history, applying the methods of reconstruction being used for human history (including biblical scholarship) was not just an effective heuristic but was rooted in an ultimately divine reality.

De Luc championed the integration of human history with earth history, and not only by the use of fertile metaphors such as nature's documents and archives. He argued that the Flood had been the unique boundary event at which human history and earth history were welded together, because it had left traces both textual and physical. He claimed that the date of the Flood, unlike the incalculable vastness of pre-human earth history, could be estimated quantitatively from physical evidence. The rates of processes such as erosion and sedimentation, which were observably at work in the present world, were, he argued, "nature's chronometers" (a nice allusion to John Harrison's recent invention of the precision chronometer for navigation, the greatest high-tech achievement of the 18th century). Having studied these present geological processes in the field all over western Europe, de

Luc concluded that they had only started to act, or re-started, a few thousand years ago, after the drastic and enigmatic event that he identified as the Flood. This was of course roughly compatible with the dating of the Flood derived by the old chronologers from purely textual sources; and in de Luc's view this matching of physical and textual evidence confirmed the sheer historical reality of the event. He defended the Genesis narrative because he believed it to be trustworthy as history, provided it was properly understood in the context of its own time; and he valued it because it carried religious meaning within the broader sweep of God's self-disclosure in and through human history.

GEOLOGY AND GENESIS REDEFINED

At the end of the 18th century and the start of the 19th, all the sciences were thrown into turmoil by the Revolution in France and the world war that followed it. Yet in this inauspicious climate de Luc's ideas on earth history were strikingly developed by the great French naturalist Georges Cuvier, Napoleon's exact contemporary. Cuvier's outstanding skills in comparative anatomy enabled him to show that the fossil bones found in the deposits commonly attributed to the Flood all belonged to mammals distinct from any species known alive: many of them, such as the mammoth, being of spectacular size. Cuvier claimed that they were all truly extinct, having been overwhelmed in some kind of natural catastrophe. He identified this as the biblical Flood and its equivalents in the records of other cultures as far afield as China, all of them more or less garbled and requiring critical interpretation. But above all, Cuvier made the idea of nature's own history familiar throughout the Western world, far beyond the circles of expert naturalists. He suggested that geologists should aspire to "burst the limits of time," penetrating back from recorded human history into pre-human earth history, just as astronomers had already "burst the limits of space" by penetrating outwards from our small planet to understand the whole solar system and even the stars beyond.

In the rest of the 19th century, geologists responded with enthusiasm to Cuvier's eloquent call to action. With growing confidence, they pieced together in increasing detail a coherent account of the history of the earth and of its living organisms. Their research massively reinforced the hunch of earlier naturalists that the time scale of earth history had been

vast beyond human imagination; and that humans were, relatively, last-minute arrivals on the scene. Some of the most prominent and effective of these geologists were ordained clergymen, and many others too were religious people in a far from merely nominal sense. Yet having absorbed the lessons of historical biblical scholarship they felt no problem about modifying the older and now outdated kind of literalism in the light of their own newer research. For example, William Buckland, the first (and reverend) professor of geology at Oxford, initially envisaged the Flood as having been a huge global mega-tsunami, dwarfing any similar event in recorded human history. But later, faced with a mass of new evidence, some of it derived from his own research, Buckland readily changed his mind and agreed with other geologists that this drastic event had not been aqueous at all, but instead an “Ice Age” in which vast glaciers and ice sheets had spread across much of Europe and north America. The biblical Flood was then reinterpreted as having probably been a quite local and much more recent event; but of course its religious significance as a potent symbol of God’s early engagement with humankind was unaffected.

Far more importantly, the recognition of a drastic Ice Age or glacial period, preceding even the earliest recorded human history and yet very recent in terms of earth history, was a totally unexpected conclusion. So it powerfully endorsed the need to treat earth history as ineluctably contingent, and impossible to predict (or rather, to retrodict) except in the most limited ways. It therefore established earth history itself as being, at the deepest level, strikingly analogous to human history. And ironically, in view of the stereotypical imagery of conflict between “Science” and “Religion,” this modern scientific view of our world, which earth-scientists now take for granted without thinking about it, was derived ultimately from the historical study of the biblical texts, as they were released from the straitjacket of inappropriate literalism and liberated for their properly religious role.

CONCLUSION

In this lecture I’ve traced some of the historical interactions between geology and biblical interpretation, though I’ve only had time to go as far as the early 1800s, still a century and a half distant from our modern world. You will have noticed an apparent match between what some

earlier naturalists suggested, and what modern American creationists now campaign for. But the similarity is deeply deceptive, because the two sets of beliefs were or are held within radically different cultural and intellectual contexts. What was good cutting-edge science three centuries ago has become inexcusable obscurantism today. In the 17th century, scholars were justified in taking for granted a very brief world history, almost co-extensive with human life. The chronologers among them interpreted biblical texts with a literalism that still seemed unproblematic, although in retrospect it was deeply unhistorical; while the naturalists among them had no good reason to reach any other conclusion. But during the 18th century biblical scholars recognised the profoundly unmodern cultural conditions in which their texts had first been produced and received; and this newly historical perspective soon spread to human historiography in general. From there it was swiftly and effectively transposed by the naturalists into the study of the natural world, at just the time when they were discovering compelling evidence for a vastly greater time scale for the earth. It therefore became possible for the first time to speak of nature’s own history, and on a scale that dwarfed the whole of recorded human history.

So the perspective of earth history that modern geologists can now take completely for granted was a gift from human historiography and ultimately from biblical scholarship. The natural sciences were hugely enriched by the human sciences: “Science,” in the anglophone sense that I promised to avoid, was enriched from outside its own sacred boundaries, and indeed enriched from that other supposedly monolithic entity, “Religion,” to which it is so often falsely opposed. In the light of all this, anyone who cares about upholding rigorous standards in scholarly and scientific work, but also about keeping open the possibility of a genuinely God-centered understanding of our modern world, must surely reject the alluring but false certainties of all kinds of fundamentalism: not only the arrogant atheistic fundamentalism of some of the self-appointed spokespersons of “Science-with-a-capital-S,” but also the religious fundamentalisms – no less arrogantly dogmatic – that are so prominent in our modern world (and not only in the world of Islam).

NOTE: The argument of this lecture is set out much more fully – with detailed references to the original sources that substantiate it and to the related work of other historians – in my book *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution* (Chicago, 2005), and in some of my articles reprinted in *The New Science of Geology* (Ashgate, 2004) and *Lyell and Darwin, Geologists* (Ashgate, 2005).

PREVIOUS LECTURES

ERNAN MCMULLIN

University of Notre Dame, 2004:
"Evolution as a Christian Theme"

MARY JO NYE

Oregon State University, 2003:
"Linus Pauling and Scientific
Revolutions of the 20th Century"

MICHAEL RUSE

Florida State University, 2002:
"Darwinism and Atheism: A Marriage
Made in Heaven?"

OWEN GINGERICH

Harvard University, 2001:
"The Copernican Revolution Revisited"

EVERETT MENDELSON

Harvard University, 2000:
"Cloned Sheep, Headless Frogs,
Human Futures: Meanings for the New
Biology"

LAWRENCE WEISKRANTZ

Oxford University, 1999:
"Percepts, Brain Imaging and the
Centrality Principle: A Triangular
Approach to the Scientific Basis of
Consciousness"

The Herbert H. Reynolds Lectureship in the
History and Philosophy of Science

BAYLOR
UNIVERSITY