Investigating Earth Science
or
'What has the British Geological Survey ever done for teachers?'

Dr David Bailey, Head of Outreach, British Geological Survey

Outreach activities have been part of the British Geological Survey's (BGS) mission from its earliest days. In recent years, improved liaison and dialogue with organisations like ESTA and ESEU, alongside initiatives from central government, such as the Science and Engineering Ambassadors scheme, has raised the profile of educational activities within the organisation and helped us to focus more clearly on teachers' requirements.

The aim of this article is to discuss the BGS's perspective on geoscience education, review how the BGS is supporting earth science education, and outline what the future may hold. I hope also to show some of the benefits that a geological survey organisation gains by promoting earth science education. Finally, I will look ahead to potential developments and ask what else we can do.

The museum era

The Geological Survey of Great Britain was established in 1835 and very soon afterwards its first Director, Henry De la Beche, persuaded the Chancellor of the Exchequer that it would be to Britain's advantage if there was a museum for the display of economically important rocks and minerals. The suggestion was approved by 1837, and the 'Museum of Economic Geology' opened in 1841 in Whitehall. In May 1851 the collections were rehoused in Jermyn Street, where there was more space, under a new name, the 'Museum of Practical Geology'. However, this building had been badly constructed and eventually had to be demolished so the Geological Museum moved to South Kensington in July 1935.

The Survey in Scotland was controlled from London until 1867, when an Edinburgh headquarters was established in the Museum of Science and Art, later the Royal Scottish Museum.

The Survey's close association with museums in our early days was part of the great Victorian tradition of public education. Important collections of geological materials were displayed alongside the industrial products derived from them and the latest scientific interpretations and discoveries.

Museums continue to be valuable educational resources, but the maintenance of permanent, publicly accessible collections is an expensive business. When the Survey finally moved out of London in 1985, the Geological Museum was transferred to the Natural History Museum, along with its mineral and gemstone displays and some other collections. This marked a significant change in BGS's approach to education and outreach and the end of an era lasting nearly 150 years.

Resources

Educational outreach is recognised as an important element of BGS's mission. The range of our activities is constrained partly by our budget and partly by our relative lack of expertise in teaching, especially in schools. After all, most of our scientific staff are recruited for their research abilities. But the ability to communicate our

science in jargon-free language is a skill that is increasingly valued. And the need to engage with all our 'stakeholders', including teachers and learners, has now been recognised as a duty for all our staff. On the positive side we have excellent resources: an unrivalled pool of geoscientific expertise and nationally important collections of rocks, minerals and fossils assembled over more than 170 years

'Traditional' publications

The traditional means of communicating BGS science, established over many decades has been through geological maps, memoirs and reports. However, it has been said that less than half a percent of the population can understand a geological map! It iis undeniable that our memoirs and reports are aimed chiefly at the professional geologist, while regional guides are suitable for advanced students, well informed amateur geologists, and professional geologist seeking an overview of a region. None of these publications was designed for the educational market.

Popular publications

In the 1990s it was realised that our publications were reaching only a narrow sector of the population and that we were mainly communicating with other geologists. This failure to address a broad range of audiences was exacerbated by the major decline in the number of students taking sciences and, in particular, geology. Several geology departments in British universities were closed while others became attached to geography departments, degree courses changed and the graduates did not necessarily have the skills that the BGS required. Our source of new graduates was disappearing.

We began to publish popular publications on fossils, the geology of popular holiday destinations, books on volcanoes and earthquakes and a magazine, *Earthwise*, aimed at a popular market, in addition to our high-level academic and professional print products. The aim was not altruistic. We hoped to encourage young people to consider science, particularly geology, as a career, ensure the future competitiveness of UK industry and to broaden our own pool of recruits.

Unfortunately, despite these publications being well received, sales could not match those published when we had a steady stream of museum visitors and proved insufficient to justify the costs of publication at a time of tight budgetary constraints. New publications would only be commissioned where sales or sponsorship could be guaranteed to cover the costs. The exception is *Earthwise* magazine, which is still published and distributed free of charge in print and on our website (www.bgs.ac.uk).

Formal liaisons

Today the need to educate the general public, and especially to inspire young people about earth sciences is, if anything, even more acute. In recent years the government departments responsible for science education, have joined with industries, universities and others to express their concern about the numbers of students taking up science in schools and at university. There are fears for the eventual impact on scientifically and technologically based industries and therefore, ultimately, the economy (All-Party Parliamentary Group for Earth Sciences / Earth Science Education Forum for England and Wales. 2004).

The BGS has formal liaisons with several national organisations who share a common interest in promoting the earth sciences. As you will be aware, the ESTA Annual

Conference was held at the BGS headquarters in Keyworth in 2002. That conference was a very positive experience for the BGS scientists involved, and was a timely reminder of the role of the education sector as an opinion-former and stakeholder in the earth sciences.

The renewed sense of partnership arising from the 2002 conference led to the signing of a memorandum of understanding between the BGS and ESTA for mutual support and the sharing of ideas, best practices and resources. The ESTA archive is now permanently housed in the National Geoscience Data Centre at Keyworth.

The BGS has been represented on the Scottish Earth Science Education Forum (SESEF) and the Earth Science Education Forum for England and Wales (ESEF), since their inception in 2001 and 2002, respectively. We became a corporate member of the Science, Engineering, Technology and Mathematics Network (now known as STEMNET) in 2003 to demonstrate our support for their aim 'to ensure that there is a flow of well-motivated, high quality people from school who have an interest in, and understanding of, STEM'.

National schemes

The BGS participates in a number of national schemes such as National Science and Engineering Week, the Engineering Education Scheme, and Creativity in Science and Technology (CREST) awards.

At Keyworth the annual 'Fossil and Rock Show' has been a regular Science Week event for many years and attracts up to 1000 children at Key Stage 2 from across the East Midlands. Rockwatch are regular contributors to this event and for several years we have supplemented the schools event with a family day branded as a Rockwatch event. Recent years have also seen 'Water Detectives' events for children at Key Stages 2 and 3 at Wallingford (in conjunction with the Centre for Ecology and Hydrology).

We have mentored several successful projects under the Engineering Education Scheme. Much of our science depends on developing new equipment and techniques and sixth-form students have had the opportunity to design and build prototype equipment that may eventually be used in major research programmes involving international collaborators. In other words, these are not hypothetical exercises dreamt up to occupy students, but can represent substantial contributions to our science. We also provide mentoring and projects for students with Nuffield Science Bursaries.

Science & Engineering Ambassadors

The Science and Engineering Ambassadors (SEAs) scheme is another national initiative, and is STEMNET's flagship programme. SEAs are enthusiastic, vetted volunteers who work with young people and teachers in schools. The BGS has been involved in the scheme from the initial consultation phase and has a growing team of 'Ambassadors' — currently more than 70 based at our Keyworth, Edinburgh, Wallingford and Exeter offices and also at GSNI.

The scheme is a high priority element of our outreach programme and provides a framework for events intended to inspire young people and provide scientific role models. We believe that staff benefit as much as the young people involved from the

experience of motivating, enthusing and communicating. SEA activities include hands-on demonstrations with a geological flavour through to interview skills workshops, and the development of enterprise skills, such as team-building and project planning. Our most popular enterprise activity is a role-play exercise in which students discuss the geological, economic and sociological consequences of the eruption of the Soufrière Hills Volcano on Montserrat. Students take on the roles of key personalities in the event, such as scientists at the Montserrat Volcano Observatory, government officials, and members of the public. The scenario is that the volcano is restless, the island's Governor is due to be briefed in an hour and they must decide whether to evacuate the area and close the airport.

In 2006 both ESTA and the ESEU generously provided training for our SEAs in communicating science to schools (see Bailey, King and Whitburn 2007). This was a valuable example of the benefits of working in partnership and one which we hope to repeat. ESTA's expertise at the 'chalk face' is of particular value to us. Our scientists have much to learn from your experience in communicating science to the most challenging and questioning audiences.

Most of our face-to-face interaction with schools is, naturally, relatively local to our offices although we do try to provide a service at a regional scale. This is mainly provided by SEAs visiting schools to facilitate activities for children, running work experience placements and providing advice at careers events. Schools are also invited to visit our offices, for instance during our annual Schools Week at Murchison House in Edinburgh, or under visits organised through the Industrial Trust. Such visits often do not have an overtly earth science theme, but are designed to complement ITC or chemistry elements of the curriculum, though a geological component is always present, albeit in disguise.

A relatively recent initiative is a professional development workshop on Hazard Mapping for geography teachers, providing an update on new techniques and discoveries. The pilot, held in 2006, was organised in partnership with Education Leeds, who arranged travel and teaching cover for delegates. The workshop received excellent feedback, for instance: "An excellent day. One of the best courses I have been on in a long time", and "Very useful…Great examples. Great for coursework". As a result of this positive response, we held a further three workshops in 2007, two of which were organised through the East Midlands Regional STEMNET (through the Lincolnshire and Rutland Education Business Partnership). This promises to be a cost-effective way of transferring our knowledge to many children via their teachers and we hope to repeat the hazard workshop and to add new subject areas, so please pass on your ideas.

Celebrity Rock Idol

Alongside our ongoing activities, such as SEA school visits, we also run special projects. In 2006 we were successful in helping Richard Bonington Primary School in Nottingham to win a Royal Society Partnership Grant to support a project called 'Celebrity Rock Idol'. This was designed to bring creativity to the teaching of science projects to Year 5 children using a familiar TV show format. Children chose a rock to 'idolise and adore', researched it and worked with BGS scientists to reveal each rock's special and unique properties.

The grant allowed the school to buy samples, microscopes and other equipment and to visit our research facilities where they were able to view their samples in thin section and under the scanning electron microscope and carry out tests in the engineering properties laboratory. The project finale was a series of presentations in which children made the case for their rock to be the 'Celebrity Rock Idol' through imaginative presentations to their peers and an 'expert' panel. One of our SEAs, Sue Wheeler, played the 'Sharon Osbourne' role and the eventual winner was 'Schist'.

We have just been successful in winning a further grant to repeat the project in expanded form with other schools, and Richard Bonington School has been able to buy resources that they will be able to use for many years.

UK School Seismology
This project was launched at the Institute of Physics in May 2007. It is described in detail in another TES article by Paul Denton. In summary, it is designed for secondary schools and aims to establish a network of schools with their own seismometers. Students will be able to measure major earthquakes occurring around the world and exchange and compare their data with other schools and professional seismologists. The project was established with a grant from the National Endowment for Science, Technology and the Arts (NESTA) with support from the BGS. We are now funding the roll-out phase in partnership with the Science Enhancement Programme and with support from a number of industrial and academic partners.

'Quarry or Not?' Challenge Day
In July 2007 BGS hosted a Challenge Day for Year 12 students from across the East Midlands. Students were presented with a fictitious scenario that involved the proposed development of limestone quarry close to a National Park. The aim was to heighten students' awareness of how society makes difficult decisions — in this case, balancing the need for raw materials such as minerals, which we need to maintain our economy and lifestyle, with the need to protect our environment. The exercise involved teamwork, time management, critical thinking, analytical, numerical, comprehensive, presentation and debating skills. The day culminated in a real life planning inquiry, in which group leaders presented their case in front of a panel of three 'inspectors' — all real life professionals working on minerals issues.

Working through partnerships
Educational networks provided by such organisations as local museums, the ESEU, the Workers' Educational Association and Rockwatch allow us to reach a larger and more diverse range of people over a much wider area than would otherwise be possible. An added advantage is that the input from such organisations ensures BGS resources and expertise can be better tailored to the requirements of a particular or local audience.

Recent examples have included the Outer Bristol Channel project, co-funded with other bodies including the National Museum of Wales, which included a CD-ROM of educational resources, *Explore the Sea Floor* and exhibit at the museum's galleries in Cardiff.

Another example is the Xplore Active Gallery at Mansfield Museum. This provides hands-on activities aimed at children, especially school parties, exploring

environmental issues such as recycling and sustainability. We provided geological advice, core samples and customised maps of the local geology to enhance the displays. A spin-off of this partnership was an invitation to contribute geological information to displays at a visitor centre in south-west England.

Partnerships with publishers who already have access to mass markets should be an effective way of getting earth science to a wider audience. Harvey Maps in collaboration the British Mountaineering Council have produced an excellent series of 'British Mountain Maps' which have won several awards. They are aimed at climbers and hill-walkers and, in addition to being waterproof and virtually indestructible, feature geological maps and descriptions on the reverse which have been specially designed by the BGS. The Lake District map has proved especially popular, having already sold out its first print run. Other maps in the series already include Snowdonia, The Dark Peak, and Ben Nevis and Glen Coe.

Geoparks and geotourism

The BGS is pleased to have collaborated in the successful launch of several Geoparks in the United Kingdom. One example is Fforest Fawr Geopark in South Wales, which joined the UNESCO global network in October 2005. Fforest Fawr Geopark has an excellent geological landscape, with Devonian and Carboniferous rocks, a geomorphology that was carved out during the last glaciation and the Welsh National Showcaves. It is therefore important for its scientific quality, attractive landscapes for geotourism, and educational value. Geoparks organise events throughout the year which provide a platform for our educational outreach activities, allowing us to reach new audiences. They also actively publish books, trail guides and other material intended to help stimulate geotourism, many of which have been written by, or with input from BGS experts.

Website

The growth of the Internet has given us a vehicle with the potential for reaching an almost limitless audience. The BGS website currently receives over 1.5 million visits each year and one of the most visited sections is the area devoted to education and popular geology. These pages are aimed principally at schools, undergraduates and amateur geologists. Where appropriate, we have developed the content with the National Curriculum, but have not been constrained by it and include a broad cross-section of geological topics.

Some sections arise as outputs from scientific projects; others address an area of general interest. Our plans for the future include improving the information for teachers and making the links to the National Curriculum more explicit, as well as developing new resources.

Pages which have proved most popular include:

- Make-a-Map, a simple interactive geological map of the British Isles;
- a geological timechart, based on the recommendations of the BGS's stratigraphical committee;
- a multimedia, interactive Geological Timeline;
- Ask-about-Geology, a free enquiry service aimed specially at schools; and
- sections on volcanoes and earthquakes.

The focus of our mapping activities is now on the development of three-dimensional geological models. As part of a commercial partnership we now have the capability to view these models with software that allows the user to rotate the model through 360 degrees and automatically generate cross-sections or borehole logs. A sample viewer, containing a model of the Thames Gateway area around Thurrock, can be downloaded from our website. A PDF file of the 'LithoFrame' 3D model for Great Britain is also available for free download. The latest versions of the free Adobe Reader software allow users to rotate the model, viewing it from any angle..

A recent addition to the website is our Digital Map of Great Britain data at 1:625 000 scale (DiGMapGB-625), which can be downloaded and used free of charge for teaching purposes in ESRI® and MapInfo® formats. Feedback from any teachers who are using the data would be most welcome: how useful are they and how are you using them (email us at using bgsdata@bgs.ac.uk)?

In fact we have recently simplified the terms of use of all our publications, including material published on the web, for educational and other non-commercial purposes. In most cases it is no longer necessary to obtain a licence, providing the correct acknowledgement is given. The current conditions can be seen under 'terms of use' on the BGS website (see 'useful links' at the end of this article).

Future developments

New technologies are opening up fresh opportunities to explain our science in creative ways. For instance, our in-house capability now allows us to develop realistic three-dimensional animations. These could be realistic representations of dinosaurs and other extinct fauna, recreations of ancient volcanic eruptions, or 'fly-through' videos of photo-realistic landscapes and geological maps.

A new initiative that should be of considerable benefit to earth science educators everywhere is OneGeology, launched at an event hosted by the BGS in March 2007. OneGeology is perhaps the largest, most extensive and ambitious mapping project ever undertaken. Supported by UNESCO and six other global umbrella bodies, it will create dynamic digital geological map data across the surface of the Earth.

Leading scientists from more than 55 countries around the world are involved, from as far apart as Australia and Brazil, Canada and Russia, Namibia and Japan. Over the next two years, geologists will agree and plan the details of a global project that will ultimately see each nation provide data on the World Wide Web about the rocks from their territory — effectively putting in place their piece of the biggest jigsaw puzzle ever.

The OneGeology project will see national geological surveys across the globe make a tangible contribution to the UN International Year of Planet Earth 2008 by developing the geological map data and converting it to a new international standard — a geological exchange language known as 'GeoSciML'. Increased use of this new language will allow geological data to be shared and integrated across the planet. It will also transfer valuable know-how to the developing world, hence shortening the digital learning curve.

In conclusion
The BGS runs a broadly based programme of activities which has seen significant expansion, particularly over the past two years. The benefits are two-way: the organisation has a higher and more positive profile in the wider community and is helping to broaden the recruitment pool by inspiring the geoscientists of the future, and our staff gain confidence in communicating their science and motivating students.

Although we are a national organisation, there will always be limitations to the extent of our 'reach'. But initiatives like SEAs allow us to contribute to a nationally based effort and learn from good practice developed elsewhere.

Partnerships will be increasingly important in helping us to reach new audiences. We hope that ESTA will continue to be a key partner in helping us develop and improve our educational resources.

Finally, I would be particularly interested in hearing from any ESTA teachers who are already using digital geological data (or can see a use for it in the future). Or contact me if you have any views on what else you would like BGS to deliver.

David Bailey publishes with the permission of the Executive Director of the British Geological Survey.

References:
All-Party Parliamentary Group for Earth Sciences / Earth Science Education Forum for England and Wales. 2004. Conference Report: *Improving the Effectiveness of Education Resources for Earth Science and Industry*. House of Commons, 19 October 2004.

Bailey D., King C. and Whitburn N. (2007) Communicating Earth Science — ESTA, ESEU and BGS, *Teaching Earth Sciences*, Vol. 32.1,12–15.

Useful web links:
British Geological Survey www.bgs.ac.uk
- Popular Geology and Education section www.bgs.ac.uk/education
- Earthwise magazine www.bgs.ac.uk/earthwise
- DigMapGB 1:625k geological map data, and Thurrock and GB LithoFrame 3D model downloads www.bgs.ac.uk/free
- Terms of use of published BGS materials http://www.bgs.ac.uk/about/copyright/published.html

STEMNET www.stemnet.org.uk
OneGeology www.onegeology.org
The Industrial Trust www.industrialtrust.org.uk
Harvey Maps www.harveymaps.co.uk

Picture captions:

Engineering Education Scheme: Students from Loughborough Grammar School explaining their prototype soil-processor design to judges at an Engineering Education Scheme celebration event.

Students at Grove School, Newark plan the evacuation of Montserrat during an SEA Enterprise day

Pupils taking part in ‘Celebrity Rock Idol’, a Royal Society Partnership Project’ visiting the BGS laboratories in Keyworth to view their samples under the scanning electron microscope.

Training for BGS Science Ambassadors: Chris King leading a workshop on communicating science to schools and the public.