Earth Sciences in the 21st century:

A forward look: 18th January 2010


Impressions and comments

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I began by complimenting UK earth science. The general view in Europe is that involvement by UK scientists is critical to the success of geoscience programmes - if UK scientists are not involved, there are questions about the worth or utility of a programme. UK scientists are well sought after - their endorsements are valued. However, UK scientists are less well known for their enthusiasm for international programmes than for their individual innovation ("often formulated on the back of a cigarette packet"). Furthermore, UK funding agencies in international science is justifiably judged to be unreliable, even when a substantial number of UK scientists are positive about participating in an EU or international programme. At this stage I mentioned ESF's EUROCORES programme, but there are many other examples (e.g. basic UK support for international organisations - IUGS, IUGG etc.) for which the UK was alone in its weak or zero endorsement.

It is important to recognise that the objective of the Earth Sciences Workshop was to enhance the level of funding in NERC's targeted / strategic research programmes and not to maintain its support for so-called "blue skies" or other (e.g. graduate student) funding mechanisms. The idea that the workshop should not try to be too "prescriptive" in its planning was not, in my view, likely to lead to new targeted / strategic money. Exciting new goals / objectives would be key to securing additional targeted/strategic funding. Nevertheless, the following common themes of all breakout groups need to be highlighted at the beginning of any document that results from the Earth Sciences Workshop:

1. need high quality graduates and post-graduates in the geosciences - there seemed to be 2 views - (i) the basic or core skills (maths, physics, chemistry, geological mapping etc.) need to be protected or even enhanced (plea from oil industry and certain academics) and/or (ii) the skills need to be broadened (plea from those interested in earth system science) - without increasing the training period, attaining both (i) and (ii) will be difficult;
2. the idea of an alternative training programme to the standard BSc, MSc and PhD did not attract much support;
3. like most other sciences, the geosciences have benefited enormously from new advances in forward modelling and inversion, which result from advances in computer codes and ever more powerful computers - our models are becoming much more realistic (mostly 1-D twenty to thirty years ago depending on the method, but mostly 2-D, 3-D or even 4-D today);
4. for some techniques our modelling and inversion capabilities are far ahead of the quality and volumes of data we are capable of acquiring;
5. like most other sciences, the geosciences have benefited enormously from the development of new types of equipment (e.g. fundamental new sensors, aircraft-, ship- and satellite-mounted systems, more powerful mass spectrometers etc.);
6. like most other sciences, the geosciences have started to approach problems using integrated multidisciplinary strategies.

FLUIDS

A theme that was common to many of the break-out groups' conclusions was fluids, which, of course, has been the subject of research both broad and in depth for the past 3-5 decades. Maximum fluid flow is the objective of hydrocarbon and hydrological exploration, whereas minimum or zero fluid flow is the objective of

nuclear waste and carbon sequestration programmes. Directions and magnitudes of potential fluid flow need to be predicted. Fluid flow at a variety of scales from nanometre (or at least micrometre) to macroscopic need to be considered. In the distant past, much was done on fluid transport and retention. Emerging frontiers include the need to account for multi-phase aspects and rock-fluid interactions (physical, chemical, geothermal and even biological). These issues need to be addressed in shallow and deep magma systems, fractured and intact rocks, consolidated and unconsolidated sediments, and soils.

Fluid transport, retention etc. relate to the exploration and exploitation of oil/gas and water supplies, nuclear waste disposal, geothermal energy, creation of metallic minerals, carbon sequestration etc.

RESOURCE SECURITY

Resource security was clearly a major theme worth pursuing: oil/gas and water supplies, nuclear power generation, geothermal energy, creation of metallic minerals. A full life-cycle approach needs to be considered for sustainable development, rather than simple extraction - leave a big hole/cavern in the ground - move on. The role of microbial systems in improving oil/gas and mineral extraction was mentioned a number of times (I am only familiar with microbes/bacteria being used to speed up landfill and other remediation).

PROBABILISTIC HAZARD AND RISK

Probabilistic hazard assessments have become more sophisticated and perhaps more robust over the past decade. Future research endeavours will go a major step further by concentrating on probabilistic risk (i.e. hazard X vulnerability; e.g. the recently launched GEMS project). In my view, this important but narrow theme is unlikely to develop into a major NERC strategic initiative, but could benefit from a "virtual" centre of excellence approach.

CLIMATE CHANGE AND NATURAL HAZARDS

I was quite surprised at the mileage one could get out of the "climate change and natural hazards" theme (rockfalls, landslides, increase in volcanic eruptions due to changing surface pressures, earthquakes as a result of crustal rebound due to melting glaciers, gas hydrate release, coastal erosion, floods etc.). Consider the almost overwhelming concentration of climate-change effort in the targeted / strategic themes, this topic is worth pursuing. However, one should not oversell some of these issues (e.g. the largest earthquakes that result from glacial rebound are likely to have magnitudes 2 to 3 lower than the largest tectonic-induced earthquakes).

HUMAN ROLE IN SOLID EARTH PROCESSES

This seems to be a novel theme (of course, it has been mentioned and researched before, but not on a large scale). Issues mentioned included climate change, slope stability, managed (or mis-managed) river paths, effects of dams. In many regions human intervention has had positive effects.

INFLUENCE OF DEEP EARTH ON THE SURFACE

This theme related to the dynamics of the earth's interior and its surface manifestation - I mentioned that this was the theme of TOPO-EUROPE, a EUROCORES programme that was not well received in the UK - one participant stated that he was not positive about TOPO-EUROPE because he thought it set out to prove one theory - I responded that this was certainly not the case.