United Nations
Educational, Scientific and
Cultural Organization

A World of SCIENCE

Natural Sciences
Quarterly Newsletter

Vol. 5, No. 4
October – December 2007
Revised version

IN THIS ISSUE

EDITORIAL

Unearthing the truth

Although tragedies like the Indian Ocean tsunami and Hurricane Katrina graphically demonstrated how indispensable geoscientific knowledge can be in mitigating natural disasters, geological knowledge benefits *all* of society *all* of the time because everything we cannot grow – all the power and raw materials on which society depends – comes from the Earth and therefore has to be 'unearthed' by geologists.

With fewer students opting for geoscience courses, Earth scientists fear we may be heading for a collapse of geological educational infrastructure worldwide. This could happen because, by the time rising prices encourage further exploration, historically low student recruitment may have already led to the closure and dispersal of university departments. Given the central importance of Earth sciences for our future, this prospect should worry everyone.

Over the next 18 months, the International Year of Planet Earth – initiated jointly by UNESCO and the International Union of Geological Sciences (IUGS) – will be urging political leaders to act.

The Year will be officially launched at UNESCO headquarters on 12–13 February. On its list of things to do: reducing vulnerability to natural and human-induced hazards; improving understanding of the medical aspects of Earth science; discovering new natural resources and making them available in a sustainable manner; getting under Earth's living skin: soil; building safer structures and expanding urban areas by utilizing natural subsurface conditions; determining the non-human factor in climate change; detecting deep and poorly accessible groundwater; and removing some of the question marks surrounding the evolution of life.

There will also be a strong focus on public outreach. Australian palaeontologist Patricia Vickers–Rich epitomizes this spirit. She is the author of the story in this issue of how life evolved on Earth. This fascinating tale encompasses the findings of an ongoing research project involving Prof. Vickers–Rich and others which is sponsored by UNESCO and the IUGS within the International Geoscience programme.

A second story focuses on the Year's geohazards theme. We shall follow the adventures of the inhabitants of Ambae after they discover a plume of steam and black smoke rising from the summit of the volcano dominating their island home in Vanuatu.

Major events over the next year include the Planet Earth exhibition at UNESCO headquarters from 16 October to 3 November, the 3rd International Conference on Geoparks in Germany in June and the International Geological Congress in Norway in August, under the patronage of UNESCO. A wealth of national events are also planned in more than 60 countries for scientists or the general public.

Meanwhile, entries close on 31 January for the photo contest being run within the Year by UNESCO for 15–20 year-olds around the globe, with 40 book prizes to be won. Look for details on UNESCO's science portal.

W. Erdelen
Assistant Director-General for Natural Sciences

Photo: M. Fenton

Modern stromatolites forming in Shark Bay in Western Australia, a World Heritage site. Structures like these were formed by microbial mats as long ago as 3.8 billion years

The **rise of animals** (Part I)

To kick off this series of articles on selected themes from the International Year of Planet Earth, we begin at the beginning with a short history of the evolution of life on Earth. Even a brief summary of this history takes some telling, so the story has been divided into two parts, the first on the ancient Earth during Precambrian times (4900–542 million years ago) and the second part, due to appear in the next issue of *A World of Science*, on the past 542 million years, the Phanerozoic.

The rise of animals is a story written in stone. It is a story with missing chapters, as the fossil record remains fragmentary. Nonetheless, palaeontologists, geologists, climate modellers, biologists and so on can already pore over a wealth of evidence covering millions – even billions – of years: mineral deposits which provide clues to the shift of continents, palaeoecosystems, trends in sea level and climate variations, as well as fossils of bacteria, tiny algae, archaic plants and ancient animals which trace the rise of the animal kingdom and many of evolution's success stories and failures.

By providing insights into the functioning and stability of palaeoecosystems and biodiversity dynamics over long time scales, this research helps scientists understand the modern Earth and intelligently try to predict its future. At the same time, it provides an invaluable treasure for industry, given the high economic stakes inherent to identifying and exploiting the world's mineral deposits and the remaining stocks of such fossil fuels as oil, coal and gas.

Visions of Hell would not be far off from what the Earth was like in its infancy five billion or more years ago. It had no atmosphere, no water, nor any stable surface on which soil could form. Around this ancient Earth circled a huge, red Moon, closer than it is today. A faint Sun hung in a black, star-studded sky. Knifing through the darkness were thousands of extraterrestrial visitors, meteorites that blasted the Earth's dark surface. Enormous clouds of rubble rose silently from each impact before falling quickly back to Earth, there being no atmosphere to suspend particles or transmit sound.

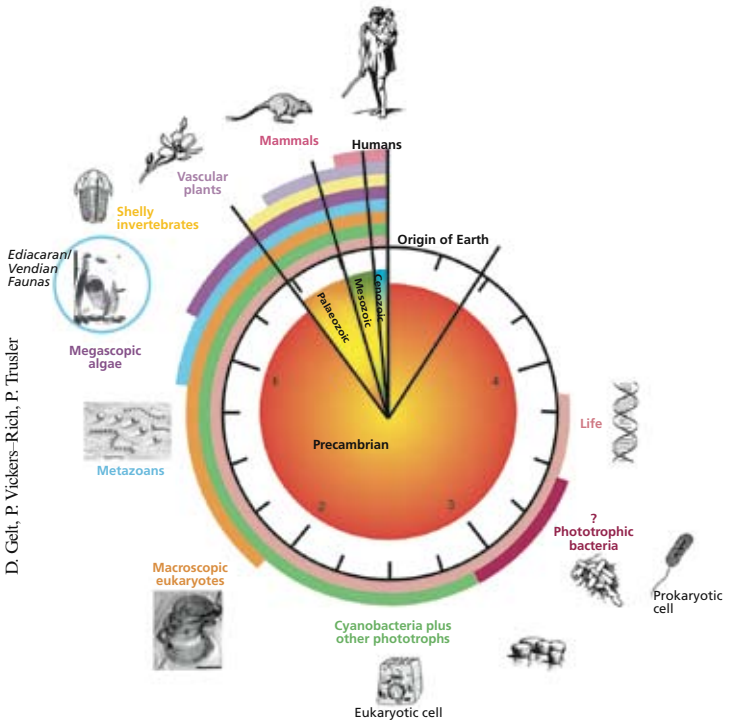
Thanks to the gases and water produced by volcanic eruptions, the oceans and atmosphere began to form. The size of the Earth and its distance from the Sun made it possible for water to remain liquid rather than turning to ice or boiling away.

The hostile Archean

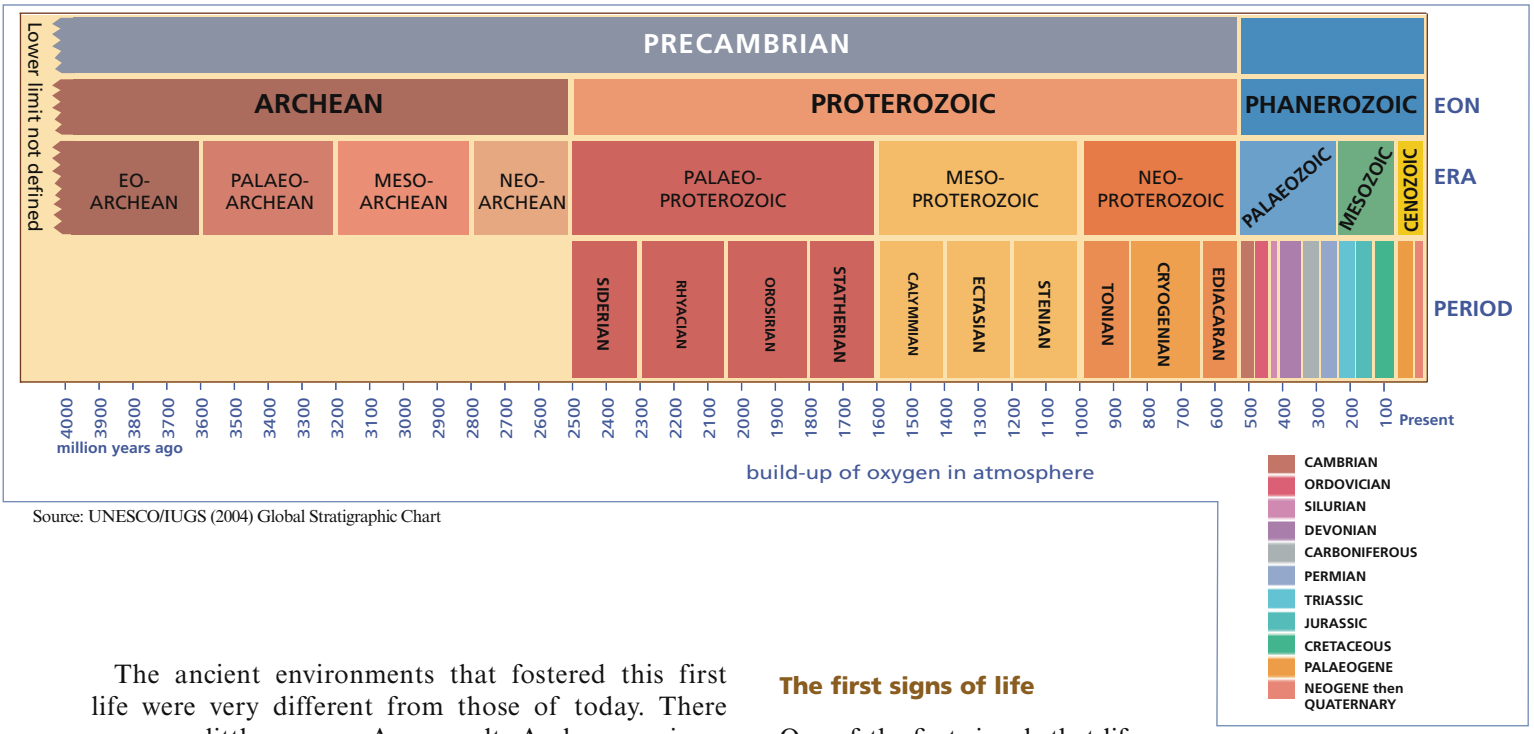
The oldest known minerals[1] on Earth are around 4.1–4.5 billion years old: zircons and diamonds from Western Australia. After this period, the Earth began to cool towards the present.

Some time later, the first evidence of life appeared on Earth, a period dominated by bacteria. Certainly, by 3.8 billion years ago, life had originated. The advent of animals would have to wait nearly another 3 billion years.

Major events in the history of life



D. Gelt, P. Vickers-Rich, P. Trusler

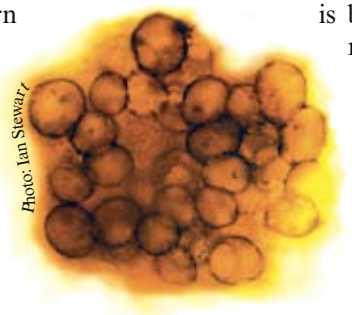


Source: UNESCO/IUGS (2004) Global Stratigraphic Chart

The ancient environments that fostered this first life were very different from those of today. There was very little oxygen. As a result, Archean environments favoured the formation of major ore deposits dominated by lead, zinc and iron, all critical to industry today.

Some of these ancient deposits are unique to this time and no longer form in any quantity. This is the case of banded iron formations (BIFs), examples of which are found in the state of Western Australia, southern Africa and northern North America. BIFs are brightly coloured red and often black rocks that are finely layered; layers of iron alternate with mudstones and glassy rocks made of silica, known as cherts. BIFs seem to have formed when cyanobacteria released oxygen which in turn caused iron to be deposited as red oxides. When there was little oxygen around, the muds and cherts were laid down.

The oldest known rocks on Earth are the Acasta gneisses from northwest Canada, dated at 3.8–4.05 billion years. They are rich in silica, the mineral that makes up glass. Slightly younger rocks come from southwest Greenland in the Isua Greenstone Belt; these are dated at 3.7–3.85 billion years of age. After initial formation, these rocks were later heated and folded (metamorphosed), at least twice. Despite a real effort, geologists studying this part of Greenland could find no evidence of continents or the terrestrial sediments associated with them. One can surmise from this that oceans covered the surface of the Earth at this time.



Fossilized cells from rocks that are more than 900 million years old in the Macdonnell Ranges of central Australia, just a few microns in diameter

The first signs of life

One of the first signals that life was present 3.8 billion years ago are the stromatolites found in rocks dating from this period. These structures are still forming today in places like Shark Bay in Western Australia (*see photo*) and the Persian Gulf, so we can compare present structures with their ancient remnants. Stromatolites can take many different shapes. They are layered sediments whose deposition is brought about by micro-organisms; these micro-organisms either bring about the laying-down of finely stratified limestome or trap sediments within their extensive microbial mats.

Other evidence of early life are the chemical biomarkers left in sediments by living organisms, which occur in rocks older than those containing the first stromatolites, and actual fossilized cell structures!

No DNA, no future!

What is life and how does it differ from non-life? Life is an organized system of chemical reactions which take place in a confined space, usually a cell. Life is a self-perpetuating series of chemical reactions and a self-assembling dynamic system. Life gets its energy and structure from basic nutrients (amino acids, sugars and fats) by a process called metabolism. Where all this takes place, inside the cell, is separated from the outside environment by a membrane. Importantly, this allows chemical reactions to take place inside the cell quite independently of the outside world. The cell membrane still allows communication with the outside

How scientists measure geological time

Fossils are the primary basis for the definition of the Geologic Time Scale, which divides Earth History into a series of eons, eras, periods and epochs.

The Archean and Proterozoic Eons described on these pages are the time of 'hidden life', as during most of this period the only organisms were single-celled microbes which left few fossils.

The Phanerozoic Eon is subdivided into the Palaeozoic (or era of Ancient Life), the Mesozoic (or era of Middle Life, informally known as the Age of Reptiles) and the Cenozoic (or era of Modern Life, also called the Age of Mammals).

Some of the methods for constructing a sequential history of life or of geological events give only relative dates, or the order in which one event occurred relative to another. Relative dates can be determined by examining the sequence of rock layers: the oldest rocks lie below the younger ones unless, of course, tectonic activity has overturned the sequence.

Absolute dating of rocks was not possible until well after the beginning of the 20th century. All absolute dating techniques rely on the principle that radioactive processes proceed at a constant rate under the range of temperature, pressure and chemical conditions typical of the Earth's surface. Here are two of the most common methods.

Fossilized Parvancorina, *one of the Ediacarans, from the Flinders Ranges in South Australia*

The Potassium–Argon technique is used to date rocks ranging from 1 million years to as much as 4 billion years old. This radioactive dating technique relies on the principle that, after a known period of time, called the half life, the amount of original radioactive material remaining is reduced by one-half because of radioactive decay. This decay continues halving the radioactive material at the same rate, until the amount remaining is infinitesimally small, essentially undetectable due to background radiation from space.

Another radiometric technique is the familiar Carbon 14 method. This is often used to date charcoal and plant material found at sites not older than about 35 000 years. Carbon 14 has too short a half life (5700 years) for it to be useful in old rock sequences. Carbon 14 is only one of the three forms (isotopes) of carbon, the other two being Carbon 12 and Carbon 13. Whereas Carbon 14 is radioactive, Carbon 12 and 13 are not. Thus, whereas the quantity of Carbon 14 declines with decay, Carbon 12 and 13 remain unchanged forever, unless the rock is unduly heated or chemically altered. Thus, by measuring the ratio of Carbon 14 to Carbon 12 and Carbon 13 in fossil material, we can pinpoint the age of a fossil.

Source: Vickers-Rich, P. and Rich, T. H. (1999) Wildlife of Gondwana. *Indiana University Press.*

but regulates what comes in and what goes out; it is the doorkeeper.

Living systems must also store information in the form of a microscopic structure called deoxyibonucleic acid (or DNA). Any life form must also be able to repair this DNA when damaged to ensure its future.

Escape from a hydrothermal prison

Life needs liquid water but can survive in a great variety of environments ranging from the very hot to the very cold. Some of the most primitive life forms we know today are what we call hyperthermophiles. These hyperthermophiles (the Archaea and Bacteria) are organisms which truly enjoy living in water at 80–110°C or even much higher temperatures, and can withstand pressures of up to 265 atmospheres[2]. The life that was around by 3.8 million years ago is likely to have been derived from these hyperthermophiles; it would likely have first developed around hot springs or vents associated with oceanic spreading ridges where the interior of the Earth flows upwards and interfaces with water.

With the development of photosynthesis[3], which cyanobacteria were the first to master, oxygen became available; oxygen combined with carbon chains to form sugars, fats, proteins and the building blocks of organic matter. Once life began to produce oxygen, it could escape its hellacious hydrothermal prisons.

Earth begins to look more familiar

By the beginning of the Proterozoic 2.5 billion years ago, the Earth would have begun to look more familiar to us. The oxygen produced by cyanobacteria was accumulating in increasing amounts. The ozone blanket around the Earth would have formed as the oxygen being produced interacted with sunlight. This provided protection for the genetic material in living systems, greatly reducing mutation.

Oceans themselves changed a great deal. Proterozoic oceans on Earth held much more oxygen at the surface than their oxygen deserts at depth. These were oceans at an intermediate stage between the oxygen-starved (anoxic) Archean seas and the well-oxygenated oceans of today. Levels of carbon dioxide (CO_2) and methane were likely higher than today and the Sun was likely less bright. Despite this, the Earth began to cool towards the first major global glaciation, the most severe ever in the history of the planet.

Sometime after this, oxygen began to build up in quantity and the first organisms with a defined nucleus (eukaryotes) appeared. Bacteria still dominated the seas and the deeper, less oxygenated ocean depths, forming vast microbial 'pastures' for the first animals to graze upon.

The emergence of continents

At some stage during the Proterozoic, plate tectonics switched on. This was a consequence of the convection

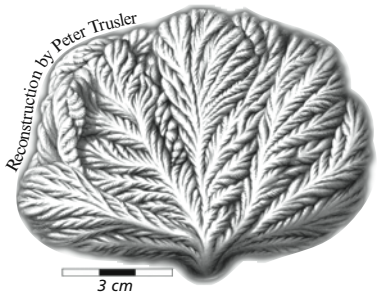
of material upwards from the Earth's hot interior, heated by both gravity and radioactivity. This produced the first fully terrestrial environments. From now on, plate tectonics would continuously change the positions of the continents, open and close ocean basins, cut off or alter the pathways of ocean currents and build or destroy continents.

The Earth's upper 100 km or so became divided into a series of brittle plates containing both continents and ocean basins. The collision of some of these plates built mountain chains which locked up heavy metals, such as manganese, iron, zinc, copper and chromium, as well as carbon stored in the buried remains of organisms for lengthy periods. This in turn had an effect on climate by removing CO_2 from the oceans and atmosphere, thereby lowering temperatures. The first shallow, sunlit seas developed on the new, broad continental shelves, areas that today nurture great biodiversity.

Meanwhile, the oceans began to mix for the first time in the Earth's history, with the nutrient-rich bottom waters welling up from below, injecting energy-rich food into those shallow, clear seas and thereby stimulating the development of new life forms. This upwelling was brought about by water masses colliding with the newly formed high-standing continents.

The first animals

It was during the dynamic times of the Proterozoic that the first animals (metazoans) and plants appeared, perhaps as early as 1.8 billion years ago. These animals were some of the first multicelled organisms. Lacking eyes and ears, they depended entirely on touch and chemical signals to evaluate their surroundings, just as jellyfish and worms do today. To us humans, with such emphasis on vision, this seems a bizarre, almost unimaginable world, one that can only truly be appreciated by those who cannot see or hear.



Reconstruction of one of the Ediacarans, Bradgatia linfordensis, *from 570 million-year old marine sediments from Newfoundland in eastern Canada*

How ice ages fostered the rise of animals

Ice ages are unusual in the history of Earth. When they occur, they have a massive impact on life. About 750 million years ago, global temperatures fell dramatically. This is revealed by the study of oxygen and carbon isotopes preserved in sediments and by the sudden appearance of other sedimentary features, including diamictites. The latter were massive sediments whose chaotic internal structure indicates they were laid down as massive ice sheets melted.

There had been ice ages before, in the Archean, but these Proterozoic ice ages were severe and may have had a major influence on the origin of animals. This is because colder waters hold more oxygen and most animals need oxygen. But animals did not appear in the fossil record immediately with the onset of these ice ages. This may have been because the seas were simply too salty, forcing the first animals to live in very restricted environments. It would explain why they did not leave extensive fossils. Most animals do not prosper in super-salty environments.

Sometime between 630 and 580 million years ago, huge salt deposits formed globally. These are best preserved in Australia, Iran, Oman, Pakistan and Saudi Arabia. These salt deposits indicate a drop in salinity levels in seawater. Before its removal from the oceans, salt in the seas could have been 1.6–2 times what it is today – not a problem for cyanobacteria or bacteria in general but it could have posed a real dilemma to the first animals.

With the seas becoming less salty, those animals that had developed during the cold times when oxygen levels were higher, but which may have been restricted to less salty areas, such as river mouths where freshwater mixed with ocean water, could almost immediately find new homes in the oceans. They could have quickly moved into these global playgrounds. They have left records of their going which show that they moved into a vast number of new niches.

D. Gelt, P. Vickers-Rich

Map of the world some 1100 million years ago. Crustal blocks formed the oldest known supercontinent, Rodinia, about this time (modified from Condie, 2001)

Tracing the rise and fall of the Ediacarans

Mikhail Fedonkin (Russia), Patricia Vickers–Rich (Australia) and Jim Gehling (Australia) are leaders of a six-year project to 2008 which is tracing the rise and fall of the Ediacarans, which appeared in the fossil record about 580 million years ago before disappearing for the most part by 542 million years ago.

The project involves scientists from Africa, Asia, Australia, Europe, Latin America and North America; it sets out to date with precision those events which affected the Ediacarans during the Proterozoic, including changing environments, climates, global ocean and atmospheric chemistry and palaeogeography. The most diverse fossil assemblages of Ediacarans can be found in parts of Australia, Newfoundland in eastern Canada, Namibia and Russia but there are also fossil records in China, India and North America, the UK and Ukraine. The team has also attempted to locate new fossil records in Latin America and elsewhere – with some success, as it has been able to publish on possible Ediacarans from the Puncoviscana Formation in northwestern Argentina. More prospecting in the region is needed however, as the forms found by the team were not very detailed.

As part of outreach to the public, the project has produced a popular book on *The Rise of Animals*, due out before the end of the year. It has also put together a touring exhibition called Before the Dinosaurs, the First Animals on Earth (*see photos*). Several public lectures have been organized and a large number of new reconstruction artworks have been commissioned, some of which illustrate these pages. In 2005, the project organized a special stamp issue with Australia Post on the theme of Creatures of the Slime, an allusion to the preferred food of microbial mats! The collection comes with a teaching guide and module. The project is also working with many museums to assist them in storing and databasing the Ediacaran fossils in their collections.

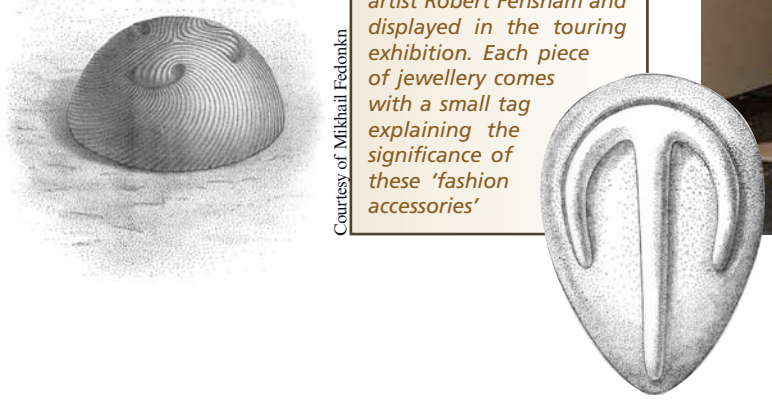
The project is sponsored by the International Geoscience Programme (IGCP), set up by UNESCO in 1972 and coordinated ever since by UNESCO and the International Union of Geological Sciences. Every year, the IGCP makes a call for project proposals. Upon being accepted in 2003, The Rise and Fall of the Vendian (Ediacaran) Biota became IGCP project 493. A sample of the project's findings form the backbone of the current article.

Project website: www.geosci.monash.edu.au/precsite/index.html
On the IGCP: m.patzak@unesco.org; www.unesco.org/science/earth

Courtesy of S. Sano

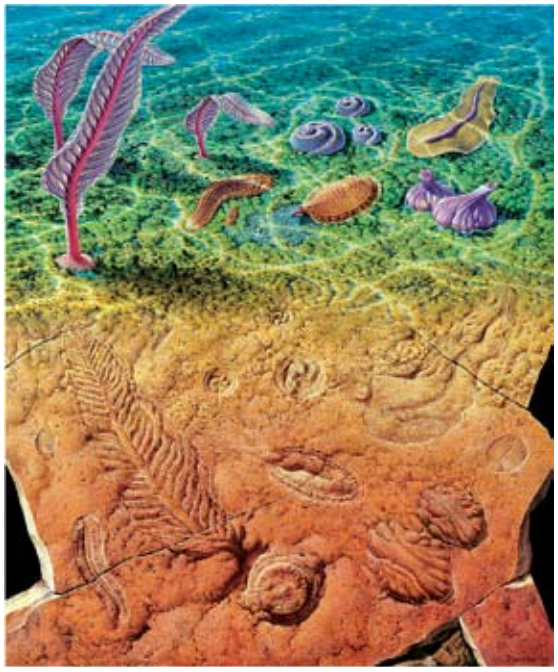
The exhibition Before the Dinosaurs, the First Animals on Earth *opened at the Fukui Prefectural Dinosaur Museum in Japan in July 2006 and drew close to 100 000 visitors in three months. It was the first time that most of the material from Russia, Namibia, Australia, Newfoundland and several other spots had been exhibited together*

The 'building blocks of educational jewellery', sketches of Tribrachidium (left) and Parvancorina. Earrings, tie clips and pins in the shape of these two Ediacarans were commissioned by the IGCP project from Australian artist Robert Fensham and displayed in the touring exhibition. Each piece of jewellery comes with a small tag explaining the significance of these 'fashion accessories'



Courtesy of Mikhail Fedonkn

Andrey Ivantsov from the Palaeontological Institute in Moscow prepares a soft toy Kimberella *for display in the exhibition*



©Peter Trusler/Courtesy of Australia Post

Artist's impression of Ediacarans, the first diverse assemblage of animals on Earth, as fossils (bottom) and reconstructed. Among the reconstructions, the two tall and one short leafy-looking creatures on the far left are Ediacarans by the name of Charniodiscus. *Next to them from left to right in the upper row are* Tribrachidium *and* Dickinsonia *then, in the lower row,* Spriggina, Kimberella *and* Inaria. Kimberella *is of special interest: a probable precursor of the modern mollusc, this animal could move and left feeding traces in the microbial mat surface*

This could explain why the fossils that most scientists accept as being of the first animals, the Ediacarans, appear almost overnight in the fossil record practically worldwide around 580–560 million years ago, long after genetic studies predict that metazoan animals should have diversified.

Meet the Ediacarans

Over millions of years, the first animals on Earth, the soft-bodied Ediacarans, experimented with new designs. Some of these designs seem to have given rise to groups we know today, like the probable Ediacaran mollusc precursor, *Kimberella*. Others, such as *Bradgatia* and *Charniodiscus*, may have been unsuccessful, leading to their demise.

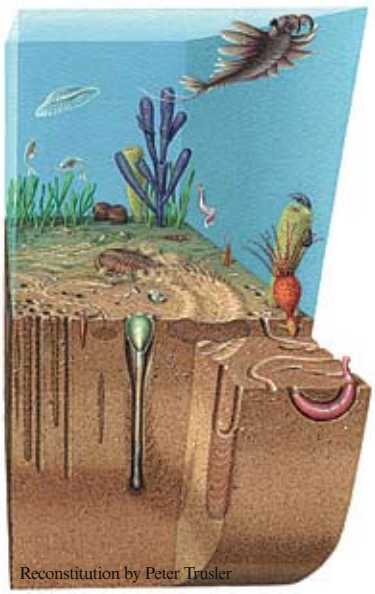
What is certain is that these new forms appeared in the late Proterozoic. Those that gave rise to later forms in the Phanerozoic changed the oceans forever. The sea bottoms, which had been covered by microbial mats in the Archean and Proterozoic, when sediments had lain undisturbed, were now being plowed and burrowed extensively.

Ediacarans came in different shapes and sizes. They are often preserved in the silica-rich sediments laid down in marine waters in such places as the White Sea region of Russia, the Flinders Ranges of South Australia and the Avalon Peninsula of Newfoundland on Canada's east coast. These sediments indicate that the Ediacarans lived in cool marine environments, as these favour the deposition of silica-rich sediments. In the sandstones and clays of southern Namibia, Ediacara macrofossils are common and may have been deposited during cool episodes.

Yet fossils of some metazoans from this time have also been found in the deserts of Namibia and in other parts of the world in younger carbonate-rich sediments, suggesting that some had adapted to warmer times. In the pure carbonates of ancient Namibia, *Cloudina*, *Namacalathus* and *Namapoika* were the first metazoans to form reefs. This is especially true of *Cloudina* which, with its thin shells made of calcium carbonate, was present nearly worldwide. *Cloudina* lived at a time when the salinity levels of oceans may have been similar to those of today, some 548 million years ago.

The collision of a number of tectonic plates bearing continental masses brought about the formation of an 8000 km-long mountain chain between 650 and 500 million years ago, thereby forming the supercontinent Gondwana (*see map overleaf*). The rivers draining this 'supermountain' may have introduced massive amounts of nutrients into the oceans, as well as the first concentration of materials for building skeletons and shells. Higher temperatures, too, would have favoured the deposition of calcium carbonate, the basic building block of shells. So, both ocean water chemistry and temperature may have played a role in the origin and expansion of the metazoans and the first development of shells in the 'ocean playgrounds of summer'.

Reconstitution by Peter Trusler



Reconstitution by Peter Trusler

On the left is the shallow ocean bottom in the late Precambrian (Neoproterozoic) times when animals neither burrowed nor possessed hard parts. Conditions changed dramatically in the Cambrian, beginning about 542 million years ago, as the diagram on the right reflects. Hard parts began to appear, animals began to burrow, some even gained eyes

From The Rise of Animals, *Johns Hopkins University Press (2007)*

This fossil shows one of the earliest known animals on Earth, Mawsonites. These Ediacarans lived more than 550 million years ago in shallow seas in many parts of the world. It is because Ediacarans were first recognized as being Precambrian in age in the Ediacara Hills of southern Australia that scientists have coined the collective term for them of Ediacara Fauna. Although most Ediacaran animals were entirely soft-bodied and did not produce hard parts such as shells, teeth and bones, some forms grew up to 1 m in length. They were perhaps similar in appearance to modern sea-pens, chitons and snails or worms. It is thought that many of these animals fed by grazing or absorbing nutrients from the widespread microbial mats which covered the sea floors of the time or that they filtered food particles from sea water. Soft-bodied animals are not normally preserved as fossils, due primarily to the fact that, once they die, their corpses are eaten by other animals. More than 542 million years ago, though, there were no large scavengers to feed on dead Ediacaran animals. The dead bodies thus remained on the sea floor, where some were embedded in mud and eventually preserved as fossils. Rapid burial and the formation of pyrite 'death masks' around the dead Ediacarans also helped to preserve them.

(With thanks to Bettina Reichenbacher, Michael Krings and Wighart von Koenigswald)
Photo and custody of fossil: Natural History Museum Senckenberg, Frankfurt/Main, Germany

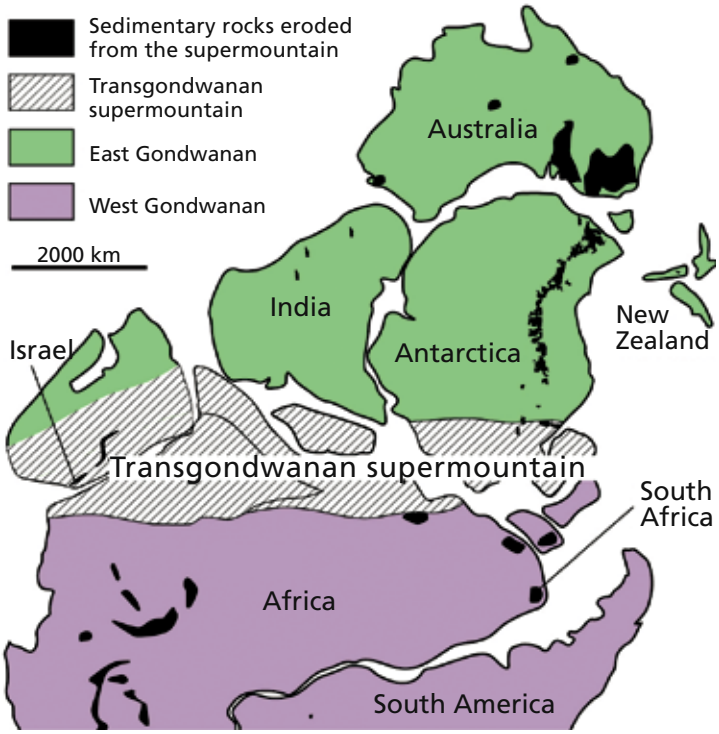
The development of shells heralds the advent of the Phanerozoic 542 million years ago. Once organisms were able to produce hard tissues and deposit skeletons and shells of various kinds, the fossil record literally exploded with variety. Skeletons have many advantages for their bearers. Muscles can be attached to them, resulting in a more efficient use of energy in locomotion and feeding. External skeletons can provide armour to protect against both predators and competitors. By providing flexibility and opportunity, skeletons were necessary ingredients for the development of the first vertebrates, primitive fish.

Our story pauses on the cusp of the Phanerozoic. The term for this eon means "visible or obvious life". The Phanerozoic is so-named to reflect the richness of the fossil record from this time onwards. This is because many of the animals that follow have left behind hard skeletons that were easily fossilized. Their forerunners had not been so graciously endowed.

When we take up the story again in January, it will be to see a parade of living things ever-increasing in complexity, from snails and ammonites to amphibians, dinosaurs and other reptiles, and mammals, including our own ancestors, the first hominids.

Patricia Vickers–Rich with
Peter Trusler and Draga Gelt[4]

This article includes excerpts from The Rise of Animals *co-authored by Mikhail Fedonkin, James Gehling, Kathleen Grey, Guy Narbonne and Patricia Vickers–Rich. Johns Hopkins University Press, Washington (USA), 2007: www.geosci.monash.edu.au/precsite/index.html; www.press.jhu.edu/books/index.html*



Samples of sandstone collected from different continents contain grains of zircon with remarkably similar ages. This indicates that those sedimentary rocks all came from a similar source. The most likely candidate was a gigantic mountain range straddling the supercontinent Gondwana, which would have formed 650–500 million years ago. Erosion of the supermountain not only flushed huge amounts of sand, silt and other sedimentary rocks into the oceans but also many of the nutrients that were vital for the explosion of animal life on Earth

Source: Rick Squire/Monash University

1. *Rocks are aggregates of several minerals. Some rocks are made up of largely one tye of mineral, like marble which is essentially made of calcite*
2. *On today's hyperthermophiles, see* A World of Science, *April 2006*
3. *Photosynthesis is the chemical reaction whereby the Sun's energy causes water to be broken down into its component parts, hydrogen and oxygen. Organisms which carry out photosynthesis are called phototrophs. Today, plants are the predominant users of photosynthesis. In aquatic environments, examples of phototrophs include algae and cyanobacteria*
4. *Respectively: School of Geosciences at Monash University (Australia). palaeontologist and artist at Monash University; and draftswoman at Monash University*

Water education comes to China's schools

A project targeting schoolchildren and designed to make people more aware of the need to protect and conserve water in China was launched at a UNESCO workshop in Beijing on 13 July attended by experts from China, Australia, France and India.

Pupils deep in concentration at Mahe Primary School in Beijing in October 2006

Over the coming year, UNESCO's Beijing office will be preparing a series of textbooks on the subject of water for Chinese primary and secondary schools, in tandem with the China Institute for Water Resources and Hydropower Research and the China Association for Science and Technology (CAST), a government-sponsored NGO specialized in the popularization of S&T and environmental education. Once completed, the textbook will be tested in CAST demonstration schools in the different Chinese provinces.

'Ideally, the book will be distributed to all primary and secondary schools in China, as we are working closely with the nationally executed Environmental Education Programme,' explains Jayakumar Ramasamy, Programme Specialist for Natural Sciences at UNESCO's Beijing office. 'Since the development of water education as an independent subject is still in the early stages in China,' he adds, 'the textbook project will be a pioneering initiative. Initially, both environmental education in general and water education in particular will be introduced as extra-curricular courses.'

The partners will also be developing a teacher's manual with ideas for practical exercises and experiments related to water, such as how to test water quality using simple kits.

In parallel, CAST and UNESCO's Beijing office will be initiating a series of training courses for school teachers. They will also hold exhibitions and run competitions for pupils who have been exposed to the new textbook in class. The exhibition and competition will form an integral part of the National Science Education Campaign being run by CAST. The winners of the national competition will be awarded certificates by UNESCO and relevant Chinese ministries.

The educational component of a broader programme for Sustainable Water Integrated Management (SWIM) in China, the school project falls within the UN Decade of Education for Sustainable Development (2005–2014); it is being financed via funds-in-trust to the tune of 126 000 euros by the Italian Ministry of Environment, Land and Sea and the Chinese Ministry of Water Resources.

Primary school poster

The project comes at a time when China is battling a water crisis. The country is roughly the same size as the USA but counts four times the population (1.3 billion). Nearly one-fifth of the country is desertic and new deserts are springing up. Average per capita water consumption (2300 m^3) is just one-quarter the world average. To make matters worse, scarce water resources are often unevenly allocated, with almost 70% being concentrated in the summer season and two-thirds being carried away by floods.

Industrial pollution has become a serious problem, affecting not only the natural environment but also the health and daily lives of the Chinese, not to mention economic growth. Water pollution from both point and non-point sources is growing dramatically. According to the Chinese State Environmental Protection Administration, the annual amount of wastewater rejected by industry into the Yellow River for instance, reached a new high of 12 billon tons in 2006. Wastewater from farming and domestic activities could be greater still but this is harder to assess due to the mobility of the pollution source.

In March this year, the State Council decided to revise the 23-year old water pollution law, which prescribes penalties for a wide range of violations but has proven weak on enforcement. The State Environmental Protection Administration has imposed a temporary ban on new construction projects in seriously polluted regions, according to a 6 July report by the *China Daily*, which quoted Director Zhou Shengxian as saying that an environmental emergency might break out anytime in most areas.

For details: j.ramasamy@unesco.org; www.unescobeijing.org/

Mission rallies support for DRC's mountain gorillas

A mission of experts led by UNESCO travelled to the Democratic Republic of the Congo (DRC) from 11 to 22 August to investigate the causes of the recent slaughter of nine mountain gorillas in Virunga National Park, a World Heritage site, and determine ways to help save the 370-odd endangered primates living there.

The mission rallied support for the endangered gorillas from the authorities of the DRC, the UN Mission in the DRC (MONUC) and local communities.

The experts from UNESCO and the World Conservation Union (IUCN) were accompanied by a UNEP representative. In Kinshasa, they met with the directors of the Congolese Institute for the Conservation of Nature (ICCN), the Special Representative of the Secretary-General of the United Nations to the DRC, William Lacy Swing, and Environment Minister Didace Pembe. Conscious of the need to preserve the mountain gorilla and other endangered wildlife, both for their intrinsic value and their potential for the local economy, Messers Swing and Pembe both pledged their support.

The mission then visited Rumangabo, the base station of the park rangers, and the gorilla monitoring centre in Bukima. After talks with numerous personnel working with the gorillas and with local communities, the experts visited the Rugendo gorilla family, in which the recent killings took place.

In Goma, the mission interviewed representatives of the various NGOs active in the southern part of Virunga as to their perception of recent events and their cooperation with ICCN and local communities. The mission also met with military and judicial leaders in the area, as well as community and traditional leaders, including Mwami Ndeze, one of the most important traditional chiefs in the area.

The President of the National Assembly, Vital Kamerhe, also pledged his support. He quoted the Head of State, Joseph Kabila, as saying he was determined to 'champion conservation.'

The mission subsequently presented its findings to the Chairperson of the World Heritage Committee, Christina Cameron (Canada).

For background: A World of Science *(July 2007) or http://whc.unesco.org/en/list/63; on Great Apes Survival Project: www.unesco.org/mab/grasp/home.shtml*

Three females and a male (silverback) slaughtered by poachers in Bukima, probably on the night of 22 July. They belonged to a group inhabiting an area regularly visited by tourists. The disappearance of these gorillas represents not only a tragedy for the preservation of the species but also the loss of an important source of revenue for local communities. Two other members of the group, a female and her young, are reported to have gone missing

Oman's Oryx Sanctuary dropped from World Heritage List

The World Heritage Committee took the unprecedented step on 28 June of removing the Arabian Oryx Sanctuary (Oman), home to a rare antelope, from UNESCO's World Heritage List. The Sanctuary thus becomes the first site to be deleted since UNESCO's Convention concerning the Protection of the World Cultural and Natural Heritage entered into force in 1972.

The World Heritage Committee deleted the property because of Oman's decision to reduce the size of the protected area by 90%, in contravention of the Convention's Operational Guidelines. This was seen by the Committee as destroying the outstanding universal value of the site, which was inscribed on the List in 1994.

In 1996, the population of the Arabian Oryx at the site numbered 450 but has since dwindled to 65 with only about four breeding pairs remaining, making its future viability uncertain. This decline is due to poaching and habitat degradation.

After extensive consultation with the State Party, the Committee felt that the unilateral reduction in the size of the Sanctuary and plans to proceed with hydrocarbon prospection would destroy the value and integrity of the property, which is also home to other endangered species, including the Arabian Gazelle and houbara bustard.

During its session in Christchurch (New Zealand) from 23 June to 2 July, the World Heritage Committee also inscribed 22 new sites on UNESCO's World Heritage List from among 45 candidates: 16 cultural properties, five natural and one mixed.

The new natural sites are: the Rainforests of the Atsinanana (Madagascar) comprising six national parks distributed along the eastern part of the island; South

© Stock.xchng/Katherine de Vera

*Arabian Oryx (*Oryx leucoryx*)*

China Karst (China), unrivalled in terms of the diversity of its karst features and landscapes; Jeju Volcanic Islands and Lava Tubes (Republic of Korea), which bears testimony to the history of our planet; Teide National Park (Spain) for providing evidence of the geological processes that underpin the evolution of oceanic islands; and Primeval Beech Forest by the Carpathian (Ukraine and Slovakia), as a transnational serial natural property of ten separate components. The Ecosystem and Relict Cultural Landscape of Lopé-Okanda is the sole mixed site and the first site for Gabon.

Three World Heritage sites were inscribed on the List of World Heritage in Danger owing to concern about threats to their preservation: Galapagos (Ecuador), Niokolo-Koba National Park (Senegal) and Samarra Archaeological City (Iraq), which simultaneously joined the List for its rich Abbassid remains.

The Committee also removed four sites from the List of World Heritage in Danger, recognizing improvements in their conservation: Everglades National Park (USA), Río Plátano Biosphere Reserve (Honduras), Royal Palaces of Abomey (Benin) and Kathmandu Valley (Nepal).

For details: http://whc.unesco.org

UNESCO joins UN response to **Peruvian earthquake**

UNESCO is assisting Peru's Ministry of Education to assess schools in communities stricken by the 7.9 magnitude earthquake which shook the Peruvian coast in the early evening of 15 August, leaving more than 500 dead, 1000 injured and 40 000 families homeless.

The tremors caused extensive damage to the cities of Pisco, Chincha Alta and Ica, including 970 schools in the Ica region and 314 in Cañete, a province located about 150 km south of Lima. At least five schools were totally destroyed.

The Peruvian government quickly appealed for international support, leading to the launch of a UN Flash Appeal for Peru in Geneva (Switzerland) on 28 August. As appointed lead agency for education, UNESCO received US$ 500,000 under the Central Emergency Response Fund to provide safe educational environments for school children in the post-earthquake emergency period.

Working together with the UN International Children's Emergency Fund (UNICEF), Save the Children and UNDP, UNESCO is helping children return to school as quickly as possible by providing stricken schools with temporary facilities and educational materials. UNESCO is also helping Peru build back the education system as part of long-term recovery. The Director-General has appealed to the generosity of Member States to contribute outstanding requirements of US$ 1,273,859, in order for UNESCO to assist fully in the post-earthquake relief and recovery process led by the Peruvian authorities.

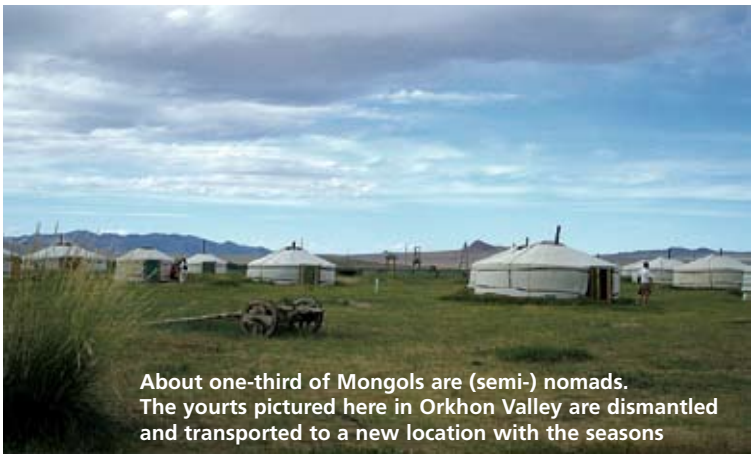
Peru has a total population of 28.8 million and annual per capita income of US$2650. Pisco (population of 63 000) was located 51 km from the epicentre, compared to 42 km for Chincha Alta (161 000), 110 km for Ica (261 000) and 32 km for Cañete (26 000).

An evaluation mission spent the weekend of 18 August in the region. The team was composed of national and international experts in seismology, seismological engineering, structural engineering, tectonics and geotechnology from the Regional Center of Seismology for South America (Centro Regional de Sismología para America del Sur, CERESIS), a centre founded with UNESCO support in 1966. The centre has been assessing the potential effects of aftershocks and defining the country's needs in terms of restoration and reconstruction of infrastructure.

UNESCO is currently setting up a 'rapid reaction platform' for regions unable to call upon such a centre. The platform will include a revolving international team which, upon receipt of a request from a stricken country, will travel to the site of any future earthquake immediately after the event to analyse the cause and survey the behaviour of buildings during the tremor, in order to draw lessons on how these and other infrastructure can better resist future earthquakes. The experts' recommendations will then be conveyed to the national and local authorities of the country concerned.

©A. Solimano

For details: www.onu.org.pe; www.reliefweb.int/fts; info@reliefweb.int; www.ceresis.org; on the platform: b.rouhban@unesco.org



About one-third of Mongols are (semi-) nomads. The yourts pictured here in Orkhon Valley are dismantled and transported to a new location with the seasons

A master plan for **science and technology in Mongolia**

Mongolia's *Master Plan* for science and technology (S&T) to 2020 was published in June with UNESCO's assistance.

Mongolia is endowed with a comparatively strong S&T base but it has scarce financial resources and its scientific capacity is largely concentrated in the capital, Ulaanbaatar, home to one-third of the population.

Now at an advanced stage of transition to a market economy after the fall of communism in 1990, Mongolia is in danger of seeing its S&T resources underutilized, dissipated or even lost. R&D expenditure represented 0.35% of GDP in 2005, down from 1.0% in 1990, and the numbers of scientists and engineers are falling, owing to a combination of lower salaries, obsolete equipment and the generally declining attractiveness of a scientific career in Mongolia. This trend has spilled over into the higher education sector, where student rolls in science and engineering are likewise falling.

One of the top priorities of the *Master Plan* is to stimulate investment in S&T by increasing the share of non-government resources in funding R&D (currently 10%), fostering greater collaboration among research institutes and universities, and using economic stimuli to foster science–industry cooperation and joint research.

At present, all but four of the 51 institutions conducting R&D are government-owned and these lack laboratory facilities and equipment. Moreover, the *Plan* notes that selected research projects do not correspond to market demands and that opportunities are limited for updating and exchanging information. Management and control over government-funded activities are also considered ineffective.

The *Plan* notes that research bodies are not equipped to operate under competitive market conditions and that priority directions for R&D are lacking, leading to a wastage of scarce resources. The country is also dependent on imported foreign technologies and equipment.

The *Plan* proposes systemic reforms to stimulate investment in new knowledge and advanced technologies. It advocates raising awareness of the need for technology among economic stakeholders and enhancing innovation through the constant upgrading of technologies and a technology forecast system. It recommends greater government support for establishing favourable customs duties and tariffs, and calls for intellectual property rights to be enforced.

The *Plan* outlines research priorities to 2010 in the natural sciences, agricultural sciences, technological sector, medical sciences and social sciences and humanities. In parallel, it advocates financial support for R&D conducted by universities, research institutes and business enterprises to develop both the national priorities for S&T and key technologies.

The *Science and Technology Master Plan of Mongolia for 2007–2020* was published in Mongolian in January and in English in June by UNESCO's Beijing office within UNESCO's Science Policy Studies series.

Together with STEPAN[5], UNESCO's Beijing and Jakarta offices assisted the Ministry of Education, Culture and Science of Mongolia in developing the *Master Plan*. The Ministry then drafted the *Plan*, which was approved by the Government of Mongolia in January 2007.

Read the Master Plan*:*
http://unesdoc.unesco.org/images/0015/001514/151490E.pdf
For details (in Beijing): j.ramasamy@unesco.org

Panorama of the Gobi Desert. Bordered by Russia to the north and China to the south with a territory of 1.6 million km², Mongolia is the world's second-largest landlocked country after Kazakhstan. It is also the most sparsely populated with just 2.8 million inhabitants. Little of the land is arable, as much of the country is covered by arid, unproductive steppes with mountains to the west and north and the Gobi Desert to the south

5. *The Science and Technology Policy Asian Network (STEPAN) was set up under the auspices of UNESCO in 1988. The current regional chair is The Philippines and the secretariat is provided by UNESCO's Regional Bureau for Science in Jakarta: www.stepan.org*

Robert Hepworth

Many of the world's most endangered species are migratory

The United Nations Convention on the Conservation of Migratory Species of Wild Animals (CMS) was adopted in Bonn (Germany) in 1979. Nearly 30 years on, the Bonn Convention, as it is known, counts 104 State Parties, 17 of which have been added in the past three years. One of only a handful of global environmental agreements dealing explicitly with the conservation of species and their habitats, the Convention is participating in the international drive to slow the rate of biodiversity loss by 2010.

Robert Hepworth has been Executive Secretary of the UNEP Secretariat to the Convention since 2004. He outlines the Convention's conservation strategy.

How common are migratory species?

Migration is one of the major mechanisms by which species respond to cyclic changes in their environment. Migratory species[6] most often contribute 20–80% of ecosystems' species diversity of birds and larger mammals. An even higher percentage of these animals are migratory at high latitudes, high altitudes and in drylands, as these extreme habitats can support them for only part of their life cycle. In fact, the colonization of these areas by large vertebrates was only possible through the development of migratory behaviour. Aquatic habitats – both marine and large freshwater systems – also include a very high proportion of migratory organisms.

These considerations, coupled with the fact that biodiversity hotspots in the tropics are already the focus of several international conventions, have motivated the CMS to focus on large land-based animals in arid zones and marine organisms, in particular sea turtles and small cetaceans. We also have a growing involvement in large freshwater migratory species like the Mekong giant catfish (*Pangasianodon gigas*) weighing up to 300 kg.

Why are so many migratory species endangered?

They basically face the same threats as all species. Chief among them is certainly the unsustainable use, over-use and abuse of space, which is being consumed at an alarming rate by urbanization and the spread of communication networks and commercial recreation facilities. A new threat on an unprecedented scale are the schemes for energy production generated by the so-called energy crisis, such as the proliferation of ill-placed wind farms and the allocation of immense surfaces for biofuel production.

In addition, the intensification of agriculture in more and more parts of the world continues to transform formerly rich agro-pastoral landscapes into biodiversity deserts.

The various airborne and waterborne pollutants are another factor; in particular, the long-range transport and deposition of fertilizers. Many migratory animals are sensitive indicators of environmental change, as illustrated by the toxic pesticides found in the tissues of Antarctic animals.

Climate change[7] can become a leading cause of concern, not *per se* but because the rate at which it is proceeding may exceed the response capability of most organisms, all the more so in that it takes place in a hemmed-in world in which the other factors of global change have made adaptation by shifting to a different range or site almost impossible. A tell-tale example of this is the ongoing desertification of semi-arid areas, most notably in the Sahelo-Saharan zone, where human pressure at the edge of these areas makes it impossible for the animals to seek food and water further afield.

For marine organisms, the global and exorbitant overexploitation of the seas, greater navigation and, most of all, the enormous waste represented by by-catch[8] associated with ill-designed fisheries are all lethal threats.

Many of the factors I have just listed hit migratory species the hardest because the necessarily multi-habitat and precisely-timed nature of their use of space makes

6. *The CMS has defined migration as all the cases in which animals move predictably between geographical locations or types of habitats in the course of their circadian (24-hour), circannual or life cycle, provided such movements entail transborder components*

7. *See* Migratory Animals and Climate Change*: www.cms.int/publications/pdf/CMS_ClimateChange.pdf*

8. *A term for unwanted species taken along with the desired catch*

them particularly sensitive to dysfunctions of the ecosystems they use. Freedom of movement is a key strategy for them. Dams, roads, fences and expanses of unsuitable habitat can thus wreak 'ecological havoc' well beyond the surfaces they occupy.

How many migratory species have already become extinct?

Several spectacular migratory species have unfortunately disappeared under human pressures. The most publicized example of course is that of the Passenger Pigeon (*Ectopistes migratorius*), once perhaps the most abundant bird on Earth; in the course of the 19th century, it went from being extremely common, with migrating flocks estimated at 2 billion individuals, to extinction owing to the expansion of North American colonization. The last bird died in 1914.

There are more recent victims like the Slender-billed Curlew (*Numenius tenuirostris*); once numerous in a long and broad flyway that extended from the steppes of central Eurasia to northern Africa and the Near East, it is now on the verge of extinction, if not already extinct. The biologically migratory Chinese River Dolphin (*Lipotes vexillifer*), alas shown to be probably extinct in 2007, is a sad testament to the need for The Year of the Dolphin[9].

Large terrestrial mammals that once moved great distances have become extinct in the wild so recently that it augurs ill for our capability to prevent such carnage. Przewalski's Horse (*Equus przewalskii*) was last seen in the wild in 1969, the Arabian Oryx (*Oryx leucoryx*) in 1972. The Scimitar-horned Oryx (*Oryx dammah*), a beautiful species abundantly represented in Egyptian art, was still common in the 1960s and a few thousands survived into the late 1970s. It was last reliably recorded in 1983. For those three species, captive stocks exist and efforts at re-introduction are being made, sometimes with remarkable success. The CMS is actively involved in such efforts (*see photo*).

The Pyrenean Ibex (*Capra pyrenaica pyrenaica*), which used to migrate shorter distances across the Franco-Spanish border and was one of Europe's most striking wild animals, became extinct in 2000 and no captive stock exists.

The Polar Bear (*Ursus maritimus*), a species whose decline is clearly linked to global warming, made a very regrettable and much heralded entry into the IUCN's Red List in the vulnerable category in 2006. Let us hope this will galvanize people into action.

Other migratory species, such as albatrosses, wild camels and some dolphin species hover on the verge of extinction.

What measures can the Convention take to protect migratory species?

As migratory species travel between several countries, all countries need to cooperate to conserve them, or the 'weakest link' in the migratory route chain will undo the effects of all.

The construction of networks of protected areas through which wildlife can migrate is essential. We have set up several projects, including a highly successful one to preserve Sahelo-Saharian antelopes that is now being extended. Its goal is to restore the specialized ungulate [i.e. hoofed] fauna that used to occupy the entire range. We are also starting up a project to preserve the drylands of Central Asia and the migratory species that in some cases still roam freely across them. This is one of the CMS' most ambitious initiatives, in terms of geography and the number of species.

If it is too late for any other course of action, other techniques can be explored, as for example the cross-breeding methods developed by the Large Herbivore Initiative to regain reasonable surrogates for some of the extinct large fauna of Europe. Augmenting financial resources – always a limitation in biodiversity conservation activities – is a crucial part of all conservation efforts to enable country-level and coordinated range-wide activities.

We also raise public awareness through education: campaigns in schools, the publication of information materials and high-profile activities like the Year of the Dolphin.

9. *Within the Year, the CMS, UNESCO and others have co-published a manual entitled* All about dolphins!: *www.Yod2007.org*

Photo: John Newby/SSIG

A Dorcas *gazelle. In all, five antelope species have been reintroduced into parts of their former range since all 14 range states adopted the CMS Sahelo-Saharan Concerted Action Plan in February 1998: the Addax (*Addax nasomaculatus*) Scimitar-horned Oryx (*Oryx dammah*), Dama Gazelle (*Gazella dama*), Cuvier's Gazelle (*Gazella cuvieri*) and Dorcas Gazelle (*Gazella dorcas*). Financed by the* Fonds français pour l'environnement mondial, *the project includes conservation measures and research in Chad, Mali, Morocco, Mauritania, Niger, Senegal and Tunisia. There has been a special focus on three pilot projects in Mali, Niger and Tunisia. For the Tunisian project for example, captive-bred antelopes from seven zoos in six European countries were released in the Sidi Toui National Park in the desert region of southern Tunisia. In parallel, a plan to rehabilitate their habitat and educate local populations to coexist with the antelopes has been put in place. On the ground, CMS has joined forces with partners like the Saharan Conservation Fund and the African Parks Foundation. Introduced populations of Oryx and Addax have grown satisfactorily but all five antelope remain extremely rare in the wild*

Is international cooperation producing concrete results?

Migratory species can only be conserved through joint international cooperative efforts, linking species- and ecosystem-based approaches at national levels, coordinated across a migratory range. In a changing world, networks of protected areas cannot just be designated, they also need to be managed and monitored. Otherwise, they will rapidly lose their effectiveness. As migratory species need the areas they use to remain not only of adequate local quality but also functionally coordinated, they, more than any other, require concerted measures.

Hopes had been raised at the time of the first Earth Summit in Rio in 1992 that conservation schemes would find global application within what is now the Convention on Biological Diversity. This has not happened.

Regional examples exist though, such as the Natura 2000 network of the European Union and its extension into Greater Europe, the Emerald Network of the Council of Europe.

The CMS is developing such networks in many parts of the world through its agreements on African-Eurasian Waterfowl, Indo-Pacific Marine Turtles, Albatrosses, European Bats and so on. We also have concerted projects, such as those for Eurasian Aridland Large Mammals and Gorillas.

We have also signed a number of Memoranda of Understanding (MoU). For example, the MoU for the Conservation of Cetaceans and their Habitats in the Pacific Islands Region entered into effect in September last year after being signed by the Environment Ministers of nine Pacific countries.

Negotiations for a fourth CMS cetacean agreement for the Eastern Atlantic will open late this year in the Canary Islands (Spain), following a recent decision by our Parties to give this priority. We expect this agreement to cover other West African marine mammals like the manatee, whereas its Indian cousin, the dugong or seacow, is expected to gain extra protection under CMS later this year through a separate MoU negotiated with the leadership and funding of Australia.

In December this year, CMS will be organizing a meeting on migratory sharks, in partnership with the Government of Seychelles. The meeting will examine the current conservation status of migration sharks, existing international, regional and other initiatives to improve the situation, and options for international cooperation, including a possible 'instrument' under CMS. We are seeking maximum participation from major shark range, fishing and consumer countries.

Cooperation between nations can be achieved only if the decision-makers and opinion-leaders involved are aware of the issues and the paramount need for concerted action. It has been a main task of the Convention in the past, and will remain so in future, to bring those problems to the attention of selected key target audiences.

You have said that globalization offers the conservation community new opportunities. In what way ?

Tourism revenues from wildlife watching have increased exponentially in the past two decades. It is now the main tourism activity in countries like Kenya, Tanzania and Uganda. Kenya alone received over 1 million international arrivals in 2004, generating international tourism receipts of over US$500 million.

Even small wildlife watching operations like the one in the Seychelles for whale shark watching, which attracted 496 tourists in 2005, provided an income of over US$35,000. Nearly two-thirds of this was used to support an NGO-led whale shark monitoring programme. Whether it involves nationwide programmes or small companies, wildlife watching can be good business. However, standards in the sector vary and are not always sufficient to maintain the species being utilized. Through its Scientific Council, the CMS is working with partners to provide practical guidance in this sector.

The acceleration in the global movement of people and goods is creating new business opportunities for ecotourism but it is also presenting new environmental problems.

Problems of what nature?

For the CMS, the prime example over the past two years has been the emergence of the Highly Pathogenic Avian Influenza, or H5N1 virus, which put wild birds under the spotlight. Vested interests pointed the finger at migrating birds, accusing them of being the main global transmitters of avian influenza. This accusation caused a media-feeding frenzy and hence considerable public alarm last year. However, good science revealed that the poultry trade was in most (if not all) regions the main incubator, transmitter and reservoir of the virus. Some of this 'good science' came from the CMS-led Task Force on Avian Influenza and Wild Birds comprising experts from 14 different IGOs and NGOs.

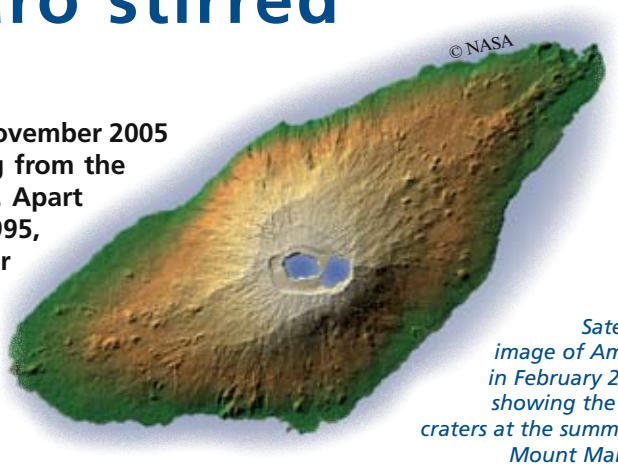
Another impact of globalization has been increased trade in world timber markets. This presents a serious threat to many migratory species and other wildlife.

The CMS is strengthening its cooperation with the private sector through partnerships that help us not only to increase our resource base but also – crucially – to establish a regular dialogue with the private sector, in order to understand its operations and constraints, and identify how companies can support conservation in parallel to pursuing their business objectives.

Over the past two years, we have established a close partnership with one of the largest tourist and travel operators in the world, headquartered like us in Germany. We discovered a natural complementarity since we are both, in our own ways, in the global travel business!

Interview by Anne Devillers

The day **Mount Manaro stirred**



Satellite image of Ambae in February 2000, showing the two craters at the summit of Mount Manaro

The tranquil peace of Ambae island was shattered on 26 November 2005 as a plume of steam and black 'smoke' was sighted rising from the crater lake at the summit of the island's volcano, Manaro. Apart from small 'hiccups' with steam plumes in 1991 and 1995, Ambae's 10 000 inhabitants had not seen a large eruption for more than 100 years. Hence, they were justifiably tense, although by no means panicked. Instead, within two days, a local disaster committee had formed and evacuation had begun. Within another eight days, more than 3300 people had been relocated from endangered areas to refuge centres in two different parts of the island.

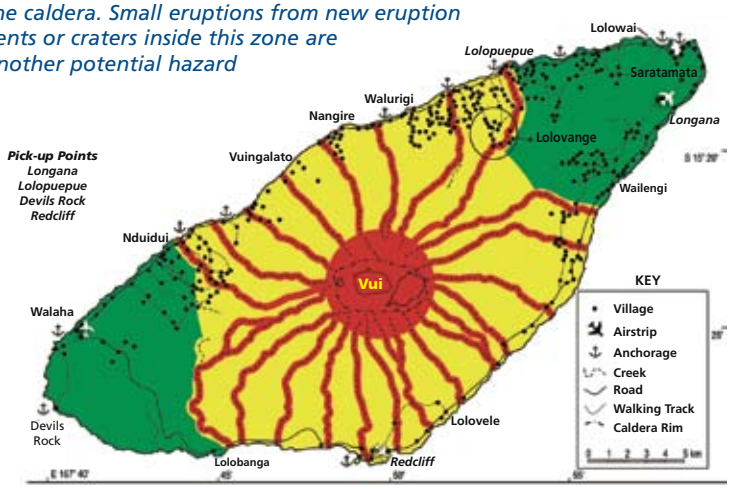
This mini-success story was not without its problems or minor controversies but the locally based emergency response was well planned, rapidly executed and involved minimal expense or outside assistance. What can be learned from the eruption and how can it be used to improve community emergency planning in both this and other parts of the world?

Ambae island comprises the largest and arguably the most hazardous of Vanuatu's volcanoes. Past eruptions have involved both lava flows and lahars, which are volcanic mudflows. The more recent eruptions known to have caused casualties are thought to date back to 1870 and 1914.

The islanders lead a subsistence lifestyle. They are widely dispersed among more than 276 small extended family settlements and villages. The community is strongly fragmented. Two main languages are spoken and up to 12 dialects. In addition, communications on the island are limited, with no road linking the eastern and western tips and many settlements lacking telephone communications.

Hazard map for eruptions from the central vent of Mount Manaro

The red zone is comprised of the caldera (see overleaf) and valleys draining the central peak. This high hazard zone is associated with volcanic mudflows and floods. The yellow zone spans a distance of 10 km from the crater and is subject to ash fall and volcanic explosions known as pyroclastic surges. The green zone at either extremity of the island is also subject to ash falls from Vui crater lake, one of two craters within the caldera. Small eruptions from new eruption vents or craters inside this zone are another potential hazard



The local administration includes two parallel systems: the government service reporting to Vanuatu's capital, Port Vila, on Efate Island, represented by the Penema Province office, and a local hierarchical structure of community governance that steps up from Nakamals (2–3 extended families) to Wards (several Nakamals) and finally Areas (several Wards), each with their own chiefs.

The stage is set for an emergency

Village-based emergency management planning in developing countries has been the focus of many recent initiatives and policies, including those driven by most major development agencies. Increasingly, participatory techniques are being adapted to disaster management.

Since 2000, UNESCO's Office in Apia has been working with a team of researchers led by Dr Shane Cronin of the Institute of Natural Resources at Massey University in New Zealand, as well as the government and local communities in Vanuatu, to use a blend of volcanology and traditional (*kastom*) knowledge as the starting point for disaster-preparedness planning.

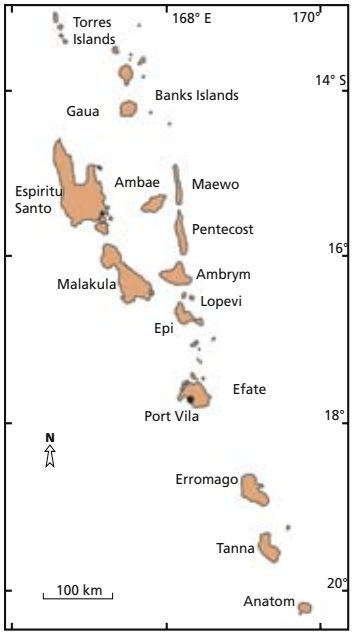
Using a strategy developed from case studies in Fiji and the Solomon Islands, Shane Cronin and his colleagues ran a series of participatory community workshops supported by UNESCO and others on Ambae from 1999 to 2003. The workshops sought to develop trust in scientific warnings and volcanic monitoring tools so that these could eventually be installed on the island. A second purpose was to preserve the traditional knowledge of

community hazard preparedness and volcano-influenced cultural practices and incorporate these into modern disaster management plans for rural parts of Vanuatu.

A range of group exercises were used in the participatory workshops to develop skeletal Nakamal emergency response plans both for the communities which would need evacuating and those which would be hosting the evacuees.

To improve the visual presentation of volcanic hazard, the template for a new hazard map (*see facing page*) was developed through workshop exercises that elucidated how the Ambaeans themselves represented landscapes and volcanic processes/impacts on sketch maps.

The results of these exercises in several volcanic islands around Vanuatu were eventually



Ambae island is part of the New Hebrides island arc in Vanuatu, an archipelago of 83 islands. An island arc is a string of volcanic islands (usually curved) that forms when one oceanic plate subducts (or plunges) under another oceanic plate. One crust has to plunge beneath the other because the Earth's diameter is constant: when a new surface forms, an equivalent surface has to disappear, otherwise, the planet would swell like a balloon! As the oceanic crust descends into the Earth's mantle, it progressively heats up until, at a depth of 100–150 km, it loses the seawater it contains. This leads to the partial fusion in that part of the mantle of periodites (rocks at depth composed of iron and magnesium silicates) and to the formation of magma. This magma rises vertically and pushes through the overriding plate to reach the surface, creating a chain of volcanoes. The Lesser Antilles, the Aleutian Islands, Vanuatu and Tonga are all examples of island arcs. When the crust of the upper plate is continental rather than oceanic, a volcanic mountain chain is formed near the edge of a continent. This is known as a cordillera arc, like the Andes Cordillera in Latin America. (Taken from Bouysse, P. (2006) Explaining the Earth*: UNESCO Publishing/ Nane Publishing)*

One of the world's most dangerous volcanoes?

Mount Manaro may have no visible vents at its apex, only crater lakes, but it is obviously active (as opposed to dormant or extinct), as the steam and ash (phreatic) eruption in November 2005 so aptly demonstrated.

A phreatic eruption occurs when rising magma makes contact with ground or surface water. Also known as steam-blast or ultravulcanian eruptions, phreatic eruptions are generally quite weak. They occur when surface water or wet ground comes in contact with hot rock or magma. This causes expanding steam to explode, blowing out water, ash, rock and volcanic bombs (a ball of molten rock greater than 65 mm in diameter) ranging from 600 °C to 1170 °C. Phreatic eruptions occasionally create broad, low-relief craters called maar, as in the case of the Manaro eruption in November 2005. The main feature of phreatic explosions is that fragments of solid rock but no new magma are erupted from the central vent. A less intense geothermal event may result in a mud volcano.

Manaro has been described as one of the world's top ten 'most dangerous' volcanoes, in terms of potential for a catastrophic eruption. One theory has it that, in a large eruption, the water in Manaro's crater lakes could become superheated steam and cause a massive phreatic explosion. The resulting landslides down the island's steep slopes could cause tsunamis within Vanuatu's northern archipelago. Phreatic explosions can be accompanied by emissions of carbon dioxide or hydrogen sulfide. The former can asphyxiate at sufficient concentration, as in Java in 1979 when a phreatic eruption killed 149 people, most of whom were overcome by poisonous gases.

Sources: US Geological Survey; Wikipedia online;
Bouysse, P. (2006) Explaining the Earth*. UNESCO Publishing/Nane Publishing. Paris.*

US Geological Survey

A phreatic eruption from a 'grey volcano', Mount St Helen's in Washington (USA). It is believed the 1883 eruption of Krakatoa along the Indonesian arc was a phreatic event.
Source: US Geological Survey

UNESCO/NANE (2006) Explaining the Earth

There are two main types of volcano: 'red' volcanoes like Mauna Loa (Hawaii, USA), which have effusive eruptions in which partially fluid magma emerges to form a lava flow; and 'grey' volcanoes like Ambae, which have explosive eruptions in which gas and fragmented lava (as ash or thick blocks depending on the size of the particles) are projected into the air. 'Grey' volcanoes can produce catastrophic eruptions, whereas 'red' volcanoes generally present little danger to neighbouring populations

incorporated into a central national volcanic warning system (the Vanuatu Volcanic Alert level System), and hazard planning templates based upon this for communities, Province administration, businesses and national authorities. This process was extended on Ambae by the concurrent development of the Penema Province Disaster Plan, which included specific responses to changes in alert level during a volcanic crisis on Ambae.

A climate of distrust

Prior to the workshops, a climate of distrust prevailed in the community, born of the conflicting *kastom* and scientific viewpoints when it came to volcanic hazard and hazard management. Much of *kastom* belief is built on legends. According to legend, eruptions can be started and stopped by sorcerers, for example. Designated *tambu* (forbidden) zones are one form of *kastom* hazard mitigation.

In 1995, this inherent distrust was stoked by miscommunication and an aborted evacuation attempt during minor volcanic unrest. Part of the problem lay in that fact that previous versions of a complex scientific volcanic hazards map had been misread in the community.

The group exercises during the workshops held between 1999 and 2003 had gone some way towards bridging the gulf between scientific and *kastom* perspectives on Ambae, especially by incorporating traditional warnings and decision-making practices in community volcanic emergency plans. Local knowledge of warning signs is particularly important on an island with no permanent volcano monitoring equipment. These signs include the migration of birds off the island, unusual insect and animal behaviour, die-off of vegetation and changes in lake colour.

The scope of the workshops was limited however by the fact that only a small proportion of the community (3–8%) actually participated. In addition, many of the community concerns raised in gender-segregated and hierarchical exercises were not satisfactorily addressed, including the lack of representation of women and youth in decision-making and difficulties in province–community relationships.

Eruption!

On 26 November, steam plumes from the summit of Ambae about 1400 m above sea level inhabitants to the start of an eruption. Vanuatu volcanologists released a bulletin on 29 November confirming that an eruption was in progress and that, since explosions were rising through the water-filled crater known as Lake Vui, there was a risk of lahars.

Difficult weather and access prevented the first scientific observers from reaching the eruption site via air or land before 3 December. The eruption had formed a new island in Lake Vui and spectacular but small explosions continued, building up in magnitude to a peak around 12 December. By around 22 December, explosions had become very small and rainfall was starting to erode the newly-formed island. Small eruptions continued until mid-January and a small steam plume has persisted ever since.

With hindsight, it transpires that there was little risk of lahars during the escalation phases of the eruption. This was just as well, since there was little scientific advice available

What is a caldera?

A caldera is a large, usually circular depression which forms when a volcano collapses onto itself. This happens during an eruption when the magma chamber empties, creating a void beneath the summit of the mountain which weakens the structure. A caldera can form during a single massive eruption or gradually in the course of a series of eruptions.

Calderas and craters are both circular depressions but craters are much smaller than calderas and are created mainly by the excavation of rock during explosive eruptions. Whereas a crater forms at the summit of a volcano, a caldera collapses the volcano, as in the photo.

Calderas are 'supervolcanoes' resulting from an eruption measuring at least 8 in the Volcanic Explosivity Index. Caldera-forming eruptions are the largest on Earth, expulsing at least 1000 km^3 of magma and pyroclastic material. They are thought to be so powerful that they destroy virtually all life for hundreds of kilometres around.

Examples of calderas are Ambae in Vanuatu, Long Valley (*see photo*) and Yellowstone in the USA (formed approx. 640 000 years ago), Toba on the Indonesian island of Sumatra (approx. 71 000 years ago) and Taupo in New Zealand (approx. 27 000 years ago). The Taupo caldera encompasses a crater lake 46 km long and 33 km wide, as well as several towns. One of Yellowstone's three calderas is 45 km wide and 75 km long!

The eruption of Mount Toba is believed to have plunged the Earth into a volcanic winter for six years and into an Ice Age for 1000 years that was colder than the last Glacial Maximum (18 000–21 000 years ago). This would have decimated the human population, with the few survivors finding refuge in tropical pockets of mainly equatorial Africa, a theory substantiated by genetic evidence.

Sources: US Geological Survey;
on the eruption of Mount Toba : Ambrose, S. (1998) Late Pleistocene human population bottlenecks, volcanic winter and differentiation of modern humans. Journal of Human Evolution, *vol. 34.*

US Geological Survey

Long Valley caldera in the USA is a 15 x 30 km depression. It formed during an eruption 760 000 years ago. As tens of thousands of years can separate two eruptions of a caldera, it is difficult to say whether a specific caldera is dormant or extinct

Photo K. Nemeth

Photo M. Harrison

Explosions through crater lake Vui at the summit of Ambae on 4 December 2005 (left) led to the formation of a new island in the crater which can be seen (right) letting off steam here eight days later. This type of eruption, involving contact of hot magma and water, is known as a Surtseyan, after descriptions of the eruption of Surtsey Island in Iceland

and no monitoring equipment. When Mount Manaro stirred, the void created by a lack of community knowledge of past deadly eruptions or lahars in 1870 and 1914 left the islanders with no choice but to improvise.

The islanders organize themselves

As soon as the volcanic activity was confirmed on 28 November, local government officers stationed in the area and members of the Provincial Council set about forming the Penema Disaster Coordination Committee at the provincial government headquarters in Saratamata in the northeast. A similar group, the West and South Ambae Disaster Committee, soon followed suit in Walaha in the southwest.

The Penema Committee began by requesting the support of a volcanologist; it then developed an operational structure, activated area and Ward disaster committees, sent delegations to the areas accessible by road and communicated by telephone with West Ambae.

Time to evacuate

The first advice bulletin from government volcanologists announced an escalation of activity to Vanuatu Volcanic Alert Level 2. This corresponds to a state of readiness in the Penema Province disaster plan, as opposed to Level 3 necessitating evacuation. Disregarding the level of alert, the Penema Disaster Coordination Committee immediately called for evacuation of the highest hazard "red" zones (*see map p. 16*) over the coming days to refuge centres in "green" areas in east and west parts of the island. In some cases, people in the "yellow" areas between the "red" valleys also evacuated of their own accord for fear of seeing their escape route blocked later by volcanic flows.

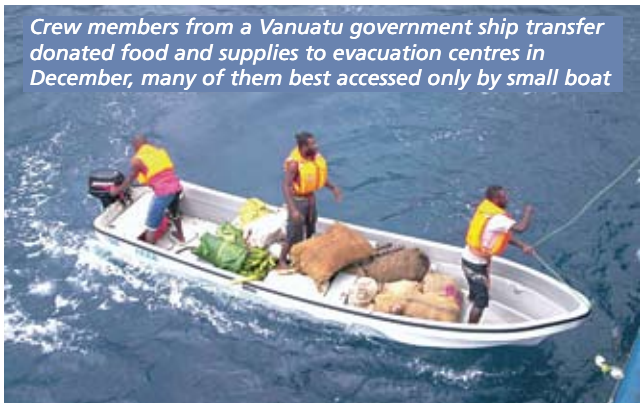
The evacuation process was spread over eight days. People either travelled on foot or via local transport operators. Taxi and truck drivers volunteered their services. Two ships were sent by the central government sent to evacuate people. Ten 'safe centres' were established in east Ambae for 2 370 evacuees and two in west Ambae for a further 954 people. Welfare was regulated by Nakamal chiefs of the host communities.

Despite high levels of tension, overcrowding, inadequate facilities and poor sanitation, there was little unrest in the camps. Food and supplies were donated throughout the evacuation period by major Vanuatu NGOs, church groups and businesses, as well as by the Penema Province communities of Pentecost, Santo and Vila. The Red Cross deployed personnel and resources to help with managing welfare and supplying water.

By 24 December, the volcano had become less active, so the National Disaster Management Office and other central government agencies began urging evacuees to return home. However the Penema Committee waited until a further investigation by Vanuatu and New Zealand volcanologists before declaring it safe for communities to return home on 29 December.

At this point, the Penema Disaster Coordination Committee announced a staged repatriation using local transport to be completed by 3 January. By this time, several communities had already returned, or partly returned in some cases when women and children stayed back at the safe centres. Morale was high by this stage.

Those in the western zone repatriated quickly following the order by the Penema Committee but many evacuated Nakamals in the eastern zone chose to remain for combined 'end of crisis' and New Year celebrations. Once everyone had been repatriated, the Penema Committee set about recovery operations consisting of a clean-up, damage assessment and operational review over the coming month.



Crew members from a Vanuatu government ship transfer donated food and supplies to evacuation centres in December, many of them best accessed only by small boat

Photo: A. Casino

Doing better next time

There were a few incidences of friction at the start of evacuation in November 2005, even though cooperation improved as the operation progressed. Here are some lessons learned for next time:

Maintain good communications with communities to ensure commitment to the plan

Some Nakamal groups refused to evacuate and a number of community disaster committees never formed. Several Nakamal groups also used safe areas defined during earlier community planning initiatives rather than those in the current plan. This led to an impromptu safe centre having to be set up for 400 evacuees in one case.

Support local decisions and leave criticism until later

The central government entrusted responsibility for the evacuation to the Province. This was due to a combination of the low-level threat, established procedures for the island in the case of an eruption and the recognition that the Province-level management required only backup support. Despite this, when the Penema Disaster Coordination Committee made the decision to evacuate early, before the alert reached Level 3, the national agencies and to a certain extent donors were privately or openly critical of the decision. This differing opinion led to tension between the Committee and the national authorities. This was because the National Disaster Committee had experienced several eruptions of greater magnitude and impact over the past five years on other islands, including Lopevi, Paama, Ambrym and Tanna. This disagreement meant that financial support from the central government did not reach the Coordination Committee until late in the operation, even though people and other resources were committed earlier.

Recognize the limits of community self-reliance

The vulnerability of this local approach would have been exposed had the volcanic activity spread to other parts of the island, especially within the green zones. The management committees would have been at risk and a second evacuation to off-island safe centres would have been required. It is not certain that national-level emergency managers would have been ready for this.

Balance local priorities against national ones

Relations between the local Committee and the national authorities were further confused by the presence of an impromptu Vila-Ambae Disaster Committee made up of Ambaens in senior government positions who were concerned that there was not enough national commitment to welfare. This group was effective in leveraging funding from the central government but went beyond its brief by criticizing both the government and the local Committee, causing conflict with government employees from other islands.

Establish effective media management

The eruption was sensationalized by local and foreign media, which resulted in critical and erroneous reporting. This fuelled many of the conflicts described above and drove the local Committee to overreact by limiting media contact to the sole person of the Province Secretary-General.

A safe centre on the day it opened on 6 December 2005 in the Lolowai area of northeast Ambae. Morale remained high in the camps, despite crowding and limited water supplies

The formal damage assessment concluded that the main losses were due to the evacuation and temporary abandonment of gardens. Interruption in the planting of cash crops had also hampered local communities' efforts to raise school fees. Although the Committee had initially budgeted 14 million vatu (*circa* $US140,000) for the evacuation, actual outgoings only came to about half this amount, thanks to the provision of food and other supplies almost exclusively in-kind.

A beneficial false alarm

This case study demonstrates that community management of an emergency on some scales is possible. The Ambae community successfully arranged for one-third of its population to be evacuated for over a month, thanks largely to the inherent independence of Ambaens and the high-level of local political organization on the island.

The participatory approach encouraged by the workshops also appears to have played its part in establishing community-level emergency plans that interlocked with island-wide efforts, even in the absence of a full-blown follow-through programme.

In some ways, the eruption was a false alarm, in that the actual threat was not as severe as first thought. It nevertheless galvanized the community in the face of an emergency. This enthusiasm is now being channelled into new community initiatives. These include the establishment of a community-funded Ambae disaster trust, the development of local training workshops in emergency management for the community and the scoping of off-island safe centres for bigger emergencies. A donor is currently being sought for the installation of volcanic monitoring equipment.

Shane J. Cronin[10], Karoly Nemeth[10],
Douglas Charley[11], Hans Dencker Thulstrup[12].

The authors acknowledge support from the New Zealand Foundation for Research Science and Technology and the assistance of Ambae's community leaders.

10. Volcanic Risk Solutions, Institute of Natural Resources, Massey University, New Zealand

11. Department of Geology, Mines and Water Resources, Port Vila, Vanuatu

12. UNESCO Office for the Pacific States in Apia, Samoa

Mini-laboratories for the Middle East


Photo: Majdi Hadid

Children in Ramallah on their way home from school

For a decade now, UNESCO has been introducing the methodology for microscience into the education systems of both developed and developing countries. One of UNESCO's key partners in this endeavour is the RADMASTE Centre at Witwatersrand University in South Africa. To date, training workshops in microscience have been organized in some 84 countries (*see map overleaf*).

Over the past year, UNESCO has turned its attention to the Middle East. In collaboration with the Islamic Organization for Education, Science and Culture (ISESCO), it has introduced the microscience project into Jordan, Lebanon, the Palestinian Territories and Syria. As project coordinator at UNESCO, I took part in the first training workshops in Beirut and Ramallah, in November 2006 and February this year.

The microscience methodology gives primary and secondary school pupils and university students alike an opportunity to conduct practical scientific experiments in physics, chemistry and biology using kits that come with a textbook. These kits are veritable mini-laboratories. They are perfectly safe, insofar as pupils never need to use more than a couple of drops of chemicals for each experiment. The kits are also affordable and far cheaper than conventional laboratory material[13]. Each kit is compact, can be reused and is unbreakable because made of plastic. In addition, the small quantities of chemicals used make it environment-friendly. The microscience approach not only helps to develop scientific thinking among pupils and students but also provides developed and developing countries with new teaching tools.

Step one: getting acquainted with the kits

The initiation to the microscience approach begins with a two-day training workshop in a given country. This workshop is attended by teachers from secondary schools and technical colleges, university teaching staff from the country and staff from the Ministry of Education.

For the two workshops in the Middle East, UNESCO's basic sciences team in Paris expedited the microscience kits, drafted and supplied practical instructions and textbooks, and dispatched international experts to Beirut and Ramallah to explain the methodology to the participants and liaise with both Ministries of Education. For their part, the UNESCO offices in Beirut and Ramallah were in charge of organizing the workshops; this entailed choosing the venue, issuing invitations and liaising with the Ministries and local authorities. The participants were enthusiastic about the workshops and, in both cases, the teachers were of a high standard.


©M. Lioulou/UNESCO

Teachers learning how to use the micro-scale material during the workshop in Beirut. As they tried the different experiments, they were delighted to discover that the results were comparable to those obtained in conventional laboratories

A deceptive serenity on my arrival in Lebanon

When I arrived in Beirut in November 2006, just months after the signing of UN Resolution 1701[14] and the end of hostilities with Israel, life seemed to have returned to normal. There was no sign of the difficult situation in which the Lebanese had found themselves the previous summer. Beirut was reborn. The streets were filled with young people. Nonetheless, the Lebanese army maintained a strong presence in these same streets and the security measures in place belied the apparent serenity. People and vehicles wishing to enter the UNESCO office in Beirut were subjected to strict inspections. This could have been construed as normal procedure for administrative and international buildings but these inspections were repeated in the streets, hotel entrances, taxis and all other types of vehicle.

This said, the microscience workshop proceeded without a hitch. The participants were mainly teachers of various scientific disciplines from Beirut's lower and upper secondary schools, both public and private. They first discovered the theory behind the new approach during an introductory lecture. They were then able to test its practical application when they began using the micro-scale kits themselves for the first time to conduct various experiments.

The workshop is held in a hotel in Ramallah

It is true that the approach can be adapted to the education system of any country. It suffices for a country to include some of the experiments from the microscience kits in the curriculum and/or use the kits to create new experiments. What seduced the participants in the Beirut workshop were the kits' cost-effectiveness and safety, the fact that they were environment-friendly and the possibility of adapting the methodology to the Lebanese education system.

From scepticism to enthusiasm

The teachers were somewhat sceptical to begin with. They found themselves confronted with material much smaller than in a conventional laboratory; nor were they used to manipulating such tiny quantities of chemicals. However, as they moved from one experiment to the next, they were delighted to discover that the results were comparable to those obtained in a conventional laboratory.

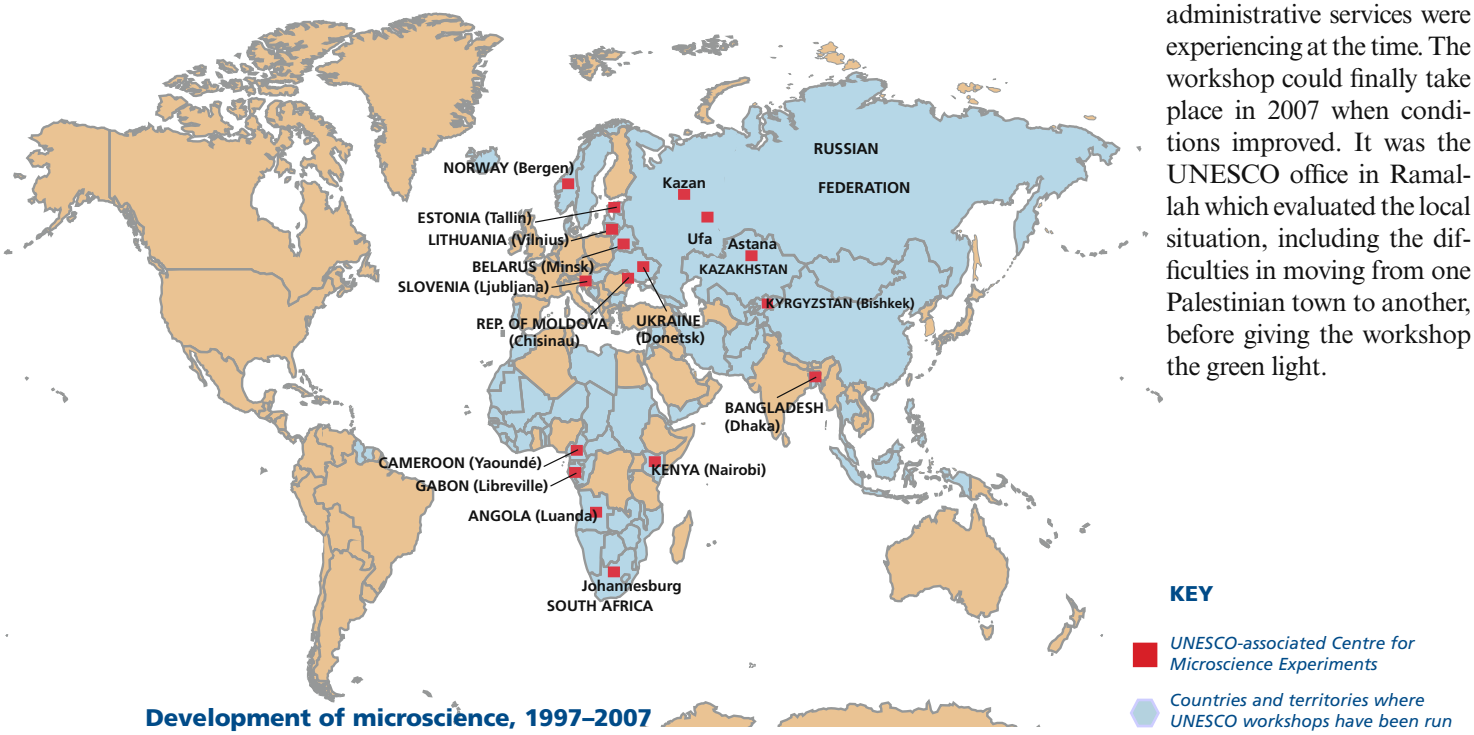
Although several schools in Beirut are equipped with conventional laboratories where pupils can conduct experiments as part of their classwork within the curriculum, the participants in the workshop felt the approach of experimenting on a micro-scale could be easily taken up and adapted in their schools.

The low cost of the kits also means that each pupil can conduct his or her own experiments rather than being a passive spectator. He or she can observe the reactions, analyse the results and draw conclusions from these: the basic tryptic of science.

As they prepared to leave the training workshop, the take-home kits under their arm, the participants all vowed to speak to their school principal about adopting the methodology in their own establishment.

The workshop in the Territories can finally take place

A few months later, in February 2007, it was the turn of Ramallah to host a training workshop. This workshop had already been postponed once, a year earlier, owing to the difficulties the Palestinians and administrative services were experiencing at the time. The workshop could finally take place in 2007 when conditions improved. It was the UNESCO office in Ramallah which evaluated the local situation, including the difficulties in moving from one Palestinian town to another, before giving the workshop the green light.



Development of microscience, 1997–2007

Self-service in microscience

Within its Global Project on Microscience Experiments, UNESCO makes teaching and learning packages available to teachers and students free of charge online. These packages may be easily downloaded and adapted to suit the needs of national curricula. The complete set of teaching and learning packages exists in English only for the time being but new language versions, including Arabic, Russian and Spanish, are under preparation and will be added to UNESCO's website once finalized.

The materials currently available online are:

Primary level

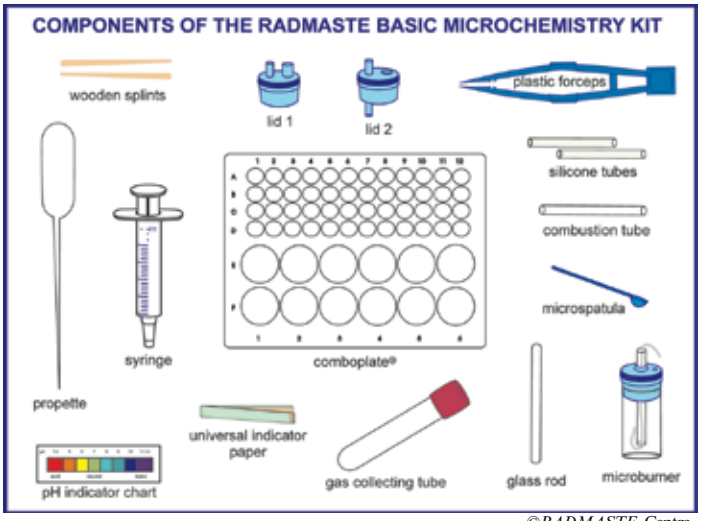
A variety of experiments covering, among other subjects : air, soil, water, acids, plants, living things, electricity, magnetism and heat.

Secondary cum tertiary level

Chemistry; microelectricity; biology; microelectrochemistry experiments (a separate manual for learners and teachers); microscience environmental experiments, water quality and water treatment (a separate manual for learners and teachers).

The microscience kits needed to conduct the experiments in the educational packages listed above have been designed and prepared by the RADMASTE Centre at the University of Witwatersrand in Johannesburg. Funding is provided by UNESCO's Division of Basic Sciences and partners that include the International Union for Pure and Applied Chemistry, the International Organisation for Chemical Sciences in Development and the International Foundation for Science Education. Manufactured by Somerset Educational Ltd in South Africa, the kits are purchased by UNESCO for use in introductory workshops.

To download materials: www.unesco.org/science/bes; RADMASTE Centre: beverly.bell@wits.ac.za; www.radmaste.org.za; UNESCO co-ordination (in Paris): j.hasler@unesco.org; m.liouliou@unesco.org



©*RADMASTE* Centre

The teachers enthuse about microscience

University professors from the different cities in the West Bank figured among the participants in the second two-day workshop, which took place in the presence of international experts. All the teachers were delighted to discover the methodology and to conduct practical experiments.

In the course of their training, the teachers came to realize that the microscience approach, and particularly the kits, could be of great use in Palestinian schools, most of which were not equipped with a laboratory. The teachers admitted that their schools were cruelly lacking in the basics, be it methodology or materials. They found the microscience approach user-friendly, safe and cost-effective. This vote of confidence did not escape the notice of the representative of the Ministry of Education who was also present.

A workshop under curfew

The workshop was run from a hotel in Ramallah and proceeded smoothly. The experts had to drive to Ramallah from Jerusalem each day, accompanied by UNESCO staff from the Ramallah office, a 15-km journey which took 45 minutes. The numerous checkpoints we ran into every time we had to pass the wall of separation brought home to us just how impeded movement is in the Territories. Multiple identity checks punctuated each day.

A policeman directs traffic in central Ramallah

©Madji Hadid

At the time of the training workshop, a curfew had been declared in the Naplouse region because of Israeli raids in search of Palestinian activists. On account of this, the workshop started earlier than planned on the second day to ensure that the participants could make it home before the curfew.

At the end of the workshop, we met with the deans and professors of the Universities of Birzeit and Al Quds. They described the difficulties students and professors endured daily in moving from one part of the Palestinian territory to another or beyond. The Palestinian professors explained that, when one of them wished to travel abroad for an international meeting, he or she had first to obtain authorization from the Israeli authorities, no easy task.

To conclude, the project seems to have great potential for broader development in Palestinian universities. UNESCO has proposed creating a Centre for Microscience Experiments in the West Bank. This centre would serve as a pilot project for ensuring that the microscience approach spreads throughout the West Bank.

Maria Liouliou

An article will follow in A World of Science *in 2008 on the role of the RADMASTE Centre in the Global Project in Microscience.*

For a profile of an existing Centre for Microscience Experiments, read about the one in Cameroon, in the January 2003 issue of A World of Science*: www.unesco.org/en/world-of-science*

13. *A microscience kits costs US$15–20 on average*
14. *Resolution 1701 was adopted unanimously by all 15 members of the UN Security Council on 11 August 2006; it established the basis for a durable solution to the conflict that had begun a month earlier. The Resolution called upon the Hezbollah, the Lebanese Shia militia, to cease all attacks on Israel immediately and upon Israel to cease all its military attacks in Lebanon forthwith*

Diary

2–4 October
Oceans biodiversity
Conf. UNESCO-IOC's IODE programme, ICES & OBIS. Dartmouth, Nova Scotia (Canada): www.iode.org/calendar

3–5 October
Space tech. applications
Workshop for Latin American teachers. Argentinian Space Commission (CONAE) with UNESCO. Cordoba (Argentina): www.conae.gov.ar; y.berenguer@unesco.org

4–5 October
Greenhouse gas status of freshwater reservoirs
Workshop. Itaipu Binacional Tech. Park, Foz de Iguazu (Brazil): phi@unesco.org.uy

4–10 October
World Space Week
On 4 October, students worldwide to launch 'rockets' to mark 50 Years of Space Age: www.spaceweek.org; y.berenguer@unesco.org

8–10 October
Towards a Caribbean marine atlas
Stakeholder meeting. Barbados: www.iode.org/calendar

10–16 October
Reservoir sedimentation management
Advanced training workshop. UNESCO co-sponsor. Beijing (China): j.ramasamy@unesco.org

16–18 October
Map of arid, semi-arid & subhumid zones in Caribbean
Validation workshop & launch of Water Balance in Caribbean project. Nassau (Bahamas): phi@unesco.org.uy

16 October – 3 November
Planet Earth exhibition
Side event for duration of General Conf. Includes panel on 17 October of indigenous speakers from environments vulnerable to climate change. UNESCO Paris: a.candau@unesco.org; on panel: d.nakashima@unesco.org

17–19 October
The journey from discovery to market
Intl workshop on biomedical R&D within Universal Forum of Cultures. InnBioGeM, University of Nuevo León (Mexico) & UNESCO Montevideo. Monterrey (Mexico): recardiel@hotmail.com; maarojasa@yahoo.com.mx

22–26 October
Asian Physics Education Network
ASPEN General Assembly & workshop on Active Learning in Introductory Physics Courses. Manila (Philippines). Registration: iculaba@ateneo.edu

26–27 October
S&T for development
Ministerial roundtable on role of UNESCO, during General Conf. UNESCO Paris: c.formosa-gauci@unesco.org

29–31 October
Water pollution & environmental protection in agriculture – 3rd UNESCO training course, under UNESCO Chair on Sustainable Water Management. Nanchang (China): j.ramasamy@unesco.org

4–9 November
Lessons from the South
Meeting of UNESCO's Local Solutions to Global Water Problems (HELP) programme. Pretoria (South Africa): s.demuth@unesco.org

6–8 November
Geoparks
3rd intl GEO/IGOS/GARS workshop. Frascati (Italy): r.missotten@unesco.org; m.patzak@unesco.org

6–9 November
Arab IHP Committees
12th regional meeting. UNESCO Cairo & ALECSO. Dubai (UAE): r.weshah@unesco.org, or hyd@mail.unesco.org.eg

8–10 November
World Science Forum
Investing in knowledge: investing in the Future. Hungarian Academy of Sciences, with UNESCO & European Commission. Budapest: m.el-tayeb@unesco.org; www.sciforum.hu

10 November
World Science Day for Peace & Development
www.unesco.org/science/psd; d.malpede@unesco.org

12–15 November
Ensuring the future of drylands – Workshop towards implementing MAB Agenda. Based on outcome of UNESCO conf. on The Future of Drylands (2006). Jodhpur (India): www.unesco.org/mab/ecosyst/drylands/FirstAnnouncement.pdf t.schaaf@unesco.org; r.boojh@unesco.org

13–15 November
Geoparks & business dialogues
Asia–Pacific Conf. on networking within national geoparks. LADA, Universiti Kegangsaan Malaysia. Under auspices of UNESCO. Langkawi Island Geopark: m.patzak@unesco.org; www.langkawigeopark.com.my

17–19 November
Popularization of science
Asia-Pacific Forum to foster role of science centres & museums. UNESCO & Korea Science Foundation. Seoul:y.nur@unesco.org

19–21 November
Coastal aquifers
Workshop of UNESCO project on Groundwater Resources Assessment under the Pressures of Humanity & Climate Change (GRAPHIC). Belice City (Belize): phi@unesco.org.uy

19–22 November
Hyper@SADC
Training & research workshop on imaging spectroscopy. UNESCO, VITO, CSIR/SA, SunSpace & University of Stellenbosch in South Africa (host). Strategy workshop follows 23 November: www.hyperteach.co.za

21–23 November
Tsunami Early Warning & Mitigation System
in North-eastern Atlantic, Med. & connected seas. 4th ICG session. Lisbon (Portugal): www.ioc-tsunami.org

25–29 November
Better buildings
Training & demonstration seminar on water-, energy-, & waste management in buildings in the Arab States. UNESCO Doha & Friends of the Environment Centre. Doha (Qatar): b.boer@unesco.org

26–29 November
Seismicity & earthquake engineering
Workshop covering extended Mediterranean region. UNESCO co-organizer. Madrid (Spain): b.sartre@unesco.org

27–30 November
Earth observations for sustainable development in Africa
Exhibition on Pan-African contribution to GEO/GEOSS. Coordinators: GOOS-Africa/UNESCO. Cape Town (South Africa): j.ahanhanzo@unesco.org

27–30 November
Science policy forum
For South Asia & Southeast Asia. UNESCO & ISESCO. New Delhi (India). Pre-registration: www.unesco.org/psd; mohsinuk@yahoo.com

30 November
Ecohydrology Programme in Brazil
Launch in San Pablo (Brazil), then joint meeting of Scientific Advisory Comm. & Task Forces. Maringa (Brazil): phi@unesco.org.uy

13–14 December
From lab to user
Intl workshop on good practices to support innovation. UNESCO Montevideo & University of Puerto Rico. San Juan de Puerto Rico: cienge@unesco.org.uy

New Releases

A World of Science
Retrospective on climate change

Special fifth anniversary issue of articles published since 2002 on UNESCO's work related to climate change. Limited edition in English and French, 60 pp.
Topics include glacier melt, biodiversity loss, ocean acidification, carbon sequestration, drought management, combating desertification, renewable energy use, the effects of climate change on world heritage and biosphere reserves, and climate monitoring via global observing systems. Download: www.unesco.org/science; request a copy from: s.schneegans@unesco.org

Venice Newsletter

4-page quarterly newsletter produced online by UNESCO's Regional Bureau for Science and Culture in Europe, situated in Venice (Italy). English only. Download from: www.unesco.org/venice; or write to: r.santesso@unesco.org

Plate Tectonics from Space

N. Chamot-Rooke & A. Rabaute. © Commission for a Geological Map of the World (CGMW); explanatory notes, Mercator projection, equatorial scale at 1:50 000 000, 67 x 99 cm. 10 euros. UNESCO and CGMW organize workshops for scientists worldwide to analyse and harmonize national geodata, and integrate them in continental or regional maps like this one and the World Stress Map that follows.
This map shows the current plate tectonics framework in light of new satellite measurements using space-based models (geodetic models), superimposed onto a physiographic basemap also obtained using space techniques. Apart from delivering horizontal crustal motion at places where conventional geologic models failed, geodetic models allow us to reassess major plate motions (steady-state motion) and ultimately discuss the evolution of their motion through time, in particular close to plate boundaries (transient deformations such as those related to the seismic cycle). To order: ccgm@club-internet.fr

World Stress Map

O. Heidbach, K. Fuchs, B. Müller, J. Reinecker, B. Sperner, M. Tingay & F. Wenzel. © CGMW & Heidelberg Academy of Sciences & Humanities. Mercator projection, scale at 1:46 000 000, 54 x 120 cm + CD-ROM, 15 euros.
A global compilation of information on the present-day tectonic stress field in the Earth's crust. This collaborative project involving university, industry and governmental organizations aims to understand the sources of stress in the Earth's crust. The accompanying CD with the WSM digital database release contains 13,853 data sets derived from a wide range of shallow to deep stress indicators, including earthquake focal mechanism solutions, well bore breakouts, drilling-induced fractures, hydraulic fracturing, strain relief measurements, and young (Quaternary) geological indicators. To order: ccgm@club-internet.fr

For the Young

Stop disasters game

Secretariat of UN International Strategy for Disaster Reduction, with UNESCO participation. Part of two-year campaign on Disaster Risk Reduction Begins at School (see A World of Science, October 2006), ending in December. English & Spanish, other language versions planned.
International Disaster Reduction Day: *12 October.*
This online game teaches children how to build villages and cities that are safer when disaster strikes, be it a hurricane, earthquake, wildfire, tsunami or flood. Children are presented with different options as to what to buy, what to upgrade & what to demolish to make a given site safer, as the countdown to a simulated disaster begins. To play game: www.stopdisastersgame.org

A World of Science is a quarterly newsletter published in English, French, Russian and Spanish by the Natural Sciences Sector of the United Nations Educational, Scientific and Cultural Organization (UNESCO), 1, rue Miollis, 75732 Paris Cedex 15, France. ISSN 1815-9583
Director of Publication: Walter Erdelen; Editor: Susan Schneegans; Lay-out: Yvonne Mehl; Printed in France by Watelet-Arbelot.
Register for free e-subscription: y.mehl@unesco.org – Free print subscription for libraries and institutions: s.schneegans@unesco.org, fax: (331) 4568 5827. This issue was printed in 9500 copies.