Vestiges and Prospects

The creation of the Earth – 'The Creation' – is a preoccupation of all the world's great religions, and Christianity, Islam and Judaism share a common creation story with its roots in prehistory. The evidence-based, scientific view of the formation of our tiny speck in the cosmos, the theme of this issue of *Elements*, is altogether younger, having evolved over little more than two centuries. It seems a good moment to reflect on the fundamental differences between science and faith, and on the modesty, underlying simplicity and unifying power of the scientific approach.

Central to the scientific view is the understanding that the Earth is enormously old – the concept of 'deep time'. This was first put on a sound footing by a Scottish farmer whose Edinburgh home was about two miles from my office. James Hutton's 1788 paper *'Theory of the Earth'* ends with one of the best-known sentences in the history of geology: 'The result, therefore, of our present enquiry is, that we find no vestige of a beginning, – no prospect of an end'. Hutton's detractors, ignoring the key word 'find', accused him of atheism, because otherwise his sentence seems to imply that there was no creation event, just an unending steady-state. In fact Hutton retained his faith and thought that his observations provided an argument for 'wisdom and benevolence' in Nature. This issue of *Elements* is about the vestiges of the Earth's origins that modern work has unearthed; 'vestiges' is still a hauntingly appropriate word.

Hutton first communicated his ideas in the form of an extended abstract, read to the Royal Society of Edinburgh by his friend Joseph Black (he of specific and latent heat, and discoverer of carbon dioxide) in 1785. Hutton's first two paragraphs are beautiful and encapsulate to perfection the way in which many Earth scientists continue to work to this day:

> 'The purpose of this Dissertation is to form some estimate with regard to the time the globe of this Earth has existed, as a world maintaining plants and animals; to reason with respect to the changes which the earth has undergone; and to see how far an end or termination to this system of things may be perceived, from the consideration of that which has already come to pass.
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> As it is not in human record, but in natural history, that we are to look for the means of ascertaining what has already been, it is here proposed to examine the appearances of the earth, in order to be informed of operations which have been transacted in time past. It is thus that, from principles of natural philosophy, we may arrive at some knowledge of order and system in the oeconomy of this globe, and may form a rational opinion with regard to the course of nature, or to events which are in time to happen.'

Hutton's concern with the end of the world seems strange to us now, but we must view his work in the context of his time. Archbishop Ussher had in 1658 published his oft-quoted estimate, based on arcane interpretation of middle-eastern calendars and holy writings, that Earth was created on October 23rd, 4004 BC. Ussher's estimate was included in the English Bible, and was accepted as Scripture. In this context Hutton's second paragraph represents a great leap from a view based on faith to one based on evidence and reason, in other words, on science. Hutton deduced that the Earth must be much older than 6000 years because he saw great thicknesses of sedimentary rocks resting on older, harder rocks that had been tilted, producing unconformities, a thrilling glimpse of 'ancient worlds'. High mountains were eroded over long periods to provide new sedimentary rocks. His inability to quantify the rates of these processes led him to write, in one of the final paragraphs of his abstract 'that, *with respect to human observation*, this world has neither a beginning nor an end'.

Hutton has here put his finger on one of the defining characteristics of the scientific method. If we cannot solve a particular aspect of a problem, we say so, and leave it to future generations to make the key observations. This editorial will be read by scientists of many faiths and by humanists like myself, but we will all agree on the essence of science: the endless questioning of received wisdom; the utter honesty, so that we state not just the precision and accuracy of our measurements but point to both the strengths and weaknesses of our arguments; we draw attention to things we do not understand and have an attitude of mind that admits to uncertainty; if we have to, we say, publicly, 'I was wrong'. And, above all, we appreciate that all scientific theories begin as myths and gain the status of theory only when they have withstood repeated attempts at falsification.

Science has grown from these simple principles through the free-thinking of pioneers like Hutton, who maintained his faith but discarded the literal interpretation of the written word. In the face of overwhelming evidence that the scientific method works for the good of mankind, religious fundamentalists of many faiths appear unable to embrace the simplicity and honesty of science. Some of these extremists hold high office in countries around the world. Inter-faith warfare is one of the central causes of avoidable horrors in the modern world. As scientists we should take every opportunity to set out the universal principles that give science its power.

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Cont'd on page 196

BEHIND THE SCENES AT *ELEMENTS*: HOW WE DEVELOP THEMATIC ISSUES

What goes on behind the scenes to produce an issue of *Elements*? Should anyone besides the editors care? Even if you have never considered being a guest editor of an issue of *Elements*, or even if you are not the least bit curious about how all this works, we encourage you to read on. The first thing to remember is that *Elements* belongs to each one of us as individual scientists. Without this simple yet powerful principle, this magazine would simply not work. *Elements* does not belong to principal editors or societies or to the disciplines that they represent. As important as these societies are, and the disciplines represented therein, it is absolutely vital that *Elements* transcend them. What drives *Elements* is the continuous and unending scientific creativity of each and every one of us. Science is what scientists do, and the goal of *Elements* is to represent, indeed to project, what we do as mineralogists, geochemists, and petrologists, for each other and for the rest of the world. With this in mind, the process of creating an issue of *Elements* becomes abundantly clear. We (the three principal editors and the managing editor) are happy to receive proposals for thematic issues at any time. One simply needs to go to www.elementsmagazine.org and click on "Forms" to get instructions on how to submit a proposal. Once submitted by a potential guest editor, the editors will consider the proposal and often ask for revisions if the proposal has potential. We will also ask for the author list to be firmed up. If the proposal is eventually accepted, it will be slotted in the *Elements* production schedule such that ample time is allowed for proper development of the issue and a balance of subject diversity in the annual line-up is maintained. If the accepted proposal is particularly timely for whatever reason, this can also be taken into account in the scheduling. The next critical step is for the guest editor, the principal editor assigned to be in charge of that issue, and the managing editor to have an extended conference call, during which the processes of producing the issue are reviewed in detail. Authors are contacted, the writing begins and finishes, and the reviewing, revising, and final production proceeds under the watchful eyes of several of us over the ensuing months. The final result will be another issue that represents all of us well. We could produce nothing less.

Editorial Meeting

The editors met in Baltimore, USA, on May 26, 2006. The main items on our agenda were choosing the incoming principal editor for 2007 and completing the line-up of thematic content for 2007. We are now in the enviable position of receiving more proposals than we can accommodate. This will ensure the vitality and the relevance of *Elements*. We are now booking issues for 2008 and welcome proposals. Some people have expressed concern that we might run out of topics. We look blankly because we see exactly the opposite happening.

2007 Principal Editor

Susan Stipp of the University of Copenhagen, Denmark, has just accepted our invitation to replace Mike Hochella as principal editor for a three-year term, from 2007 through 2009. We are delighted that Susan will join the *Elements* team. An article about Susan and her background will appear in the first issue of 2007.

Welcome to AIPEA

We welcome the International Association for the Study of Clays (Association internationale pour l'étude des argiles) as an affiliated society, thus joining the International Mineralogical Association and the European Mineralogical Union. President David Bish introduced AIPEA in the last issue (page 188). The affiliated status is reserved for umbrella organizations. In this case, AIPEA members are the clay societies of the world. We look forward to reading their news.

New Features

"Publications Forum" was quietly introduced in volume 1, issue 4, with two articles on open access. Since then, we have published on GeoScienceWorld and on copyright issues. Other articles in preparation will deal with impact factors, the Fog index, references, etc. If there is a topic you would like us to discuss, please send us an e-mail.

In this issue, we give a voice to students by launching a "Students Page," and we hope it will become a regular feature of *Elements*. Graduate and undergraduate students: if you want to raise issues of concern or share an important experience, the space is yours. This page will also be the ideal place to advertise grant and scholarship application deadlines.

Elements *is Yours*

Elements is your magazine. Let us know what else you would like to read in it. We welcome letters to the editors concerning the editorials or any other topic you think would interest the mineralogy–geochemistry–petrology community. We welcome contributions to "Parting Shots," in which we publish spectacular or interesting photographs. And we rely on members to bring to our attention "People in the News."

Thanks

We thank John Valley, guest editor, and the five authors who contributed papers to this issue; the society news editors of the participating societies; the other contributors to this issue: Alain Baronnet, Dan Kyle, Crystal Mann, Kaspar Mossman, and Anthony J. Naldrett.

Mike Hochella, Ian Parsons, Bruce Watson, and Pierrette Tremblay

Cont'd from page 195

Footnote to Editorial

I was surprised to learn, while researching for this editorial, that slightly before Ussher, in 1644, Dr. John Lightfoot, Vice-Chancellor of the University of Cambridge, had deduced, by exhaustive study of the Scriptures, that 'heaven and earth, centre and circumference, were created all together, in the same instant, and clouds full of water,' and that 'this work took place and man was created by the Trinity on October 23, 4004 BC, at nine o'clock in the morning.' A remarkable convergence, and what enviable precision! The 9 am is often wrongly ascribed to Ussher.

Ian Parsons