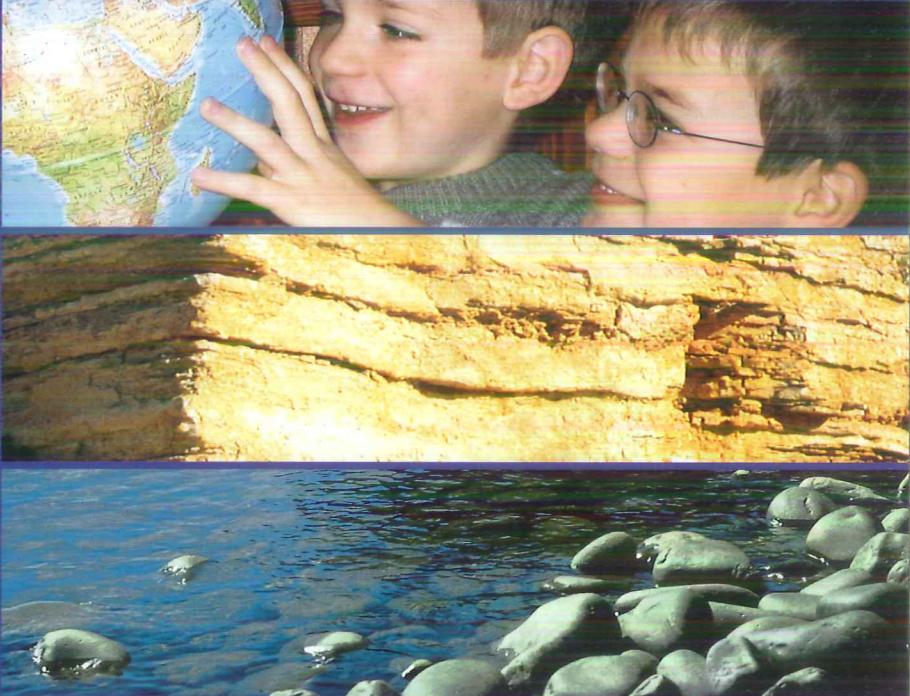


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Planet Earth in our hands

Earth sciences for society

A prospectus for an International Year of Planet Earth 2005-2007

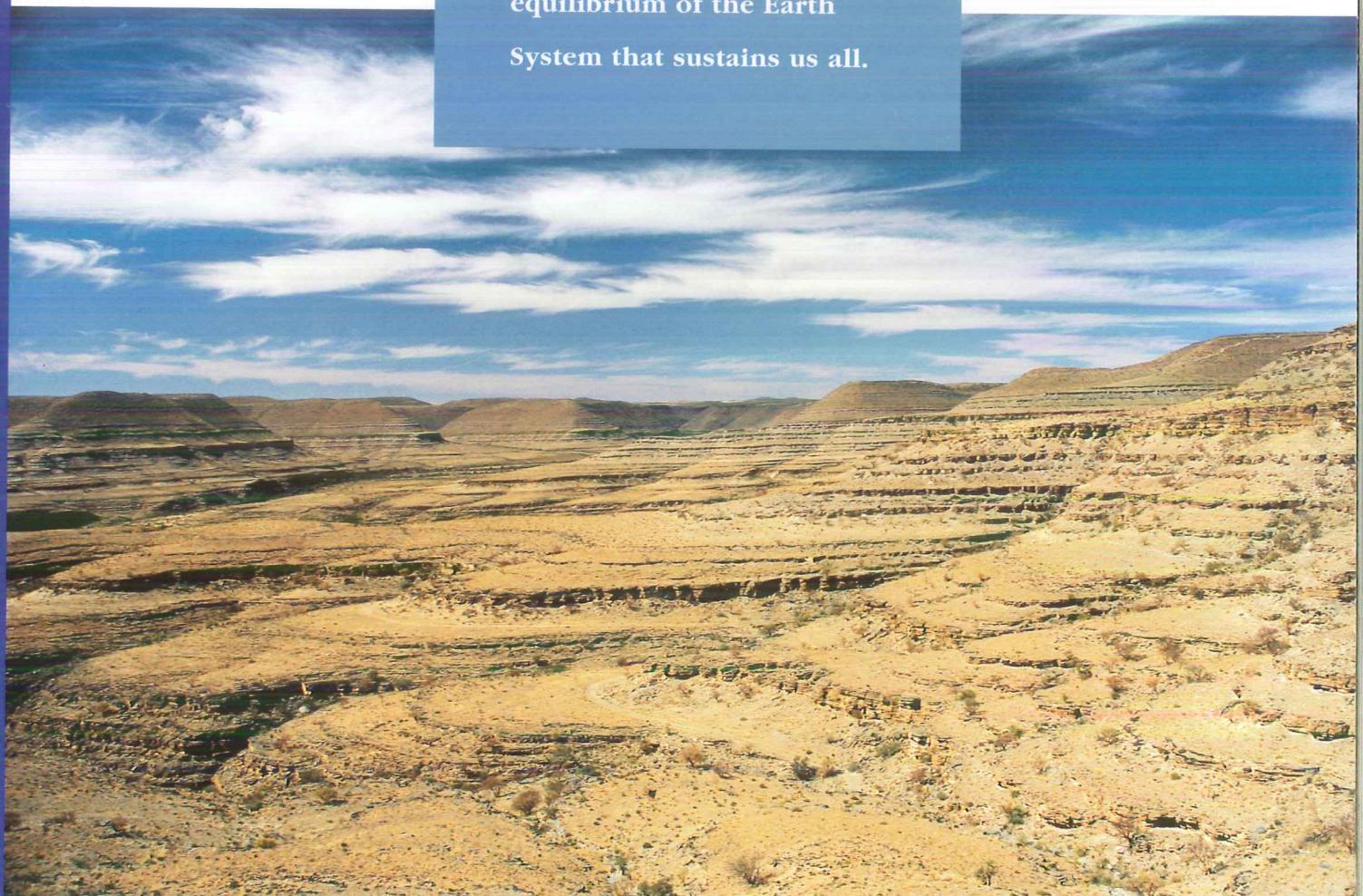


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Keeping our balance

Earth scientists are today's key players in building a sustainable world. For our children's sake we must be able to use the Earth's riches without wasting resources that cannot be replenished, and without upsetting the dynamic equilibrium of the Earth System that sustains us all.



Planet Earth in our hands

The human race needs its planet. We depend upon it completely, because we evolved from it, remain forever part of it, and can exist only by courtesy of the self-sustaining Earth System.

The Earth is unique not only in our Solar System, but as far as we know, in the accessible universe. It is not just the only planet we have – it is the only living planet we know, or may ever know.

The Earth provides so many riches, about which we have so much more to learn – as innovative new research techniques are brought to bear. The more we learn, the more we understand that we must nurture the Earth as we would our children, for their sake.

The changing world of Earth science

Traditionally, Earth scientists study the rocks of Planet Earth, and try to understand the planet's history and structure. We try to decipher from the record of the rocks all the things that have happened since its origin, with the rest of the Solar System, 4.6 billion years ago. We try to understand processes that created minerals, hydrocarbons, metals, aggregates (sand, clay and gravel) and even life itself. From this we come to understand the extreme age of the world, and of life, and the tiny moment for which human beings have existed – and perhaps will exist - on its surface.

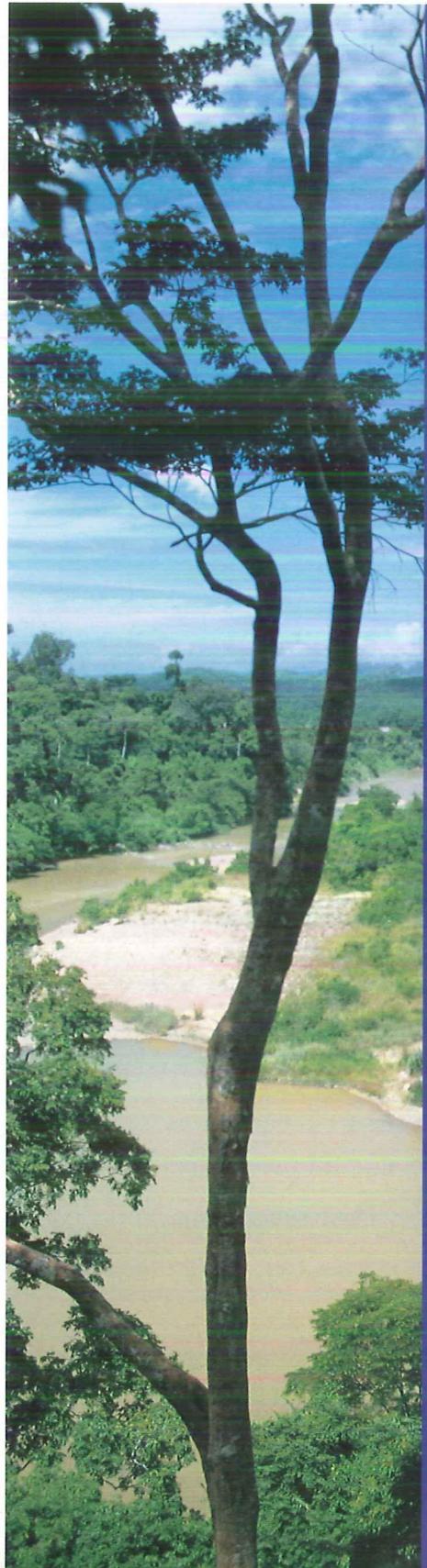
Earth scientists are on a quest for pure knowledge, but this is knowledge we desperately need. All humanity's raw materials and nearly all its power must come from the Earth – and it is Earth scientists who find it.

The men and women in Earth science today – pure and applied – constitute the largest living database of information about the past and present of planet Earth that has ever existed. We are also stewards of planet Earth. Humanity's survival – and that of life itself – depends on maintaining a functioning Earth System. For that reason, activities that interfere with this delicately balanced system are a matter of global concern. Earth science is now at the forefront of understanding how the Earth System works, and stewardship is an issue right at the forefront of policy – exemplified by the Johannesburg Summit (2002), the work of the International Council for Science (ICSU) and its World Summit on the Information Society (2002).

Today, Earth scientists' work has come to encompass all interactions between land, life, water and air in making up the total Earth System. Earth science now not only seeks to explain the Earth's past, but also helps predict and manage its future.

Humans in the landscape

Throughout Earth's history many animals and plants have become geological forces – think of the Great Barrier Reef, or worldwide deposits of coal. Humans are now perhaps the most geologically significant species ever.



● **Earth Scientists are on a quest
for pure knowledge, but this is
knowledge we desperately need** ●

Fresh groundwater

Water is the ultimate resource. Although 70% of the Earth's surface is covered by it, only 2.5% of all water is fresh – of which most is locked in glaciers and permanent snowfields. This leaves only 0.26% of the planet's water available to support humankind. Of this tiny 0.26%, nearly all (>90%) is held as groundwater, in the pore spaces of rocks beneath the land.

Most groundwater begins as rain that sinks into the ground and collects within permeable rocks, or "aquifers".

Our burgeoning population and its various polluting activities pose serious threats to this small volume of fresh water.

Moreover as the people of Bangladesh have found out, not all groundwater is drinkable.

For example, we now move more material around the Earth's surface than all natural agents of erosion. Meanwhile our species is depleting water and fuel resources, causing floods and droughts, producing wastes and "greenhouse" gases - disturbing the planet's dynamic equilibrium. Yet, offering our growing population a secure and prosperous future requires ever more intensive searches for nutrients, energy, water, ores and building materials.

These resources continue to be found as Earth sciences develop their understanding. All predictions of the exhaustion of such resources have so far proved wildly wrong. There is, as yet, no reason to believe that the Earth will not continue to support our needs – as long as we manage those resources sustainably.

How can we explore and benefit from the planet's resources without disturbing the proper functioning of the Earth System? We need to integrate our knowledge of the spheres...



How the "geosphere" interacts with the other spheres of the Earth's surface. These spheres are artificial academic distinctions; they interact completely within the single entity that is the Earth System.



Spheres within spheres

In the past, scientists tended to split the Earth System into "spheres". But we have now reached the point where - having mentally taken the world apart - we must put it back together, to see how it actually works as a whole.

Earth sciences for development

Earth science is essential to understanding this complex, balanced Earth System on which we all depend. But it is all too easy to take the Earth's resources for granted. All civilisations depend on supplies of energy and raw materials.

To take an example from humanity's oldest continuous civilisation, in North China, as early as 6000BC, "salt wars" were fought over Lake Yuncheng. Five thousand years later the Chinese began using iron. Due to taxes on salt and iron (both state monopolies) the Chinese were able to create a great empire that, around 100BC, was larger and more advanced than that of the Romans.

Three hundred years later, the Chinese people succeeded in piping gas from those mines to their stoves, using bamboo - the first known use of natural gas.

To solve global environmental problems we need multidisciplinary research. To take just one pressing example; we cannot work out a global budget for "greenhouse" gases in the atmosphere without considering the solubility of those gases in water (hydrosphere), the carbon dioxide locked up in the wood of the world's great forests (biosphere), or those rocks in the "geosphere" that bind carbon in deposits of limestone, coal, oil, gas, or methane hydrate. Nor can we ignore volcanoes, which also produce huge quantities of natural greenhouse gases.

Nor, indeed, can we simply stop burning fuel. A world power shortage would have human consequences as terrible as runaway global warming. For Earth scientists, understanding those geological "carbon sinks" is also vital to finding the resources that all countries desperately need to help their people towards a better life. Burning fossil carbon has powered the progress of civilisation and improved the living standards of humanity immeasurably – but only by incurring environmental costs that are unsustainable in the long term.

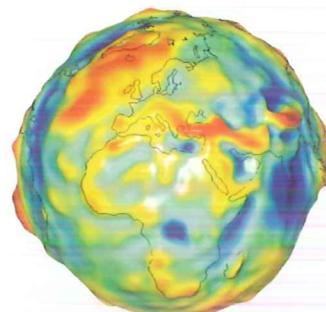
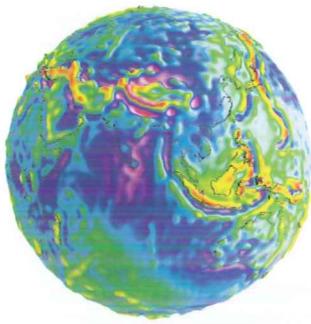
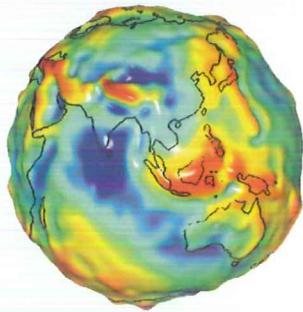
Earth sciences are in the forefront of detecting these changes, and finding ways of mitigating them before it is too late. For example, experiments are now under way to turn polluting coal – which contributes to global warming if burned – into pure hydrogen, without even removing it from the ground. Other research may pave the way for large quantities of waste carbon dioxide to be re-injected into the rocks from where the fuel originally came.



In Poland, greenhouse gas extracted from the atmosphere is safely sequestered in the geosphere by being injected into coalbeds 1km below the surface in a pioneering experiment.



It is all too easy to take the
Earth's resources for granted



Amazing GRACE

Several recent developments will improve our ability to observe the Earth's response. For instance, high precision gravity measurements by satellites such as GRACE (Gravity Recovery And Climate Experiment) will improve our understanding of mass flows on Earth – such as magma in its crust, water in oceans and melting icecaps on the poles. GRACE will enable Earth scientists to predict floods in lowlands by allowing them to monitor more accurately the degree of saturation in upstream catchment areas,

for example. In future, space satellites will be able to monitor and detect earthquake activity in areas where no ground stations exist. Radar interferometry – an extremely sensitive altitude observation technology capable even of detecting the Moon's tidal pull on the continents – will soon be able to detect land movements before damage to built structures has become apparent. Other emerging satellite technologies can use disturbances in the ionosphere to detect earthquakes – including under the oceans.



The challenge facing Earth science is to combine all these new data, and use them to visualize, explain and predict flows of ice, water and magma, the movements of tectonic plates and ocean currents, the activity of faults and volcanoes, the rise and fall of the crust and – ultimately – the Earth's response to human activity. This will then enable them to forecast more accurately – and then mitigate – geological hazards facing people all over the world.



Rocky riches – and horrors

In 1980, mining of diamonds, uranium, copper, lead, zinc, tin, silver and cadmium accounted for 50% of Namibia's gross national product and 75% of exports. Since 1960 the Republic of Congo has exploited the riches in its subsurface. In that year the first oilfield was taken into production at Pointe Indienne. By 1984 Congo had seven oil fields that together accounted for two thirds of its income. The lives of over 100 million inhabitants of the State Republic of Bangladesh, in South Asia, are also largely controlled by geological phenomena, since the discovery in groundwater

of high levels of natural arsenic exceeding World Health Organisation guidelines.

Arsenic causes skin lesions, poisoning and cancer. Continuing research is showing that natural geochemical processes liberate the toxic element from buried river sediments, so that it now occurs in water drawn from tube wells that (ironically) were constructed in an attempt to reduce disease from the use of polluted surface water.

Earth scientists are urgently striving to find alternative water sources, and to develop affordable alternative technology methods of extracting arsenic from existing water sources.

Building high, building deep

Apart from finding riches in the Earth's crust, Earth scientists also make it possible to build great structures on or in its surface.

About 70% of the world's population lives in coastal areas - on sandy, clayey and muddy soils at sea level. The geotechnical knowledge of Earth scientists is essential in establishing cities, building industries and constructing dams. Nowadays, as urban populations rise, geotechnical engineers are helping to build safe underground structures like the Channel Tunnel (linking the UK with the rest of Europe), the subways of Paris or London, or the bullet trains of Tokyo.

In the near future, humans will be making greater use of the subsurface for living, moving, storage and environmental mitigation. To do this will require knowledge of the Earth System's response. Subsidence due to mining or lowering of the groundwater table by water extraction, and earthquakes induced by exploration for natural gas are just a few examples of how human activities in and on the crust may cause adverse effects for which we need to be ready.

We now move more material
around the Earth's surface than
all natural agents of erosion



Damming the tide

In Holland, every person can be said to own one metre of dam, 20,000 kilometres of which protect two thirds of the country from flooding. The Dutch government has recently planned several new residential areas in polders at depths varying between 4 and 7m below sea level. Keeping the streets dry will require additional pumping to lower the groundwater in the peat and clay on which the new homes are being built. But this causes subsidence - at a rate of c. 1cm per year - which is more than the figure by which average sea levels are rising.

Earth scientists predict that in the next century only massive investments in water management will prevent the Delta metropolis of Amsterdam, Rotterdam and The Hague from drowning. In the next few decades, their knowledge of the geological formations and groundwater flow, the behaviour of the Rhine, Meuse and North Sea, as well as geotechnical aspects of pumping, building and tunnelling, will all be essential to design and implement safe scenarios for Holland's future.





What does the International Year's logo mean? The International Year is intended to bring together all scientists who study the Earth System. Thus, the solid Earth (lithosphere) is shown in red, the hydrosphere in dark blue, the biosphere in green and the atmosphere in light blue. The logo is based on an original designed for a similar initiative called Jahr der Geowissenschaften 2002 (Earth Sciences Year 2002) organised in Germany. The German Ministry of Education and Research presented the logo to the IUGS.



Towards an International Year

Who is involved?

The International Union of Geosciences (IUGS), representing about 250,000 geoscientists across 117 countries, has taken the initiative to proclaim an International Year of Planet Earth 2005 - 2007 with the subtitle *Earth Sciences for Society*.

Its purpose will be to focus on the relationship between humankind and Planet Earth, and to demonstrate that geoscientists are key players in creating a balanced, sustainable future for both.

The International Year will be proclaimed through the United Nations. The initiative has already been adopted by UNESCO's Division of Earth Sciences as a core activity. It has also been supported by IUGS's sister organisations, the International Union of Geodesy and Geophysics (IUGG), the International Geographical Union (IGU) and the Scientific Commission on the Lithosphere-International Lithosphere Programme (SCL-ILP). The International Council for Science (ICSU) is also supporting the event.

According to UN Guidelines for the proclamation of international years, suitable subjects should be "of priority concern to political, social, economic, cultural, humanitarian or human rights"; of concern to "all (or a majority of) countries, regardless of economic and social system", and should "contribute to the development of international co-operation in solving global problems", paying special attention to those affecting developing countries.

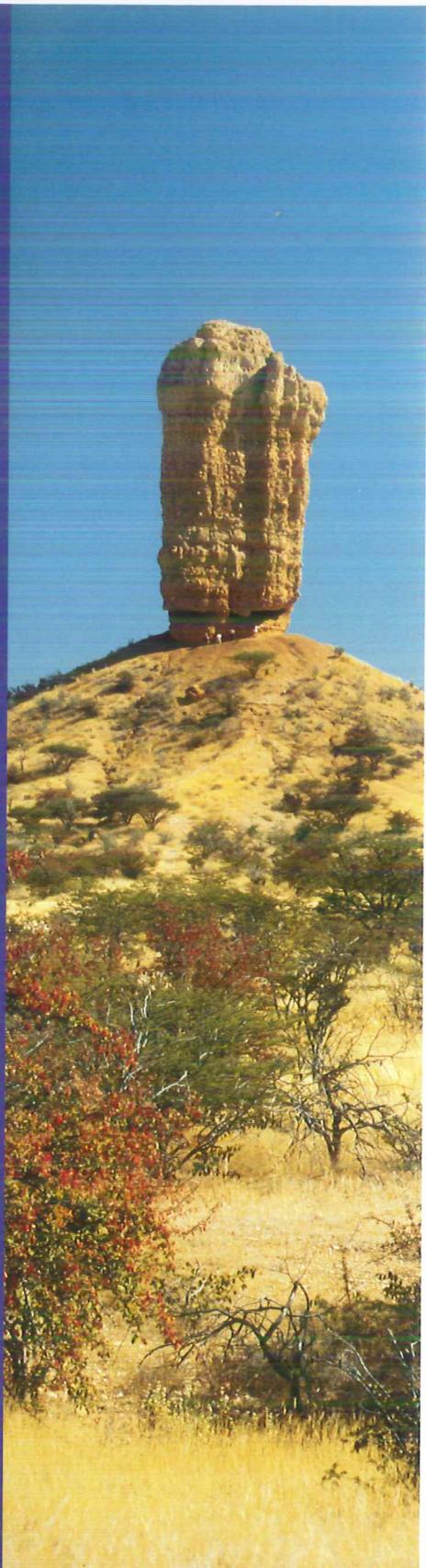
World summits on sustainable development during the last decade have stressed the urgent need for action to conserve and sustain the Earth System (Johannesburg summit, Rio de Janeiro summit, Agenda 21, the ICSU World Summit on the Information Society, etc.). IUGS, representing the Earth science community worldwide, therefore decided to take a lead, and preparations will enter the final phase in March 2004.

Project structure

The Management Team, in overall charge, devolves executive function to two sub-committees: a Science Programme Committee (SPC) and an Outreach Programme Committee (OPC).

The Management Team consists of the Project Manager, representatives of the two initiating organisations (IUGS and UNESCO), and the chairpersons of the SPC and the OPC. It is expected that a representative of the People's Republic of China will soon join the Management Team, as China will most probably take responsibility for presenting the resolution to the UN General Assembly in 2004.

We expect that 2006 will be declared International Year of Planet Earth under the UN system. However, activities within the framework of the Year will run for a period of at least three years (2005 - 2007).



Work to date

By November 2003 a website (www.esfs.org) had been launched, a flyer published, a PowerPoint presentation created, and this brochure produced. Eight socially relevant science topics have been selected.

Costs

Running costs have largely been covered by IUGS, with contributions from UNESCO and Shell Exploration & Production BV. Further financial support is expected from the People's Republic of China, IUGG, IGU, and ICSU's International Lithosphere Programme. We anticipate that these organisations will cover the costs of the implementation phase (below), together with IUGS, UNESCO and sponsors from industries, consultancies and financial institutions involved in the sector. We estimate that that the total budget for the three-year period (2005 - 2007) will be c. \$20 million.

The way ahead

The route to UN proclamation has two stages.

Stage 1. A combined high-level international conference on *Earth Sciences for Society*, and an information meeting for UNESCO delegates, in Paris (February 11 2004), to stress the timeliness of the International Year. This meeting will coincide with the 32nd Session of the IGCP Board.

Stage 2. An official request from the highest levels of the Chinese Government to the UN General Assembly, with a declaration from the Paris meeting, as soon as possible after February 11 2004. A copy of this will be sent to ECOSOC for discussion at its meetings in April and July. The UN resolution, proposed by China, is expected to be supported by ICSU. It is expected that the UN will proclaim the International Year for 2006, during the General Assembly of Autumn 2004.

In addition, all 117 IUGS member countries will be asked to support the process through their UN representatives and by implementing an appropriate range of International Year activities. At the same time, major sponsors (ranging from national science foundations to industrial and commercial bodies) will be asked for financial support towards full implementation. Finally the media and major national and international centres of science and education will be invited to play their part in outreach.

To solve global environmental
problems we need
multidisciplinary research

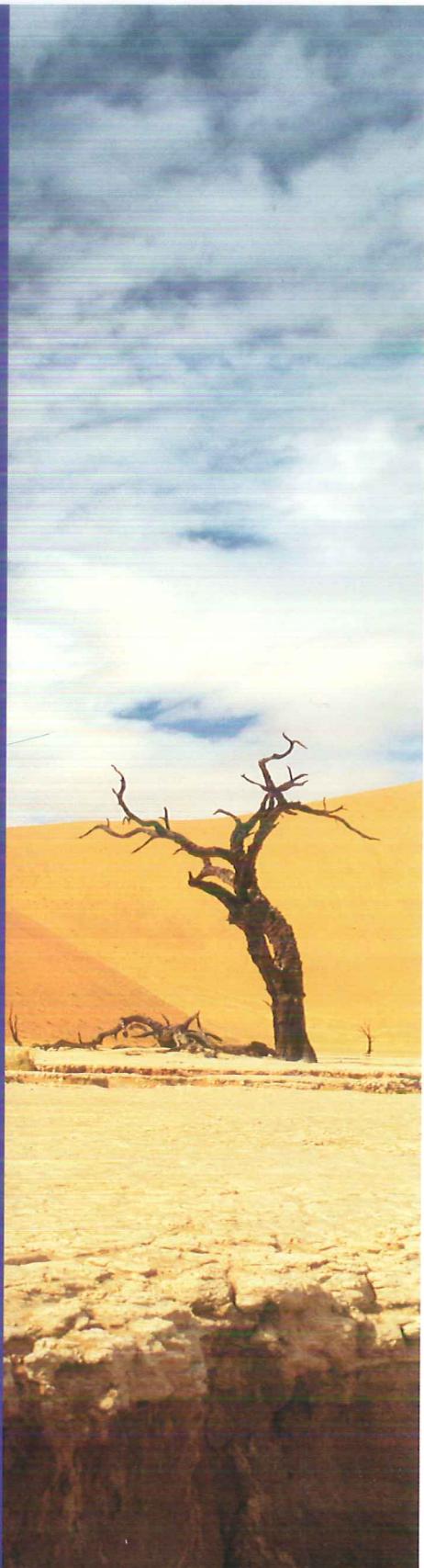
Other International Years

The International Year of Planet Earth will join a prestigious list of UN-proclaimed international years, beginning with World Refugee Year (1959/1960). In 1957/1958 an International Geophysical Year, preceding the UN series, ignited many new developments in our understanding of the Earth. In 1998, the United Nations proclaimed the International Year of the Ocean, the International Year of Mountains (2002), and the International Year of Freshwater (2003). The International Year of Planet Earth is succeeded by the 50th anniversary commemoration of International Geophysical Year and International Polar Year (both 2007/2008).

The IUGS-UNESCO initiative fully complies with the requirements of the UN and has translated these into its Aims and Objectives (see below).



● **Earth scientists are today's
key players in building
a sustainable world**



Aims & objectives

The International Year of Planet Earth aims to "demonstrate the unique and exciting ways in which Earth sciences can help future generations meet the challenge of ensuring a safer and more prosperous world".

The Scientific Programme Committee (SPC) has placed boundary conditions on any research project hoping to become eligible for incorporation in its programme. Such projects will have to:

- be global (supra-regional)
- be holistic
- emphasise human impact and interaction
- have potential for successful and wide-ranging outreach
- actively involve developing countries.

Through the International Year of Planet Earth 2005-2007...

Earth scientists of the world will demonstrate how they are working to:

- Understand and keep intact for future generations the rich record of our planet's history, knowledge of its structure and function and of its self-sustaining dynamic equilibrium.
- Make sustainable use of Earth's richness and diversity for the benefit and prosperity of all peoples.

Governments will be urged to pay greater attention to the Earth sciences.

A science programme, concentrating on globally important issues facing all nations, will promote multidisciplinary research towards a fuller understanding of the Earth System.



The International Year will support research projects within the following eight broad themes. Each theme will be described in a separate brochure in this series.

Groundwater - *reservoir for a thirsty planet.*

Nearly all the potentially drinkable water on the Earth exists as groundwater. New techniques of exploration and production, and improved understanding of the dynamics of natural water reservoirs, are helping Earth scientists find this most precious of all commodities.

Hazards - *minimising risk, maximising awareness.*

The Earth can be a dangerous place, and is often made more dangerous by human intervention. Crucial to minimising the hazard potential from different geological threats facing people all over the world, is the accurate assessment and communication of risk.

Earth & Health - *building a safer environment.*

Everyone who lives in a polluted city appreciates that where you live affects your health. Much, if not most of the control over whether an environment is healthy or not lies beneath your feet – the environmental geochemistry of your habitat.

Climate - *the “stone tape”.*

Understanding climate trends, so vital to our stewardship of Planet Earth, relies heavily upon the preserved record of sedimentary rocks of many types. By studying this precious natural record, using proxy indicators for different aspects of climate, Earth scientists are now understanding in increasing detail how the climate works and how it has behaved in the past. However, these records are rare and precious and must be conserved before development destroys them forever.

Resources - *sustainable power for sustainable development.*

Earth scientists have consistently confounded gloomy predictions about the exhaustion of resources, by improving their understanding of the Earth and of how potentially useful minerals accumulate. However, this does not absolve the world of responsibility to use these resources intelligently, or to find new, cleaner ways of liberating their energy.

Megacities - *going deeper, building safer.*

Urban areas, often concentrated on narrow coastal strips, are running out of space and the price of land is sky-high. More and more, architects will wish to switch from building high to building deep. This is more expensive in the short term, but much more sustainable in the long term.

Mineral wealth

Minerals can only be mined where they occur, of course, and for this reason every country's mineral needs and resources are different. Many countries, particularly in the developing world, are largely or wholly dependent upon their geological riches - from Gulf states like Kuwait dependent on oil and gas, to Namibia with its minerals.

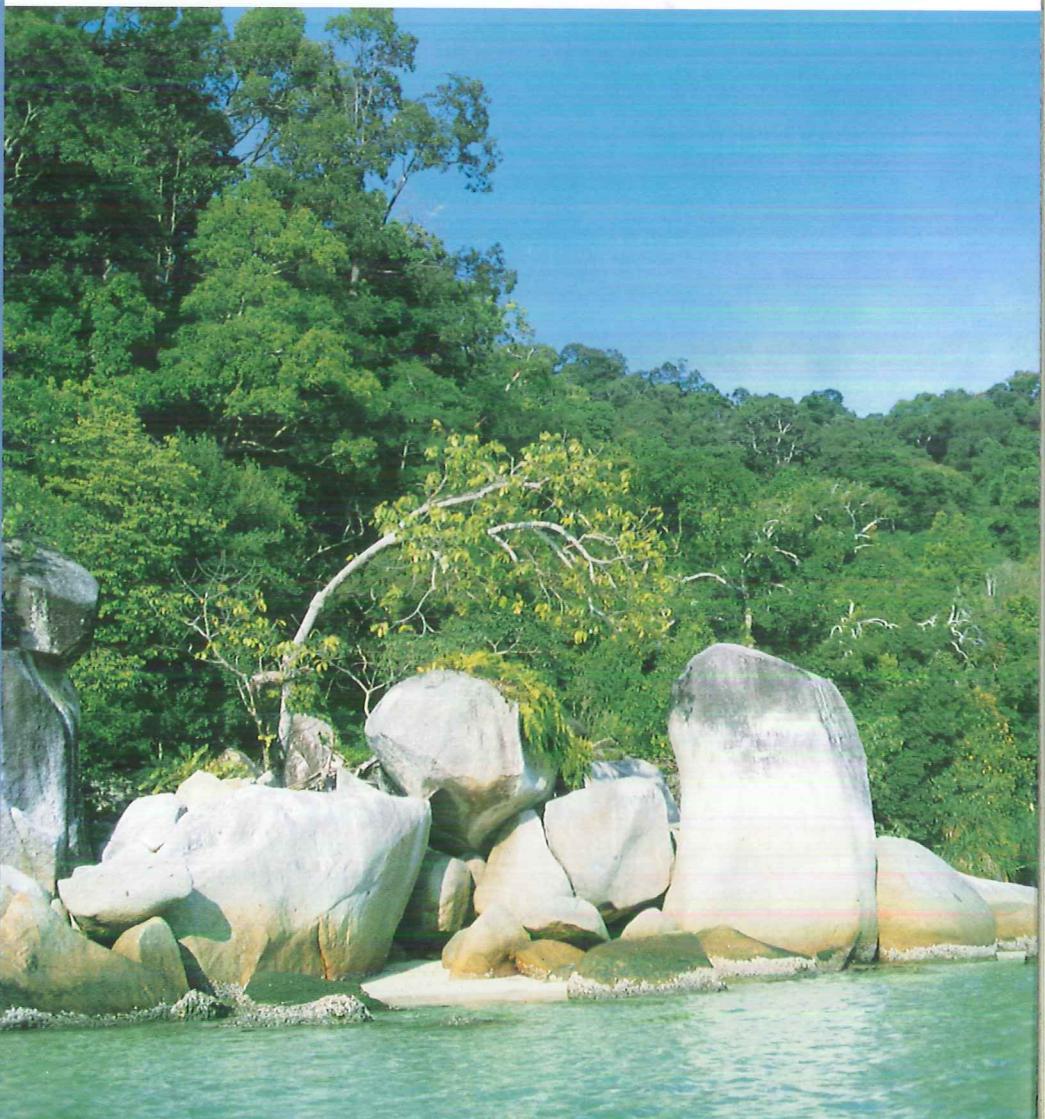
Developed countries like the United Kingdom, Norway or the Netherlands would be severely damaged economically without revenues from oil and gas. However, countries can be equally dependent as consumers. During an average 70-year life, each Western European person uses up 460 tonnes of sand and gravel, 39 tonnes of steel, 100 tonnes of limestone and more than 360 tonnes of fuel. Nearly everything in our homes is mineral in origin - cookers, computers, batteries, radios, compact discs, cosmetics, toothpaste, medicines, china, glass, plastic, paper, insulation - even tomato ketchup, chocolate and other food-stuffs!

Deep Earth - *from crust to core.*

All of the Earth's long history and evolution right up to its current condition is really but scum on the surface of a vast, heat-driven engine. Consisting of a central nickel-iron core (an inner solid core and outer liquid core, generating most of the Earth's magnetic field) and the mantle, which though solid nevertheless convects and moves the planet's crustal plates, this motor is what makes our planet "alive".

Ocean - *abyss of time.*

The oceans, which began to be scientifically explored 200 years ago, hold the key to how the Earth works. Although our improving knowledge of the oceans has revolutionised our understanding of the planet as a whole, much more remains to be discovered - not only in the use of oceans to the benefit of humankind, but also in preventing disruptions around the continental margins where so much of the human population is concentrated.



Outreach

The Outreach programme will interact with all educational levels worldwide. Through UNESCO, all national committees will be asked to co-operate in producing and disseminating Outreach programme material to the necessary educational levels. Information material will be produced in printed form, on CD-ROM and on www.esfs.org.

Public relations activities will encourage the involvement of newspapers, magazines, journals, radio, TV and the film industry. Earth science institutions, organisations, societies etc. will assist.

This brochure, *Planet Earth in our hands*, is the first in a projected series of 10. The second will describe the objectives of the International Year's Outreach Programme Committee. Numbers 3 to 10 will describe the eight major research topic areas of the Science Programme.

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