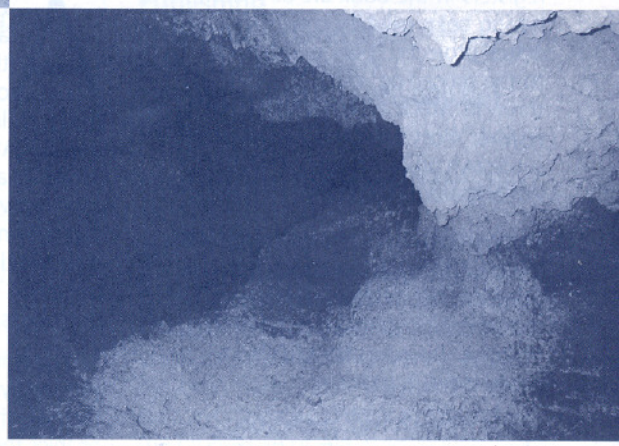
Photographs: Jonathan Cowie

Left: The author in the Cheia geological reserve within the Danube World Heritage Biosphere reserve. An island of limestone amidst a sea of river-borne sediment, illustrative of one of the life-mediated processes regulating the global carbon cycle and which (happened to(?)) keep the conditions on Earth right for life.

Below: One of Cheia's limestone caves. double value. Not only does the limestone play a part in an Earth systems process that has helped make Goldilock's Earth just right for life, but these caves were also the home to humans during the last glacial.



Earth Systems Science comes of age

So why are there geologists? And what has this to do with the Danube's World Heritage Biosphere Reserve? ***Jonathan Cowie**** *explains how the newest Geological Society specialist group will address the BIG questions in natural science.*

Returning to London hot foot from the Danube World Heritage Biosphere Reserve, I was struck by the new 370 x 10 foot hoarding adorning the Wellcome Trust's Euston Road headquarters. Entitled *The Geology of Biology*, it is the Trust's latest project to bring science to the public. Unfortunately it's not so much about Earth System Science (ESS) but chromosomes, macromolecules, vacuoles and other cellular structures - not surprising perhaps, when its inspiration was the human genome. However - and fortunately for those life scientists who recognise that the biosphere has both biotic and abiotic interdependent components - October 2 saw the launch of the Geological Society's latest Specialist Group to further the study and understanding of ESS.

The Group will answer some of the BIG questions in geology. Like - how come there are geologists? You might reply, with justification, because geology is inherently interesting and of economic value. While this is a valid response with which I would not dare argue, it fails to address the really BIG question - which is, how come - over billions of years - organisms have evolved that are of sufficient complexity to understand the triaxial indicatrix? I put it flippantly, but this is a seriously non-trivial question.

Geology not only helps illuminate our understanding of biological evolution but starkly demonstrates to us how processes have fostered life itself. Just prior to the ESS inaugural meeting I was the privileged guest of the Romanian Ecological Society at a UNESCO-sponsored science education event in the Danube World Heritage Biosphere Reserve. Among the many things to be found there are clear examples of both past and present processes that enable our biosphere to sustain life.

The Cheia geological park consists of limestone that could not exist on Venus, whose carbon remains in the atmosphere. Limestone has been fundamental to ensuring life's continuity. Poignantly, the limestone at Cheia contains caves that provided shelter for primitive humans: caves produced through the action of water in a process which itself is part of the global homeostatic systems without which life on Earth would have long ago become extinct. The limestone has helped living creatures in more ways than one.

Prof. John Lawton, NERC's Chief Executive, in a recent *Science* editorial (v. 292, p1965) referred to this biospheric homeostasis as 'the Goldilocks effect'. Highlighting the value of ESS, he asked why the natural atmospheric blanket has made our planet just right for life: neither too hot (like Venus) not too cold (like Mars). He cited James Lovelock's "Gaia" theory - the work that has provided much of the inspiration for the new Specialist Group. Some scientists find the notoriety of Lovelock's work unseemly. It came about when Lovelock, explaining the idea of the biosphere's self-regulating systems, likened them to those homeostatic ones in a living organism. Many concluded that Lovelock believed biosphere was a single conscious organism. Not so. You and I have consciousness, but we do not consciously control our homeostatic processes. Your kidneys continue to function as you read this article - perhaps with increased efficiency. Absorbed as you are in this prose, I trust you will not have to remember to breathe.

Homeostatsis in organisms works by the laws of physics and chemistry, moderated largely by proteins and carbon structures. Fantastic and fascinating as it all is, there is nothing supernatural or magical about it. Lovelock himself bemoans the unfairness of much of the criticism levelled at his Gaia metaphor. He is puzzled as to why other scientific metaphors, such as Richard Dawkins's "selfish gene" have not received such a ravaging.

Bio-geocycles are virtually omnipresent. Not only do all living creatures participate in them, they happen every time rains runs over rock. Within the Danube Biosphere Reserve I was able to witness many of these processes writ large. The Danube itself has a catchment covering much of central Europe (Austria, Bulgaria, the former Czechoslovakia, Hungary, Romania and Serbia). The lower Danube receives sediment from all these

The lower Danube part of the Danube World Heritage Biosphere reserve sees considerable sedimentation processes at work. Each year floods abate the upstream end of the islands and deposit sediment down stream. Note the various generations of trees with the younger ones on the most recently deposited sediment. Carbon cycling is an important part of the lower Danube's ecosystem function. Keeping in mind that the Danube watershed covers much of central Europe, the Danube's carbon cycling is not insignificant on a global scale.

countries in such volume that, even before the river becomes a delta, midstream islands form, moving slowly downstream, capped by alluvial forest. In terms of ecosystem function, the entire area not only plays a key role in Central Europe's carbon cycle, but is of considerable biodiversity value.

I have cited lower Danube partly because I just happen to have been there, and because it is a World Heritage Site. But bio-geocycles operate throughout the biosphere. They are reflected in the geology of countless sites. You pick your own.

This is not of solely academic interest. The carbon cycle has its applied dimension, and it relates to key problems facing life on Earth today; problems that not only command the attention of many scientists, but also of politicians on the international stage. Soil erosion is one - but so is global warming. In essence, global warming is largely (though not solely) due to human short-circuiting of the carbon cycle through burning fossil fuels.

Without going into the detail, we would need to cut our emissions of carbon dioxide by around 60% just to "stabilise" the global climate at its current levels. Yet given a growing *per capita* demand for energy compounded with a growing world population mean this simply will not happen. With international will, politicians tell us, we might just be able to stabilise emissions (not climate). The developed nations will have to cut their *per capita* consumption to allow less developed nations to increase theirs in a policy called 'contraction and convergence'. Yet, even so, Earth will continue to warm.

How will this affect life and its homeostatic processes? Could it be that while overall the Earth warms, some regions might cool? (The NW European peninsula is a possible candidate, should the Broecker thermohaline circulation shut down, diverting the Gulf Stream.) To answer these questions we need geologists, biologists, climatologists, palaeoclimatologists, atmospheric chemists, physicists, computer scientists - to name just some of the specialisms involved in ESS. The new Specialist Group will be uniquely placed to provide an ambassadorial role for geology and geologists to all these other disciplines. Furthermore, the Society will be seen as the first learned body with the necessary vision to explore this synergy.

At the Group's inaugural meeting, ably arranged by Tim Lenton, Euan Nisbet reviewed the isotopic evidence as to whether life drove the Archaean carbon cycle. Ian Fairchild discussed "Snowball Earth", and Mary Midgely provided a humanities perspective on past philosophical approaches to the nature of the Earth, placing ESS in its historical and cultural context. Dave Wilkinson refined this theme by examining the historical relationship between biology and geology. Darwin, though famous for his biology was, at the time of his Beagle voyage, as much (if not more) a geologist.

Mike Widdowson enthusiastically reviewed the Open University's teaching of ESS.

The afternoon saw sessions on how Himalayan weathering affected global climate, while Andy Ridgewell explained how dust linked biogeochemical processes of land, air and sea into a single cycle. Those concerned with current climate change were treated

to a concise view of the latest understanding of global warming. But the most important session of the day was the inaugural meeting of the Earth System Science Specialist Group, chaired by Sir Crispin Tickell.
The meeting agreed to accept a draft Group constitution approved by Council and nominated a caretaker team to look after matters until a proper AGM could be held to elect its first Committee. This interim team will be chaired by Sir Crispin with Professor Mike Whitfield (formerly Chief Executive of the Marine Biological Association) as Vice Chair. Tim Lenton agreed to act as Secretary, while Susan Canney will be Treasurer. Tom Wakeford, Euan Nisbet, Mike Widdowson and Dave Wilkinson make up the rest.

They have a difficult task ahead, but have much going for them. They will be helping to take forward one of the most exciting and challenging areas of contemporary science. They also have the huge enthusiasm of those at the inaugural meeting. We have much to look forward to.
*Jonathan Cowie is the author of *Climate and Human Change: Disaster or Opportunity?* (Parthenon). He co-ordinates some 75 learned biological societies on science policy matters.

* The ESS Specialist Group will be holding its first AGM this month (see Calendar) at which the speakers will include Dr James Lovelock (originator of the Gaia concept) and Sir Crispin Tickell. The Group also has a Circular, the first issue of which will be produced shortly. If you are not a member of the Group but would like to receive a copy regularly, please write to enquiries@geolsoc.org.uk giving your name and postal address for inclusion on the mailing list.