The Fruits of Curiosity: science, innovation and future sources of wealth: response from the British Geophysical Association

The British Geophysical Association (BGA) is a Joint Association of the Geological Society of London and the Royal Astronomical Society.

The aims of the BGA are to promote the subject of geophysics, and particularly to strengthen the relationship between geology and geophysics in the UK, by holding meetings and courses, by encouraging the publication of the results of research, and by such other means as are deemed appropriate to an Association by the parent Societies. The BGA welcomes the Royal Society 'Fruits of Curiosity' inquiry and offers its services now and as the work progresses. Our response is aligned to the set of questions listed in the consultation document:

3. What are the emerging fields of science and research where the UK has, or could soon have a position of global leadership?

   Geophysics - the application of physics to the study of the Earth and its Solar System environment – is a broad subject, but one in which the UK is a world lynchpin. However, the BGA has in the past three years reported (Khan 2006) that the UK is part of a global trend of shortage of geophysics specialists in academia and industry, partly because young people make career choices ignorant of the existence and nature of the subject. This shortage undoubtedly threatens the UK's leadership position in geophysics. The greatest "fruit" of our continued involvement is the inspiration of school pupils and university undergraduates to choose to enter geophysics as a career, in research, industry or government service.

4. Could a similar leadership position be achieved through strategic alliances with other partners in Europe or internationally?

   and

7. How can policy balance the need for return on investment with the long-term and often unpredictable pathways between research and its eventual economic or social benefits?

   There are many subfields of geophysics in which curiosity-driven research is also closely aligned with societal needs. In geomagnetism and solar-terrestrial relationships, monitoring and research spin off into protecting global communications and electrical infrastructure from the effects of solar disturbances. Seismology has been driven by the needs of oil and gas exploration to greater and greater precision and accuracy of subsurface imaging techniques: these techniques are now being applied to the entire Earth right down to the inner core in the quest to understand the formation and evolution of our planet. Electrical and electromagnetic prospecting, well known as archaeological tools, are applied to oil exploration and monitoring the movement of contaminated groundwater and, along with magnetotellurics (the measurement of naturally induced electric currents in the Earth) to deep imaging of active faults and the lower crust. Ground-probing radar, which is at the

crossroads of seismology and electromagnetism, is used for geoforensics and ground and structural stability investigations. Geodesy is used for the measurement of sea level, Polar ice changes, and deformation due to engineering and natural geohazards. Gravity has benefited from measurement technology advances that allow tiny variations to be used in the detection of underground voids and mineral deposits. In all of these fields, groups of UK-based scientists are carrying out world-class research, often in international collaborations. Such collaborations are natural, if not essential, to gain funding for global or international datasets, since geophysical phenomena are unrestricted by political boundaries.

9. What role will research play in accelerating the shift towards a low-carbon economy, and addressing the environmental challenges of the next 20 years?

   Geophysicists play a crucial role in monitoring and remediating in a number of environmental and Earth resources challenges. These include:

   - Climate change – monitoring and mitigation (e.g. carbon capture and storage underground)
   - Global sea level change – monitoring; predicting the effect of local remedial actions
   - Tackling the increasing demand for oil, gas and mineral and rock resources – detecting and predicting reserves and predicting and remediating the aftermath of extraction (e.g. subsidence)
   - Groundwater resource exploitation and contamination – detecting, predicting the effects of exploitation
   - Earthquake- and volcano-caused natural disasters – prediction, monitoring and warning
   - Prevention and effects of nuclear warfare, accidents and waste disposal – detecting weapon tests; predicting global effects, contamination transport and the geological future of storage sites

   It is worth emphasising that many lines of geophysical research depend on long continuous datasets, e.g. sea level, earthquake occurrence, the geomagnetic field, weather and river flow. If Government and private investment in this work is even temporarily halted by the current economic downturn, then one of the worst long-term consequences is the discontinuing or interruption of these data. If the UK also becomes an unreliable partner in international collaborations then this leads to not only loss of immediate access to data by British scientists but also a loss of UK influence on decisions of how and where to collect data and which avenues of research to pursue.

18. How can the education system deliver (sufficiently) appropriately skilled, knowledgeable and globally employable future generations of scientists and mathematicians? What changes and / or resources need to be in place to achieve this?

   Like the rest of the physics community, the BGA is very concerned by the continuing shortage of secondary school teachers who are physics graduates. The Association urges the

Government to continue to provide financial incentives to encourage the best graduates to enter the teaching profession.

A specific concern of the geophysics community is that careers in our area are not being promoted in schools and universities. Many students are consequently unaware that industry and academia face a severe shortage of people in this area and of the opportunities presented by such a career.

The 2006 Khan report for the BGA on ‘Geophysics Education in the UK’ (see www.geophysics.org.uk) suggested a number ways in which the Research Councils could act to address this issue, including through public engagement in our science. One good example of this is the Schools Seismology Project, where pupils and teachers are introduced to geophysics by the installation and operation of a seismometer. This has been taken up by a large number of schools and is highly successful.

In line with the conclusions of the Khan report, we suggest that deeper engagement with schools, using a variety of geophysical techniques and fields of investigation, could raise the profile of geophysics and science as a whole with pupils and teachers alike, and should be planned and (financially) encouraged. We therefore urge the Fruits of Curiosity Advisory Group to highlight this concern in its final report.