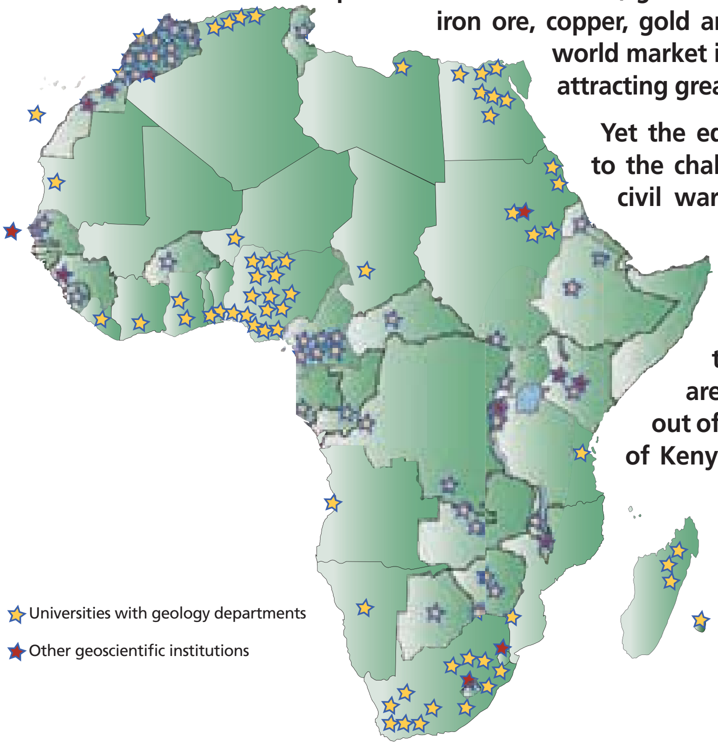
What future for **geo-education in Africa?**

Africa is a continent rich in minerals, oil, coal, gas and other geological resources. For African countries in transition, it is becoming increasingly urgent to exploit these to fuel sustainable socio-economic development. The economic potential is considerable, given the escalating global market prices for such raw materials as iron ore, copper, gold and oil. The latter hit a new high of US$110 a barrel on the world market in March. In this context, it is hardly surprising that geology is attracting greater attention from policy-makers and government officials.

Yet the education system in many African countries is unable to rise to the challenge: after decades of instability, including military coups, civil wars and periods of economic stagnation, there are yawning inequalities across the continent in terms of teaching resources and research facilities; this affects staffing, curriculum development, fieldwork and the quality of libraries, with the knock-on effect of low numbers of graduates who are in turn handicapped by insufficient expertise. In Germany, there are more than 10 000 students currently studying Earth sciences out of a population of about 80 million. In the East African countries of Kenya, Tanzania and Uganda, grouping a population of close to 100 million, fewer than 500 students are enrolled in the Earth sciences.

This single example speaks volumes for the crisis gripping geo-education in Africa. One of the primary objectives of the International Year of Planet Earth is to encourage more young people to study geosciences, both in the national interest and as an astute career choice. Africa's future will depend on what incentives its leaders can provide.



A date is approaching which will have great ramifications for Africa: 13 May 2009. This is the deadline for the submission of claims by countries around the world for the extension of their Legal Continental Shelf. The continental shelf is rich in mineral and bioactive resources, including oil and gas. An initial assessment for Africa indicates that the total potential area that may be claimed for the continent is some four times the size of France. It therefore represents a substantial source of wealth.

But coastal African countries should also ask themselves if they dispose of the geoscientists, equipment and strategies to seize this exciting opportunity if and when their claims to the continental shelf are validated. Or will they leave the exploitation of their new property to multinationals and expatriate experts?

The situation today

Africa counts a population of about 930 million, distributed over 53 independent countries and six other territories. Altogether, about 100 university departments and other geoscientific academic institutions offer courses in the Earth sciences, corresponding to roughly one Earth science department per 10 million people (*see map above*).

Classic mining countries like South Africa yield, for a population of about 48 million, at least 13 universities with Earth science departments, which often rank quite highly in international databases.

At the other end of the scale, some of the smaller countries provide no facilities at all for training and education in the geosciences; these include the Comoros Islands, Equatorial Guinea, Gambia, Guinea Bissau, Mauritius, São Tomé & Principé and the Seychelles.

Somewhere in-between, countries like Morocco, Nigeria and Egypt have a good number of Earth science departments with sometimes highly skilled people but are often poorly equipped.

Meanwhile, political instability in recent years has contributed to the deterioration of Earth science departments in Burundi, Liberia, Rwanda, Sierra Leone and Somalia.

Setting aside the dire situation in many countries, the general question has to be raised: are the teaching methods and curricula still relevant to the needs of Africa today? Apparently not, because decision-makers and the voting public in most African countries seem oblivious to the fact that geoscientific knowledge can be used for sustainable development and for the benefit of their countries.

Geology and Major Ore Deposits of Africa

Countries and territories (mineral resources in brackets are of sub-economic value)

Modified after the Bureau de recherches géologiques et minières, France, by Elisabeth Sillmann, Germany, www.blaetterwalDesign.de

Algeria Fe, Pb, Zn, Petr Angola D, Au, Ni, Cr, PGS, Fe, Mg, Cu, Ph, (Ag, Co, U, Va) Benin Au, Petr Botswana D, Cu, Ni, Au, PGS, Fe Burkina Faso Au, Ph, (D, Zn, bx) Burundi Au, T, (Ni, Va, Ph, Ni) Cameroon bx, Petr, (Au, D, T, Ni, Co, gem) Canary Islands (Spain) - Cape Verde - Central African Republic (D, Au, Fe, Cu, T) Chad (bx, Cr, Au, Petr, colt) Comoros - Democratic Republic of Congo (DRC) Cu, Co, Zn, T, colt, Mg, D Republic of Congo Petr, Cu, Pb, Zn, Fe, Ph, (Ni, Cr, Au, U, D) Côte d'Ivoire Au, D, Fe, (Ni, Co, bx) Djibouti - Egypt Petr, Ph, (Au, Cu) Equatorial Guinea Petr, (Au) Eritrea Au, (Cu, Fe) Ethiopia Au, (Fe, Cu, Ag) Gabon Petr, Mg, U, (Au, D, Ph) Gambia - Ghana Au, D, bx, (Mg) Guinea bx, D, Au, Fe, Ni, U Guinea-Bissau (bx, Ph) Kenya Trona, (Au, gem) Lesotho D, U Liberia Fe, D, (Au, bx, Ni, Co) Libyan Arab Jamahiriya Petr, (Ph) Madagascar Cr, gas, (bx, Fe, gem) Madeira (Portugal) - Malawi Coal, (bx, U) Mali Au Mauritania Fe, Cu, Ph Mauritius - Morocco Ph, Pb, Zn, Cu, (Ag) Mozambique Au, coal, (Cu, Pb, Fe, Ni, bx) Namibia D, Au, Ag, Cu, Pb, Zn, U, gem Niger U, Au, coal, (Ag, PGS, Cr, Ph) Nigeria Petr, Au, T, coal, (colt, Pb, Zn, Fe) Reunion (France) - Rwanda T, colt, Au, (gem) São Tomé & Príncipe - Senegal Au, Ph, (D, Fe) Seychelles - Sierra Leone Bx, D, Au Socotra (Yemen) - Somalia - South Africa Au, PGS, D, coal, Fe, Mg, Cr, gem, U, Va, Pb, Zn, Ph Sudan Petr, gas, (Au, Cr) Swaziland Fe, Au, D, coal Tanzania Au, D, gem, coal, gas, Ph, (Cu, Pb, Zn, Ni, Fe) Togo Ph, (D, Au, Mg, Fe) Tunisia Ph, gas Uganda Au, Cu, Co, T, (Ni, PGS, colt) Western Sahara (under Moroccan administration) Ph Zambia Cu, Co, Pb, T, Zn, coal, gem, (U) Zimbabwe Cr, Au, Ni, PGM, D, coal

Abbreviations : Ag: silver; Au: gold; bx: bauxite; coal: coal; Co: cobalt; colt: coltan; Cr: chromium; Cu: copper; D: diamonds; Fe: iron; gem: gemstones; Mg: manganese; Ni: nickel; Pb: Lead; Petr: petroleum; PGS: platinum group minerals; Ph: phosphate; T: tin; U: uranium; Va: vanadium; Zn: zinc

Studying the geodynamics of the East African Rift System

Skull of an australopithecine found in the Turkana Basin in the Rift Valley and exhibited at the Koobi Fora Museum and Research Base in Sibiloi National Park on the shores of Lake Turkana in Kenya. The Rift Valley is a rich source of fossils because the rapidly eroding highlands have swept sediments into the valley, creating an environment conducive to the preservation of remains

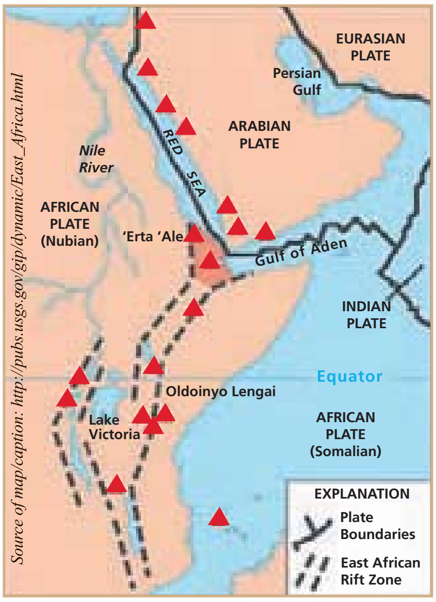
In 2002, the International Geoscience Programme (IGCP) sponsored by UNESCO and the IUGS approved a five-year project to study the geodynamic evolution, resource potential and hazard impact of the East African Rift System.

The East African Rift System extends from the Afar region (Eritrea and Ethiopia) in the north to Malawi in the south and is the best-developed active rift system on Earth. It consists of an Eastern and Western branch in the Lake Victoria area. The rifts are cut by a number of major faults, along which many of the major stratovolcanoes are positioned.

One of the world's most geologically active regions

Most of the Earth's active and recently extinct volcanoes are confined to the Pacific Ring of Fire. The second large region of active volcanoes encompasses the Mediterranean, the north of Asia Minor, the area around the Red Sea and Central Africa. Most of the latter volcanoes are confined to the East African Rift System. The system is thus one of the world's most volcanically active regions.

A number of volcanoes need constant monitoring. These include Nyiaragongo on the Congolese–Rwandan border, which erupted in 2006 causing several fatalities, Nyamuragira in Rwanda and Erta Ale in Ethiopia. Moreover, 'it is thought that a hot reservoir exists beneath Rungwe Volcanic Province in Tanzania,' observe the IGCP researchers. 'Temperatures in the gas emanating from the Rungwe vent have been increasing, suggesting that the reservoir may be about to erupt.'



Source of map/caption: http://pubs.usgs.gov/gip/dynamic/East_Africa.html

Map of East Africa showing some of the historically active volcanoes (red triangles) and the Afar Triangle (shaded part in the centre), a so-called triple junction, where three plates are pulling away from one another: the Arabian Plate and the two components of the African Plate (the Nubian and the Somalian) splitting along the East African Rift Zone

The system is also frequently shaken by earthquakes, like that of 6.8 magnitude which hit the Lake Tanganyika region in December 2005, or the 6.2 magnitude earthquake which shook the western shore of Lake Kivu in October 2002.

Evidence of the system's history and future

Rifting in the East African system is thought to have begun in the early Miocene (*circa* 23 Ma) and continues to the present day. Seismic studies show that the crust within the rift has thinned to ~20 km. In time, the East African Rift Valley may become an ocean basin, like the Red Sea and the Gulf of Aden which opened up during the Miocene. This is because the East African Rift Valley is located at the junction of plate boundaries which are pulling away from one another (divergent boundaries).

Mapping the system's geological structures…

The IGCP project sets out to answer questions like: what controls the changes in the volumes and composition of magma along the system? How do the dynamics of rifting affect resources? What are the causes and consequences of environmental hazards?

The project is creating a transnational African research linkage which will stimulate and enhance collaboration with developed countries to map the geological structures of the southwestern branch of the East African Rift System using Landsat, aeromagnetic and gravity data to establish the distribution of faults and the thickness of sediments in the rift basins. It is also compiling a set of microearthquake data using seismometers operating at earthquake monitoring stations in Botswana, Zambia and Zimbabwe.

The project is also compiling data on sedimentation patterns in terms of tectonics and palaeoclimate. It is also analysing hydrological data on the effect of abrupt changes in climate on the development of drainage during the early stages of continental drift.

…. and its rich resources

The East African Rift System contains major geological resources: minerals (some of which are rare on Earth), geothermal energy and surface and sub-surface water.

According to the researchers, 'Eastern Africa has potential to generate about 2500 MW of energy from geothermal power,' yet geothermal energy in the East African Rift System remains largely untapped. The sedimentary basins in the western branch, like the Tanganyika basin, also give indications of sediments thick enough for the generation and accumulation of hydrocarbons.

Industrial minerals found in the East African Rift System include pumice, scoria, sulphur, kaolin, gold, sulphide, carbonate rocks, phosphate, diatomite, silica and trona. Trona has many uses, including the production of soap, glass and paper. It is found around Lake Magadi in southern Kenya and Lake Natron in northern Tanzania.

In terms of water resources, the system 'houses a chain of elongated lakes that have potential for irrigation, soda abstraction, commercial fish farming and recreation. There are high prospects for developing groundwater resources for irrigation in many parts of the system, which crosses mostly dry areas.' The researchers underscore that 'lake water resources need strict protection.'

Mining and other human activities are causing hazards in rift lakes and rivers, including the Rift Valley's largest, oldest (12 Ma) and deepest lake, Tanganyika. In some of the smaller lakes, the research team has found that 'fish have been contaminated by mercury from artisanal gold mining,' making them dangerous for human consumption.

IGCP project 482/489, as it is known, is led by Ethiopian Genene Mulugeta from the Institute of Earth Sciences in Sweden; it also involves Nigerian-born Estella Atekwana from the University of Missouri-Rolla in the USA, M. P. Modisi from the University of Botswana, M. N. Sebagenzi from the University of Lubumbashi in the DRC and Jean-Jacques Tiercelin from the Centre national de recherche scientifique in France.

The project has organized two international conferences on the East African Rift System: the first in Addis Ababa (Ethiopia) in June 2004 and the second in Kampala (Uganda) in July 2007. Each conference attracted more than 100 participants from a score of countries. The Proceedings of the first have been published by the Geological Society of London and the *Journal of African Earth Sciences*. The same journal is currently publishing the Proceedings of the second.

Sources: UNESCO (2005) Annual Report of the International Geoscience Programme; adapted from the online Encyclopedia of Life Support Systems published by UNESCO and EOLSS Publishers and freely accessible to institutions in developing countries: www.eolss.net

Moving towards a majority of home-grown PhDs

The virtual collapse of geoscientific research in many African universities raises another question: who is left to monitor junior faculty members and supervise postgraduate studies? It is increasingly rare to see a senior professor supervising postgraduate students or working with junior colleagues on projects. Unfortunately, the more typical profile is the senior scholar distracted from devoting much time to graduate supervision or to monitoring junior colleagues by consultancies, project-oriented research and business meetings.

The Karoo Middleburg Mine. South Africa is the fifth-biggest coal-mining nation after China, the USA, India and Australia. Neighbouring Zambia also has large coal deposits but these are as yet largely unexploited

This neglect encourages the best students to head off-shore to complete their PhD. 'I do not need to state the obvious advantages of African universities beginning to produce the majority of their PhDs at home,' remarks Professor Kwesi Andam, former Vice-Chancellor of Kwame Nkrumah University of Science and Technology in Ghana[1].

He explains that, at his university, 'we reversed this old-fashioned trend [of Africa's good brains heading for off-shore universities to gain a PhD] by simply finding money to improve graduate student stipends and lecturer PhD supervision fees to attractive levels.' As a result, he says, 'instead of the normal 2–5 annual intake of PhD students for the whole university, we enrolled nearly 200 PhD students in three years.' Professor Andam is convinced this approach would be even more effective if African universities encouraged 'their diasporan scholars to get involved by offering their skills to help supervise PhD students.'

Tackling internal brain drain

One of the dilemmas governments face is the ease with which implanted multinational companies are able to lure geoscientists away from the public sector with attractive pay packages and career opportunities. This can have a perverse effect, with governments then finding themselves deprived of the very expert advice they need to negotiate technical questions with multinationals on an equal footing.

François Pinard of the International Centre for Training and Exchanges in Geosciences (CIFEG), a foundation headquartered in France, observes that 'very few countries have tackled the problem of internal brain drain with financial incentives.' He suggests the option of government student loans in geosciences, including in related areas like geographical information systems (GIS). 'Under this scheme, young graduates who choose to work in the public sector for a set number of years are dispensed of repaying their student loan. This scheme only works, however,' comments Pinard, 'if in tandem the government improves the attractiveness of careers in the public sector by providing young geoscientists with a decent salary and the opportunity to use and develop their expertise. One way of doing this is to support the national Geological Survey.'

Earth scientists in isolation

Today, perhaps the biggest problem facing African Earth science graduates is not the lack of basic training but rather their non-integration into the world society of Earth scientists and consequently their limited access to the latest techniques, approaches and concepts. Thus, when there are jobs to be done, both national and multinational mining and oil companies still think it necessary to bring in specialists from abroad, thereby bypassing local scientists.

Despite the crisis in geo-education, some good research is still coming out, albeit minimal. But research results of African geoscientists are rarely indexed in major international databases because they tend to be published only in local journals with very limited distribution, or not even published at all, as international journals rarely accept papers dealing with local problems. This problem is exacerbated by the inaccessibility of theses and dissertations completed in a given region, many of which contain local empirical data that are mostly unavailable in international literature.

Photo: Martin Trouth/University of Potsdam

A factory exploiting diatomite in the Kariandusi area of the Rift Valley in central Kenya. Diatomite is a chalk-like sedimentary rock composed primarily of the fossilized remains of unicellular aquatic plants known as diatoms. Diatomite is used inter alia *as a mild abrasive, as an absorbent for liquids, as a mechanical insecticide and as a component of dynamite. As it is heat-resistant, diatomite can also be used for insulation*

The inability to learn about and access African geoscientific material is frustrating to students and scholars alike. Policy-makers, government advisors and other actors, whose role it is to formulate policies, stipulate and implement guidelines and regulations based on findings from university geoscientific research, are similarly denied access to these findings. Yet opportunities are legion, thanks to the developments in information and communication technologies (ICT) for disseminating and exchanging information.

Emerging opportunities

Student attitudes have changed since the 1980s. Today, many African students tend to enrol in Earth sciences not out of a genuine interest in the subject but because of lucrative job prospects in mining industries, or after having failed to gain admission to first-choice disciplines offering similar salary opportunities.

This is regrettable, as Earth scientists are arguably more pertinent now than ever before for Africa's development. Rapid urbanization and fast population growth will lead to sprawling megacities. By 2015, a number of African cities will count a population of over 5 million, including Abidjan, Cairo, Johannesburg, Kinshasa and Lagos. Urban areas are often concentrated on narrow coastal strips where land is scarce and comes with a high price-tag. More and more, architects will be wishing to build deep rather than high. Qualified geoscientists will be needed to assess the suitability of new building sites but also for other tasks like designing waste and groundwater management systems or identifying sites vulnerable to geohazards.

Much of Africa is subject to heavy rains. Despite this, many governments economize on a geological study at the time of planning construction of a road or highway. This is short-sighted: with the incorporation of sufficient drains at the time of construction, rainwater can be evacuated properly,

Africa's geoheritage:

a potential goldmine for geotourism and education

Across Africa, there are countless examples of landscapes, rocks and fossils which hold the key to understanding a particular moment or period in the history of the Earth. There are at least three good reasons for conserving this geoheritage. Firstly, each site is unique. Secondly, geosites have intrinsic value for aesthetic reasons or for the development of ecologically responsible geotourism. Properly managed, these sites can generate employment and new sources of income. Thirdly, geosites are an open-air classroom for learning about the natural world and its past, as well as human history. Geosites can also explain why human activities like mining form an integral part of the natural world.

With the notable exception of South Africa, only a small community of geoconservationists in Africa has provided an inventory of national geosites to date, in Kenya, Namibia, Tanzania and Uganda.

UNESCO launched the Global Network of National Geoparks in 2004 to provide a platform for active cooperation between experts and practitioners in geoheritage. Under the umbrella of UNESCO, important national geological sites gain worldwide recognition and benefit from the exchange of knowledge, expertise, experience and staff with other members of the global network. As yet, none of the 54 national geoparks in 17 countries is located in Africa but several African countries have expressed interest in joining the network.

Some geoparks are also part of a UNESCO biosphere reserve and/or have been inscribed on UNESCO's World Heritage List. The IUGS proposes cooperating closely with UNESCO's Geoparks programme to protect geological heritage via its own Global Geosites Project launched in 1996.

For details: www.unesco.org/science/earth/geoparks.shtml

Engraving of two huge giraffes in a sloping slab of rock in Niger. These petroglyphs and others of elephants, addax, oryx, gazelles and ostrich are probably 6000–8000 years old and date from a time when the Sahara was greener. This site is situated within Aïr et Ténéré, an area covering 24 million ha which has been a UNESCO biosphere reserve since 1997; 8 million ha of Aïr et Ténéré were inscribed on UNESCO's List of World Heritage in 1991 and, just a year later, on the List of World Heritage in Danger

Wadi Al-Hitan, or Whale Valley, in the Western Desert of Egypt, is unusually rich in fossil remains of the earliest sub-order of whales, Archaeoceti, now extinct. About 40 Ma, these fossil remains were trapped in sandstone which formed the seabed during the Eocene when this part of Egypt was under water. The fossils found here show the youngest archaeocetes in the last stages of losing their hind limbs. These fossils tell one of the major stories of evolution: how the whale emerged as an ocean-going mammal from its previous life on land, before evolving into the two types of modern whale. Wadi-Al Hitan was inscribed on UNESCO's List of World Heritage in 2005, soon after the discovery of the first complete skeleton of an 18-m long serpentine archaeocete, Basilosaurus isis. *In the picture on the left, the whale excavation site is ringed with stones* rendering roads impermeable to flooding and landslides, and avoiding costly maintenance. These drains, or culverts, can always be incorporated after construction, of course, but at a much greater cost.

One emerging debate Africa cannot afford to ignore is that concerning carbon capture and storage in geologically suitable repositories on land to enable the use of fossil fuels like oil, gas and coal without releasing carbon dioxide (CO_2) into the atmosphere and thereby contributing to global warming. Although the editorial published in *Nature* in August 2006 targeted the G8 countries and China in particular, the world's biggest CO_2 emitters, the journal's counsel to countries 'to tell their energy industries in no uncertain terms that carbon production will cost them and that sequestration is a partial solution available in the short term' was also directed at Brazil, India, Mexico and South Africa. One can easily imagine how this issue will become pertinent to other African countries in coming years as they develop fossil-powered industries.

The Big Hole in Kimberley (South Africa) is more than 1 km deep. A former diamond mine, it has now become a museum

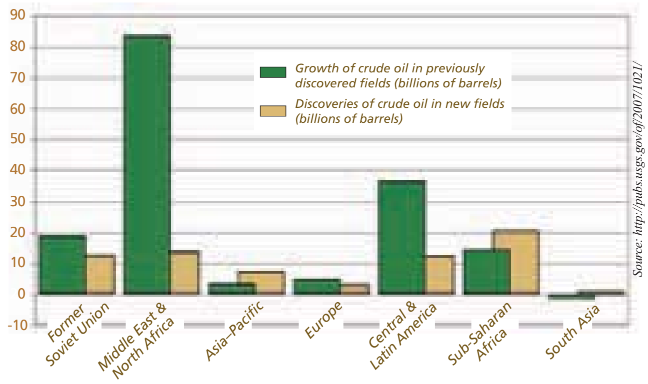
Another example of the need for African geoscientists to integrate the world community is the intergovernmental project launched in 2003 to build a long-term, comprehensive system of Earth observation by 2015 known as the Global Earth Observation System of Systems (GEOSS). To date, 15 of the 71 member countries of the project's pilot Group of Earth Observations are African. Obviously, these African countries need to be able to provide expertise in remote sensing and *in situ* observation if they are to contribute effectively to this initiative and draw maximum benefits from it.

Short-term international exchanges and other forms of cooperation can help staff and students acquire new knowledge and skills while giving their work greater international exposure. 'One of the most ambitious international co-operation programmes today to my knowledge,' says Pinard, 'is the European Union's Seventh Framework Programme, which encourages African participation. One example is the Euro-African project being launched in Arusha (Tanzania) in May this year to develop a Pan-African observing system for African georesources by 2015. Known as AEGOS, the two-year project is a contribution to GEOSS.

International research projects can help to identify opportunities at the national level. After participating in a French-funded project known as MAWARI involving scientists, students and water authorities from Djibouti, Ethiopia, France and Kenya, the Department of Earth Sciences at the University of Nairobi recently decided to introduce a specific hydrogeology course. The MAWARI project had targeted the complex issue of groundwater management in the volcanic context of the Rift Valley.

The way forward: specialization and networking

Specialization in fields such as remote sensing and GIS for geohazard mapping and other purposes, hydrogeology, engineering geology and micropalaeontology, accompanied by some practical orientation even at undergraduate level, will no doubt enhance the chances of African Earth science graduates securing jobs in the mining, engineering and water sectors, or in other relevant areas.



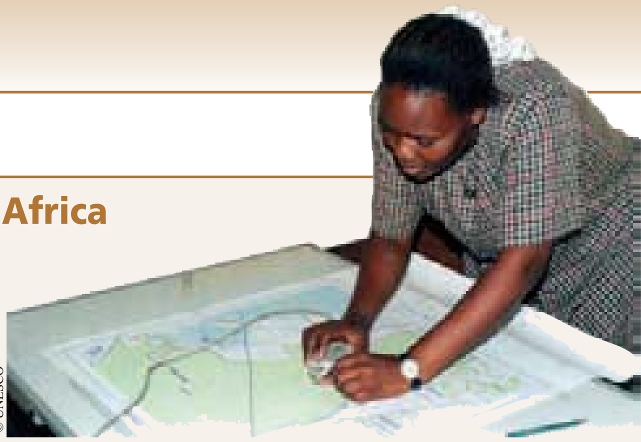
Additions to world crude oil reserves between 1996 and 2003. The greatest contribution from new-field oil discoveries came from sub-Saharan Africa

Governments themselves need to recognize the importance of these sectors for their country's socio-economic development by providing the requisite funding and infrastructure. Unveiled last June, Ethiopia's new science policy[2] acknowledges that neither the quality nor the quantity of most of its mineral deposits is fully known, despite tangible evidence of petroleum, natural gas, platinum, copper, nickel, iron ore, tin, zinc, coal and potassium. The policy recommends setting up research centres in the mining, water and energy sectors.

The establishment of regional networks linking existing national institutions and other agencies has been suggested as a means of upgrading the teaching of Earth sciences and providing specialist training in the latest techniques and concepts. The basic objective of a regional network is to strengthen national facilities and institutions through regional programmes and activities and to spread the benefits of the network's activities to all institutions in the respective region.

Networking is also a way of keeping scientists in touch with the international geoscience community. This serves both to stimulate African research and to ensure that the quality of their work earns the recognition it deserves.

Sharing geo-information across Africa



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Digitization of data for inclusion in the African Marine Atlas, at the Kenya Marine & Fisheries Institute in Mombasa

Pan-African Geological Information System (PANGIS)

UNESCO uses ICTs to make geo-information and data available to 32 African countries* through their Geological Surveys and universities. Via PANGIS, set up in 1987 with CIFEG, partners use UNESCO software and personal computers to reorganize their bibliographical and factual geodata handling, thus making them more accessible to scientists and engineers from other disciplines, as well as to managers and policy-makers. Geological Surveys and universities also receive assistance in setting up GIS and using modern technology for geological research, such as satellite imagery for remote sensing.

African Marine Atlas

From May 2006 to February 2007, a team of Earth scientists within the marine data management group of the UNESCO-IOC's Ocean Data and Information Network for Africa (ODINAFRICA) collected marine and coastal datasets for the African Marine Atlas. Using published and unpublished sources, hundreds of basic datasets – many of them global in scope – were painstakingly edited down to an agreed-upon area of interest for the African continent, converted to GIS formats, documented then posted on the open access Atlas website. The Atlas acts as an online library of GIS-compatible data covering the geosphere, hydrosphere, atmosphere, biosphere, human environment and base maps. Examples of available layers are diatom algae and whale shark populations, mangroves, Reefbase coral reef locations, marine ports, maritime boundaries, sea-level measuring stations, coastal hotels and marine optical fibre submarine cables. Data in the geological field cover geological provinces of Africa, tsunami and earthquake sites, minerals, ocean drilling programme sites, sediment thickness, land cover and soils, etc.

Putting together the Atlas – which is regularly augmented with new datasets – involved a team of 16 marine scientists and GIS experts from national oceanographic and data information centres in Benin, Ghana, Kenya, Mauritania, Mauritius, Mozambique, Namibia, Senegal, Seychelles, South Africa and Tanzania.

TIGER

Launched by the European Space Agency in 2002, TIGER helps African countries overcome problems they face in collecting, analysing and disseminating water-related geo-information by exploiting the advantages of Earth observation technology. The initiative involves more than 150 African organizations, water authorities, remote sensing centres and universities.

UNESCO participates in TIGER via the Geological Applications of Remote Sensing programme it co-sponsors with the IUGS and via its International Hydrological Programme. UNESCO's Regional Bureau for Science in Africa, in Nairobi, has hosted the TIGER Executive Bureau since March 2007.

UNESCO Chairholder in Water Resources in Sudan, Dr Kamaluddin El Siddig Bashar, leads a team which is putting in place a system for flood forecasting, early warning and preparedness in the Gash River basin using space technology. The River Gash is a source of frequent terror for the inhabitants on both sides of its banks. Shared by Sudan, Eritrea and Ethiopia, it experiences flooding about every one to three years.

Another TIGER project involves the UNESCO-IHE Institute for Water Education in the Netherlands; it focuses on transboundary water allocation and conflict prevention in the Incomati River Basin shared by Mozambique, South Africa and Swaziland. The project estimates the rainfall–runoff relationship and monitors water use via Earth observation analysis.

African Journal of Science and Technology

UNESCO facilitates the dissemination of research results across Africa through a grant to the *African Journal of Science and Technology*. The journal is published biannually by the African Network of Scientific and Technological Institutions (ANSTI), hosted by UNESCO's Nairobi's Office .

The journal's Chief Executive Editor is Prof. Norbert Opiyo-Akech, a geologist from the University of Nairobi who is a former Dean of the Faculty of Natural Sciences. One of the journal's six subject editors, Dr I. K. Njilah, is affiliated to the Department of Earth Sciences at the University of Yaoundé in Cameroon.

Last June, the journal published an article by scientists from the Department of Geology at Makerere University in Uganda on the potential for gold mining in greenstone belts of southeastern Uganda.

To read the journal: www.ansti.org
To consult the Atlas: www.africanmarineatlas.net; m.odido@unesco.org
on PANGIS: Thomas.Schlueter@unesco.unon.org ; www.cifeg.org (in French)
on TIGER: www.tiger.esa.int; www.unesco.org/science/earth;
www.unesco.org/water; www.unesco-ihe.org/

* *Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Chad, Congo, Djibouti, Ethiopia, Gabon, Ghana, Guinea, Kenya, Lesotho, Madagascar, Malawi, Mali, Morocco, Mauritania, Mozambique, Niger, Senegal, Sierra Leone, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe*

Turning crisis into opportunity

Earth scientists in Africa should perceive the present crisis as an opportunity for progress. The prescription for the renewal of Earth science education on the continent offers an ideal occasion to develop a realistic vision of African society, renew confidence in human dignity and worth, and improve training and education.

Ideally, scientists from the developed world should consider their counterparts in the South as full and equal colleagues but this is often not the case. This is especially important in terms of the acquisition, handling and sharing of large and frequently disparate datasets.

Considerable responsibility also rests on the shoulders of geoscientists living in Africa to communicate with one another. They should not only welcome colleagues from beyond their country's borders with open arms but also engage in collaborative projects with them to improve understanding of the natural laboratory beneath their feet.

In education, a system should be instigated which rewards effective teachers, as at Kwame Nkrumah University of Science and Technology. In parallel, students need to evolve in a positive learning environment. A first step towards creating such an environment – and one which demands little or no financial investment – is to inculcate in students that learning is important, enjoyable and beneficial not only for themselves but also for the sustainable development of the society in which they live.

Thomas Schlueter[3] and Theophilus C. Davies[4]

1. *Professor Andam made these comments in ANSTI's Annual Report for 2006. He is Chair of the ANSTI Governing Council*
2. *See* A World of Science*, July 2007*
3. *UNESCO Regional Bureau for Science in Africa, Nairobi, Kenya: Thomas.Schlueter@unesco.unon.org*
4. *Department of Geology and Mining, University of Jos, Nigeria: daviestheo@hotmail.com*