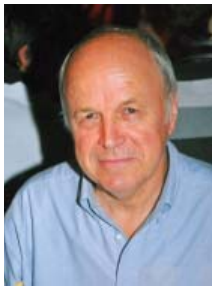
EVOLUTION AND EXTINCTION



David J. Vaughan

The subject matter of this issue of *Elements*, like many excellent ideas, will seem obvious to other scientists when put before them. Its elegance makes it appear simple. Mineral evolution provides a sense of progress, or at least of a progression from the simple to the complex, since the explosive beginnings of our universe. The idea of a process of 'evolution' that extends back in time for many billions of years before the emergence of any life form on Earth is particularly apt at a time when we have just celebrated the bicentenary of the birth of Charles Darwin, the man who essentially gave us biological evolution. However, there is at least one very important difference between the evolutionary development of life forms and that described here for minerals: it is that minerals, however rare, cannot become extinct, whereas for living organisms extinction is the rule rather than the exception. Probably more than 99% of all the organisms that have ever lived are now extinct.

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So what can we say about the Earth and its 'systems' in the context of evolution and extinction at the beginning of the year 2010? Chiefly that Earth is a planet dominated by one mammalian species whose actions have already led to the extinction of numerous life forms and threatened the extinction of many others. At the time of writing this editorial, the Copenhagen Conference on climate change has just ended with little real progress towards dealing with the dangers of greenhouse gas emissions as the cause of potentially catastrophic changes in global climate, sea level, ocean currents and ocean chemistry. I will not dignify the arguments of the tiny handful of 'climate-change deniers' with an attack on their follies – their case has been discredited in numerous books and articles, including many in this magazine. If global warming continues unchecked, this will have a devastating impact on the survival prospects of millions of people and could even portend the 'extinction' of *Homo sapiens*. The unfortunate lesson of Copenhagen seems simply to be that our remarkable technological development has not been matched by the evolution of the social and political systems needed to deal with global problems, particularly if they involve politicians having to make unpopular decisions.

What, if anything, might we do as scientists in the face of this unprecedented challenge? Clearly there is the possibility of contributing to technological 'fixes', which include the capture and storage of greenhouse gases emitted from power plants and vehicles, the development of alternative (green) forms of energy, helping to solve problems associated with existing low- or zero-emission energy forms (notably the waste-disposal problems of the nuclear industry), and even novel ways of modifying Earth's atmosphere or the input of heat from the Sun. The latter might involve some means of directly extracting CO_2 from the atmosphere and disposing of it in the deep ocean, in deep sedimentary formations, or through reaction with Mg and Ca in silicate rocks such as basalts. Other novel proposals include 'geoengineering' stratocumulus clouds by injecting into them a fine spray of sea salt from the ocean surface which would act as nuclei to increase the number of water droplets and cause them to reflect more of the Sun's heat. However, at present, some *deus ex machina* total solution to our climate problems seems very unlikely. We will surely need to call upon many of these ways of reducing the impact of our human activities on the global climate. We will also have to accept the need to make changes in our lifestyles and the need to help our more threatened neighbours in poorer countries, both technically and financially. Amongst the most important things we can do is to waste no opportunity to educate our fellow citizens about the dangers we all face and the terrible price we may all pay for inaction. It is astonishing, so the pollsters tell us, that very many of the general public either do not 'believe' in global warming and its consequences or think that it does not pose a serious threat to our survival.

The mineral world is remarkably beautiful, but even those of us who spend our working lives studying it would not wish to see it 'evolve' to outlast the living world.

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