



**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

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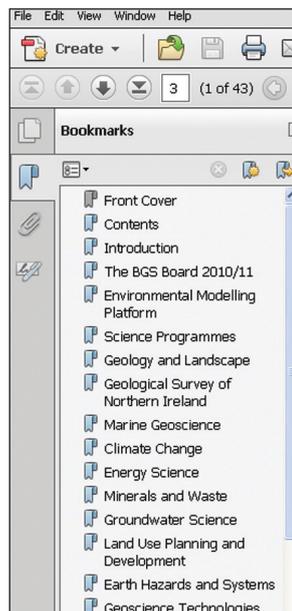


2010–11
Annual Report

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**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey Annual Report 2010–11

The British Geological Survey (BGS) is a part of the Natural Environment Research Council and is its principal supplier of national capability in geoscience.

We advance understanding of the structure, properties and processes of the solid Earth system through interdisciplinary surveys, monitoring, modelling and research for the benefit of society.

We are the UK's premier provider of objective and authoritative geoscientific data, information and knowledge for wealth creation, sustainable use of natural resources, reducing risk and living with the impacts of environmental change.

Our vision

To be the world's leading centre for applied geoscience.

Some research reported here may not yet have been peer-reviewed or published.



Next generation science for planet Earth

The BGS's programme is designed to help the NERC deliver its strategic goals, which are to deliver world-leading environmental research at the frontiers of knowledge:

- Enabling society to respond urgently to global climate change and the increasing pressures on natural resources.
- Contributing to UK leadership in predicting the regional and local impacts of environmental change over timescales from days to decades.
- Creating and supporting vibrant, integrated research communities.

With its researchers and stakeholders, the NERC develops the priorities that provide a focus for the marine, polar, atmospheric, geological, terrestrial and freshwater science communities. This research is often multidisciplinary and in collaboration with national and international partners.

The NERC runs a fleet of research ships and scientific aircraft. It has bases in some of the world's most hostile environments and invests in satellite technology to monitor environmental change on a global scale.

The NERC is committed to developing UK and international capability across the environmental sciences. It funds centres and universities to carry out research and to train and support a world-class community of environmental scientists.

The NERC has six major environmental research centres:

British Antarctic Survey	BAS
British Geological Survey	BGS
Centre for Ecology & Hydrology	CEH
National Oceanography Centre	NOC
National Centre for Atmospheric Science	NCAS
National Centre for Earth Observation	NCEO

Visit www.nerc.ac.uk for more details.

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Cover: Damage caused by the tsunami resulting from the Great Tohoku Earthquake, Japan, March 2011. BGS © NERC

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Introduction

Executive Director
John N Ludden



Our staff numbers continued to decline as part of an initial programme of workforce management and we remained within budget during a challenging year in which the impacts of external forces on our income streams were difficult to predict. At the same time outputs in research products, such as peer-reviewed papers, web content, books and reports increased appreciably. Significant capital investment continued with the construction work on the James Hutton Building, a new media centre and a major extension to the Keyworth Core Store. Cores from the UK's North Sea sector will be relocated from Gilmerton to Keyworth during 2011/12 and will become part of a state-of-the-art national geological repository.

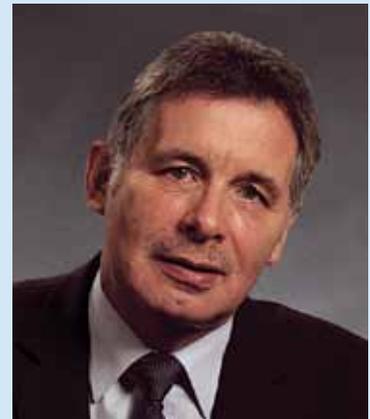
Ian Jackson and David Ovadia, members of the BGS senior management team, stood down at the end of this financial year and I thank them and all the staff at the Survey for their contributions through a demanding year, at the end of which our organisation is structured and poised to face further government budget cuts, but also to diversify and develop our external income.

The first pages of this report highlight the environmental modelling platform that is at the centre of our science strategy. To a geologist, all geological maps represent a two-dimensional view of a three-dimensional model from which he or she can visualise the third dimension and interpret the processes that have allowed the geology and landscape to evolve. The environmental modelling platform takes the map into third- and fourth-dimensional reality and then allows geologists and other stakeholders to quantify processes and define the limitations of the model through error calculations. It is a fundamental change to the way we will work as a geological survey. Although it requires a more numerate approach it also relies on observation and field description, so we will continue to have geologists and geophysicists working in the field. They will often be called upon to address the strategic problems of the day rather than systematically update existing maps, but a 'yellow jackets' team of experts will be maintained to provide local and regional expertise.

We have started a multi-year programme to enhance our mapping of the continental shelf through the MAREMAP programme, in partnership with other NERC-funded research centres and government departments. This map is essential for the development of infrastructure that will take place over the coming decades on the continental shelf and will help define resources and protect key natural habitats. In the years ahead, this multipartner approach to our science, exemplified in the offshore mapping, will be increasingly applied to work with higher education institutes and other stakeholders so that we can optimise the return on our resources in key research areas and especially in carbon capture and sequestration and in studies of strategic metals.

Our scientific research and support facilities are focused to an increasing extent

on crucial issues related to the vulnerability of the planet: water security in times of drought, past and future climate regimes, and subsurface fluid flow and storage. All of these are supported by centres of analytical excellence: in rock physical properties, in geochemical tracers, and, in geochronology, through the NERC Isotope Geosciences Laboratory.

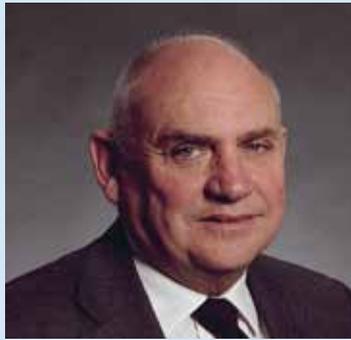


" If there was a point at which the benefit of the BGS's professional approach to data management was underscored, it was the launch and staggering uptake of the iGeology smartphone app; downloaded more times in a few days, than the number of paper maps we sell in a whole year "

Ian Jackson, Chief of Operations

We continue to play a strong international role in natural hazards research. In addition to advising the UK administration we have worked with numerous governments this year. Of particular note are our work with Iceland on the volcanic ash emissions, the effects of the Tohoku earthquake and tsunami in Japan, and the red mud catastrophe in Hungary.

A continued strong focus on information products and increased delivery through web services has characterised our information and knowledge exchange programme this year. This is exemplified by the launch of new information platforms, such as the soils portal, and iGeology smartphone app, through which geological data for the whole of the UK can be viewed. ■



“ The new Earth Science sector National Capability strategy, approved by the NERC in March sets the

Survey’s direction for the next 10 years: a 3D world with property attribution to understand environmental processes in the subsurface. The BGS has now got to grips with this strategy and is ready to create a multiscale 3D geological framework model of the UK as the basis of the Environmental Modelling Platform. ”

Denis Peach, Chief Scientist

The BGS Board 2010/11

The BGS Board was established to support the management and strategic direction of the Survey. Board members are appointed by the Executive Director and are ratified by the NERC. Membership comprises up to ten non-executive members from a broad cross-section of the BGS user community and the BGS Senior Leadership Team.

Professor J G Gluyas

Chairman
Director of Centre for Research into Earth Energy Systems
Durham University
Department for Communities and Local Government
Environment Agency
Executive Director, EuroGeographics
Chief, Global Earth Observation Section, UNESCO
Executive Secretary, Geological Society of London
Consultant, formerly Shell
Director, Bristol Environmental Risk Research Centre
Bristol University
Emeritus Professor Environmental Law
Aberystwyth University

Mr P Bide

Ms T Henton

Mr D Lovell

Dr R Missotten

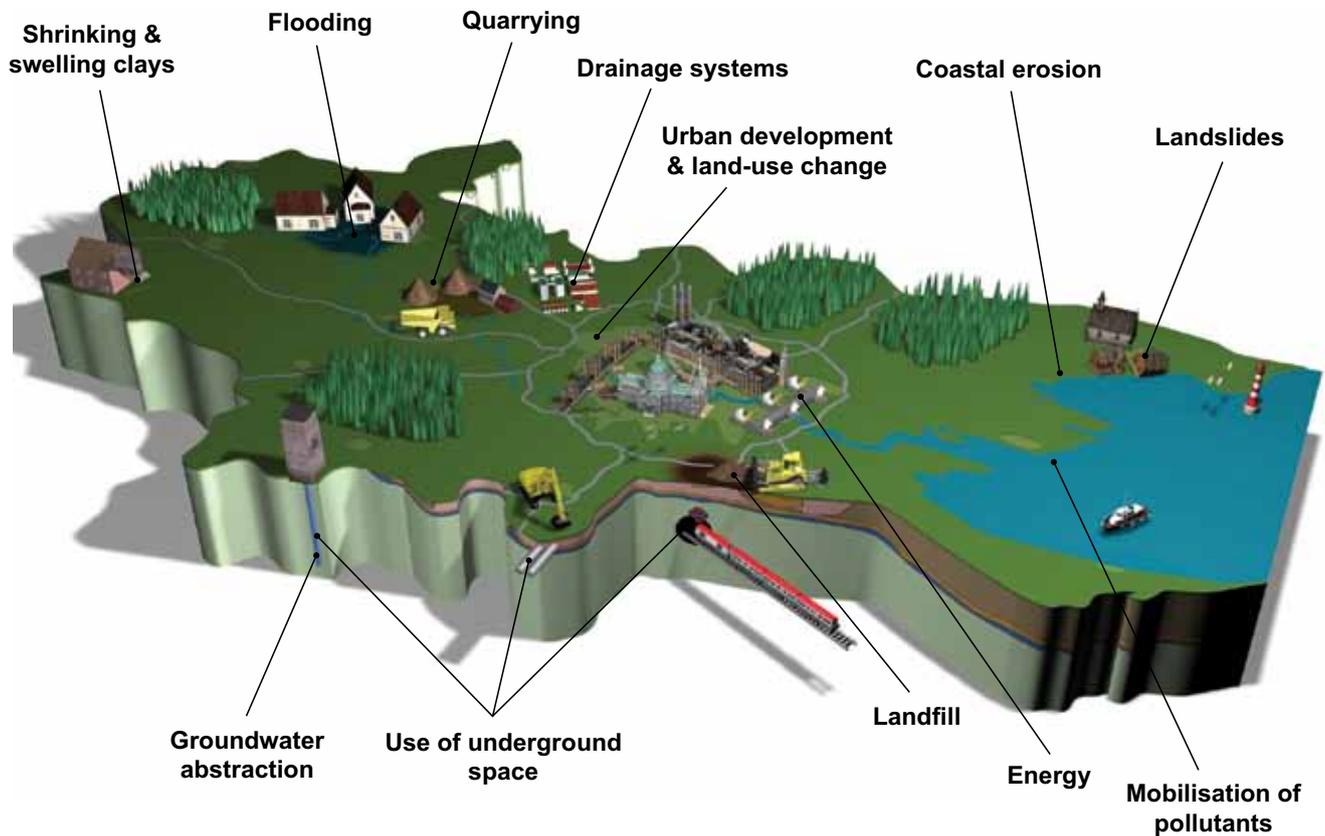
Mr E Nickless

Dr S Paterson

Professor S Sparks

Professor L Warren

Environmental Modelling Platform

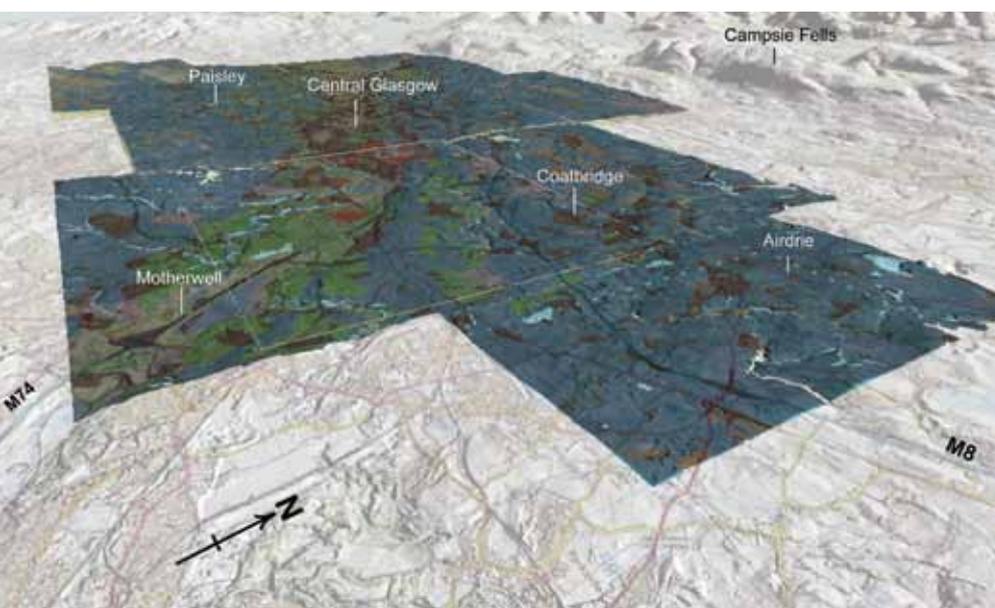


FutureThames: geology has a profound impact on many aspects of our lives, even in densely populated areas, such as the Thames Basin.

Adapting to the impacts of environmental change presents huge challenges for the future of our planet. A key objective of the BGS strategy

is to lead the development, with partners, of an Environmental Modelling Platform that integrates new environmental observations, state-of-the-art analytical capability, models

of environmental properties and processes, and interoperable data. The aim is to model and forecast impacts of environmental change over a wide range of spatial and temporal scales and to communicate the outcomes effectively to decision-makers, from governments to individuals. Our four cross-cutting 'super-projects' are developing common methodologies to implement the Environmental Modelling Platform. They integrate, for example, spatial models of geological properties, heterogeneities and uncertainties with numerical models of environmental processes. This approach fosters greater internal and



CUSP: 3D model of superficial deposits in the Clyde catchment.

external collaboration and provides a multidisciplinary operational model for our approach to science in the future.

The **Clyde–Urban Super-Project (CUSP)** is a multidisciplinary project characterising the shallow subsurface of the Clyde catchment and Glasgow conurbation, Scotland's national focus of regeneration. CUSP works closely with Glasgow City Council, other local and regulatory authorities, academia and industry to exchange more accessible, relevant and comprehensible geoscientific knowledge to aid local decision makers. CUSP has developed 3D geological models of the Clyde catchment at low resolution, and its urban areas at high resolution, based on mine plans and records of about 50 000 boreholes. The models are attributed with engineering properties of the subsurface strata and have provided the framework for numerical modelling of the recharge and flow of the Glasgow's groundwater. CUSP is now exploiting a range of models and data, for example to forecast impacts of sustainable drainage and assess heat resources in abandoned and flooded mine workings beneath Glasgow. Preliminary assessments suggest up to 40% of Glasgow's space heating could be met from this source.

The Thames Basin is home to over 13 million people, includes Europe's largest megacity, and is sustained by the UK's principal groundwater aquifer, the Chalk. The **FutureThames project** is drawing together our capability in 3D geological modelling, geochemical surveys, coastal geoscience and groundwater modelling to address some of the key challenges in the region, such as ensuring sustainable use of the subsurface, managing groundwater resources and protecting coastal communities and habitats. Working with partners from industry and academia, an enhanced knowledge base is being developed to respond to the challenges. Targeted survey and 3D geological models of the Chalk and other strategic horizons beneath London has significantly improved the understanding of the region's shallow subsurface. Associated research into groundwater systems, engineering properties and mineral resources is building on this understanding, providing our stakeholders with relevant and accessible geoscientific knowledge to improve decision making.

Rock formations of Permo-Triassic age will play a crucial role in meeting the UK's future requirements for strategically secure and sustainable energy and water resources.

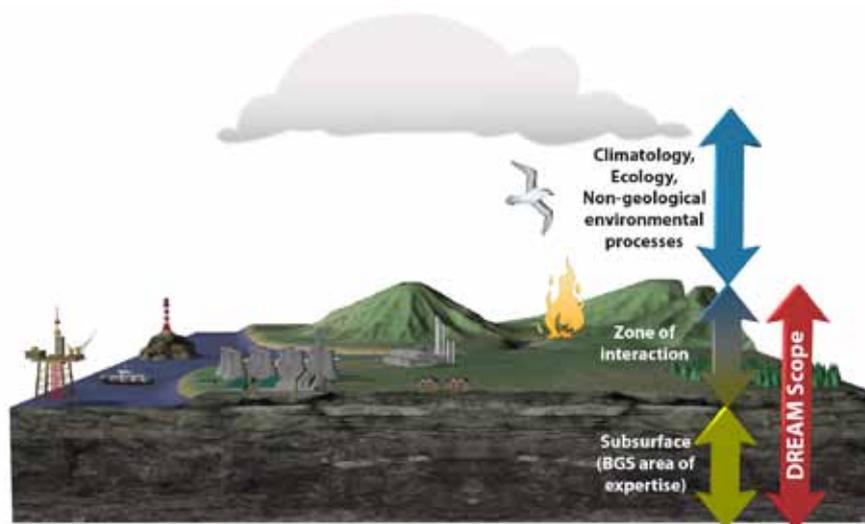
This complex sequence of sandstones, mudstones and evaporites includes the UK's second largest aquifer and, offshore, provides important hydrocarbon reservoir and cap-rocks. These rocks also have major potential for carbon capture and storage (CCS) and natural gas storage and provide important geological containment for many contaminated land sites. The **Permo-Triassic Reservoirs and Storage project (PTReS)** combines multidisciplinary research and expertise across the BGS to characterise, understand and predict the 3D distribution of pore space, fractures, permeability and engineering properties. The relationships of these characteristics to sedimentary facies, structure, mineralogy, diagenesis, and fluid flow is analysed by scaling up outcrop-based observations to formation and basin scales. Detailed 3D outcrop-scale models are being developed for the Penrith, Frogsmouth and Otter Sandstones using LIDAR, which will then be populated with hydrogeological and engineering properties, and fracture, sedimentological, petrological and diagenetic information derived from a shallow drilling and cross-hole geophysics programme. These models provide analogues for use in evaluating groundwater and solute transport, and potential offshore CCS systems.

The development and use of computer modelling within a variety of environmental disciplines has resulted in a plethora of discipline-specific models designed to solve particular problems. There is a growing impetus to develop methods, applications and standards to allow these diverse environmental models to be linked. This will allow the whole Earth system to be modelled and address key challenges such as



PTReS: granulation seams in Penrith Sandstone can influence 3D permeability.

environmental change and sustainability of natural resources. The **Data and Research for Environmental Applications and Models (DREAM)** project is addressing these issues by promoting an open research community to share data applications and environmental models. The aim is to increase collaboration, achieve sustainable solutions and to create an open Environmental Modelling Platform. Work over the past year has focused on community-building activities, including presentations at several international conferences. Greater engagement has been achieved with European geological survey organisations with the aim of developing EU funding proposals to augment the BGS's resources. Progress has been made in analysing the requirements for a 4D viewer that will enable the results of integrated models to be visualised. Models developed by the FutureThames project will be used to test the methodologies. ■



DREAM: promoting an open research community and developing an Open Environmental Modelling Platform that encompasses the whole Earth system.



Science Programmes

The influence of humans on our planet's environment is so profound that many scientists now believe we are living in a new geological epoch, the 'Anthropocene'. The BGS is not only at the forefront of international efforts in the geological community to define the specific impacts and indicators that define the Anthropocene, but also, as a geological survey organisation, is committed to the wider objective of observing, understanding and modelling human impacts on our planet and helping decision-makers prepare for, and adapt to, environmental change. Our achievements this year highlight how our science and our partnerships with others are evolving to meet the challenges of living in the Anthropocene world.

The demands of growing populations and economies often result in competing pressures on land and resources. These pressures extend to the subsurface environment, where demands for minerals, groundwater, and energy resources compete spatially with subsurface infrastructure and waste management needs. The subsurface is a new frontier for spatial planning, requiring innovative tools and joined-up approaches if we are to understand and communicate the opportunities and constraints inherent in developing and sustaining this complex environment. This objective is driving our major projects in the Thames and Clyde Basins, which are combining newly completed geological and geochemical surveys with 3D geological models and numerical groundwater models to provide unprecedented understanding of properties and processes in the shallow subsurface environment. In minerals and

energy, our science has a global outreach, contributing to strategic assessments of critical metals and carbon storage opportunities. The Nottingham Centre for Carbon Capture and Storage (NCCCS), a new partnership with Nottingham University, provides a unique UK research capability on the whole chain from capture to geological storage of carbon dioxide, and through the University's campuses in China, the NCCCS has the opportunity to export UK know-how on carbon capture and storage to help reduce the future carbon emissions of one of the world's major, emerging economies. In west Cumbria, we have used geological maps and models as subsurface spatial planning tools to advise the Department of Energy and Climate Change on areas that would not be suitable for an underground geological storage facility for radioactive waste. Supported by European government funding, we continue to deliver world-leading research on fluid transport in low permeability seals and host rocks to inform design of underground radioactive waste repositories worldwide.

Geoscientific contributions to spatial planning are also essential for sustainability in the marine environment. In the MAREMAP project, we have joined forces with other UK marine research centres to provide integrated national capability in seabed mapping, informing sustainable development of marine renewables and infrastructure while conserving sensitive marine habitats and ecosystems. In the recently commenced NAGTEC project, we are collaborating with other northern European geological surveys to share knowledge and synthesise

the geological evolution of the north-east Atlantic margin, informing regional assessments of hydrocarbon prospectivity for a consortium of oil industry clients.

Many of the major earth processes that drive environmental change and extreme events are not influenced by the activities of humans. However, our growing population, concentration of development in cities and increasing dependence on complex technologies make both humans and ecosystems more vulnerable to the impacts of environmental change and extreme events. The recent earthquake and tsunami in Japan (*see cover*) have demonstrated how even the most prosperous and technologically advanced economies can be devastated by natural hazards. Following the Iceland volcanic eruptions (*opposite*), we have contributed to the development of new natural hazard resilience and advisory infrastructures by the Cabinet Office and the Government's Chief Scientific Advisor, with the UK's preparedness for further volcanic eruptions and space weather events being especially high profile concerns. Understanding the vulnerability of complex systems to natural hazards requires new scientific alliances and their engagement with the designers and managers of critical national infrastructure. Through our experience with user consortia for national seismic and geomagnetic monitoring, and our participation in the emerging Natural Hazards Partnership of UK research centres and agencies, we are centrally involved in developing the UK's security and preparedness for the extremes of environmental change. ■

Geology and Landscape



Constructing flood defences near Forres.

Our Geology and Landscape theme (G&L) delivers fundamental knowledge on the 3D geology of the onshore UK. It informs policy and decision-making on safe and effective development, prioritising new geological surveys and investigations in areas of major urban development and critical national infrastructure. New digital mapping and 3D models are being delivered to support spatial management and stewardship of the UK's subsurface environment for sustainable resource development, waste storage and underground infrastructure.

Developing renewable energy and related infrastructure is a key objective of Scotland's National Planning Framework (NPF2). As a contribution to this objective, we have produced 3D geological models of the bedrock structure and overlying Quaternary and man-made deposits along the Great Glen, particularly in the vicinity of Loch Ness and the rapidly-growing Inverness urban area.

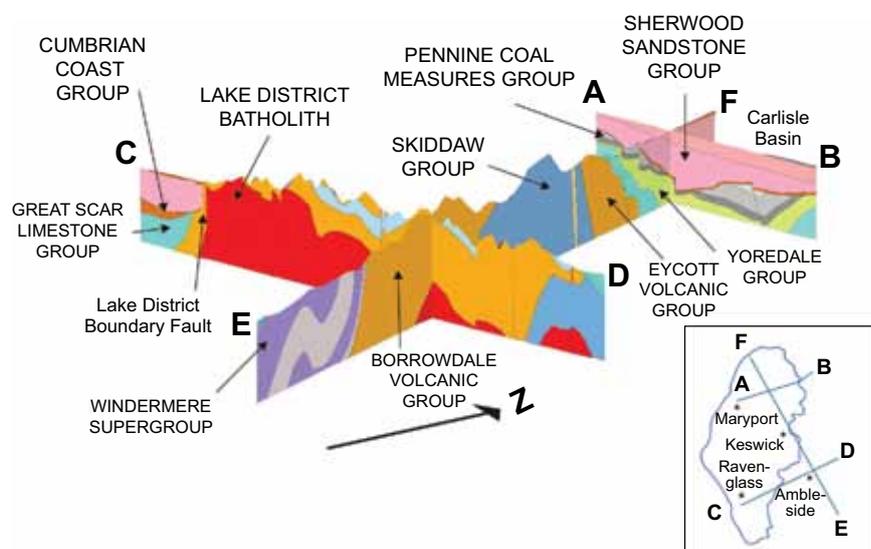
Geological 3D models were delivered and used to inform planning and design of hydroelectric schemes in the area and helped to refine the location of related underground infrastructure. In turn, rock exposures newly revealed by these schemes both below ground and on the surface have

provided new insights into the geology of the area. Similarly, 3D models were delivered for the Forres area and enabled the production of a high resolution groundwater flow model that has directly informed construction of flood defences along the River Findhorn.

G&L projects contributed 3D geological models to the BGS Environmental Modelling Platform initiative, which focuses on the

Thames, Clyde and Permo-Triassic Basins (see pages 8–9). The geological models were produced using GSI3D and GoCAD software, and incorporate physical properties parameters informed by outcrop-scale capture of new LIDAR and high-resolution geophysical data, enabling more refined linkage to groundwater numerical models. In the Thames basin, 3D geological models have been produced of the Chalk and Jurassic aquifers that support 70% of the region's public water supplies, rivers and wetlands, to inform the Environment Agency's management of this essential resource. Multiscalar geological models were also completed for Moray–Ness, the Cleveland Basin, Anglesey and the South Wales Coalfield. New surveys have completed gaps in the national DiGMap database and released the equivalent of seven maps at a scale of 1:50 000 and a further 145 at 1:10 000 scale, with accompanying explanatory texts.

Project staff also carried out public engagement activities and published a report on the high-level geological screening for an underground geological disposal facility for radioactive waste (GDF) covering the Copeland and Allerdale areas of west Cumbria, and an area five kilometres offshore. Commissioned by the Department of Energy and Climate Change (DECC), the aim of the report was to exclude from further consideration areas which would be clearly unsuitable to host a GDF. These comprised areas of potential mineral resource that might be 'intruded' (i.e. penetrated by boreholes) by future generations and rock volumes (aquifers) representing exploitable groundwater resources that require protection. ■

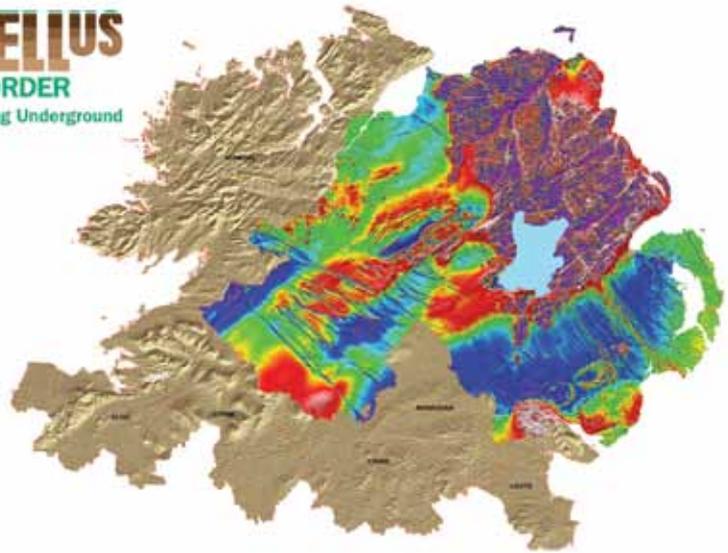


3D 'fence diagram' of cross-sections illustrating the generalised regional geology of Cumbria, including the West Cumbria Partnership area.

Geological Survey of Northern Ireland

The Geological Survey of Northern Ireland (GSNI) provides geological advice and information to government, industry and the public in Northern Ireland from its office at the Department of Enterprise, Trade and Investment. The GSNI's programme is currently focused on managing a growing portfolio of mineral and energy prospecting licences, providing advice on land-use planning and groundwater management issues, 3D geological modelling on regional and urban scales and developing collaborative research with partners in the UK and the Republic of Ireland.

New legislation for licensing onshore hydrocarbons exploration in Northern Ireland was introduced during the year and four new licences issued. Minerals exploration, notably for gold and platinum-group metals, continues at a high level. Companies are also assessing the potential for storing natural gas and compressed air in the salt formations of County Antrim. Enhanced exploration continues to be stimulated by the GSNI's Tellus geochemical and airborne geophysical surveys; in 2010 Tellus expanded into the Republic of Ireland with the launch of 'Tellus Border', a collaboration with the Geological Survey of Ireland (GSI) that will extend the Tellus



Tellus Border is a new survey that will extend the Tellus geophysical and geochemical surveys into the six northern counties of the Republic of Ireland. Existing magnetic data and the new survey area is shown above.

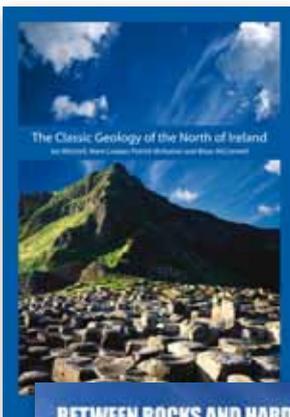
surveys over the six northern counties of the Republic and facilitate integrated cross-border analysis of data.

The GSNI has actively collaborated with the GSI in constructing a new 3D geological model of the northern part of Ireland. This model provides a framework for conceptual modelling of tectonics and structure, and for modelling specific areas of interest. Detailed 3D models have been constructed of Belfast and Londonderry and contribute to urban planning.

Other initiatives with GSI included publication of *The Classic Geology of the North of Ireland*, a colourful field guide to the northern part of Ireland, presented as a six-day tour. The GSNI's popular publication of the year *Between Rocks and Hard Places* is a hardback, high-quality production for the general reader that tells the story of the formation of the landscapes of the north of Ireland and explains how geology and landscape have shaped the region's natural and cultural heritages.

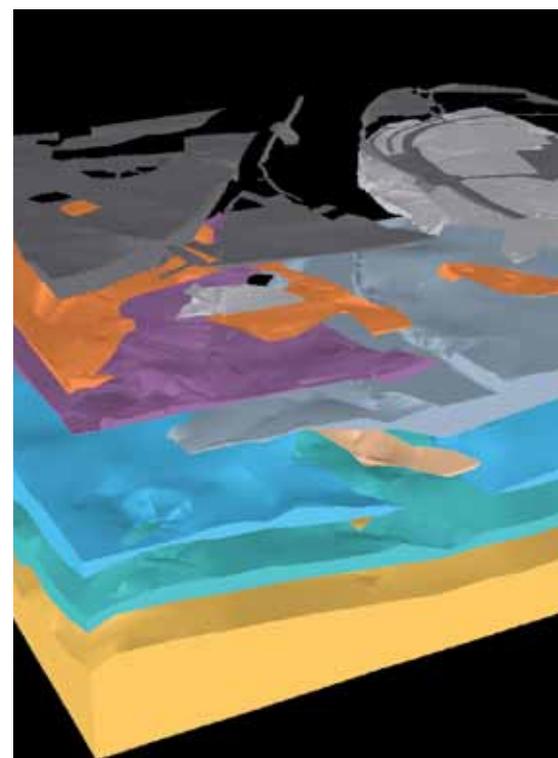
The GSNI continues to provide specialist hydrogeology support to the Northern Ireland Environment Agency in the management of groundwater resources. Current research

is focused on studying processes in less productive aquifers, in conjunction with Queen's University, Belfast, and Trinity College, Dublin, where four post-doctoral, two Ph.D. and four M.Sc. projects are in progress. This work will lead to improvements in the way that groundwater bodies are managed and how information on their status is reported for the EU's Water Framework Directive. ■



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Recent GSNI publications.



An 'exploded' view of the Belfast Gasworks subsurface model created in GSI3D (detail).

Marine Geoscience



BGS marine engineers and scientists organised the IODP Great Barrier Reef Environmental Changes Expedition in 2010 on board the drilling vessel Greatship Maya.



The Marine Environmental Mapping Programme (MAREMAP) was launched at a public event at the National Maritime Museum, London, in June 2010. MAREMAP is a joint initiative led by the BGS, National Oceanography Centre and the Scottish Association for Marine Science with partners from the University of Southampton and the Channel Coastal Observatory. MAREMAP aims to achieve common national objectives in seafloor and shallow geological mapping, addressing themes such as habitat mapping, Quaternary science, coastal and shelf-sediment dynamics and the assessment of human impacts and geohazards in the marine environment. MAREMAP has been designated a 'pathfinder' project for integration of common science objectives across NERC organisations.

We continued to lead the geological input to the European Marine Observation and Data Network (EMODnet), funded by the European Commission. The consortium of geological survey organisations from fourteen countries in northern Europe is delivering harmonised maps of seabed substrate, bedrock lithology and stratigraphy, coastal behaviour, natural events and minerals, which are being delivered through the OneGeology-Europe portal.

As part of the European Consortium for Ocean Research Drilling (ECORD), the

BGS and partners successfully completed the offshore and onshore phases of the Great Barrier Reef Environmental Changes Expedition for the Integrated Ocean Drilling Program (IODP). The aim of the project is to establish the course of sea-level change during the last deglaciation between 20 000 and 10 000 years ago, to define sea-surface temperature variations and to analyse the impact of these changes on reef development.

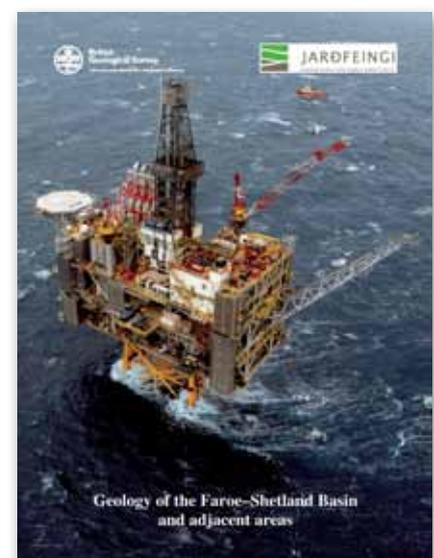
The Southern Permian Basin Atlas was published in June 2010. This major publication presents a comprehensive overview of the results of over 150 years of petroleum exploration and research in the basin, extending from eastern England to western Poland. The five-year project was sponsored by 28 organisations, mainly hydrocarbon exploration and production companies, and the atlas was produced by authors from national geological surveys, universities and industry. The BGS provided two of the principal authors and the chief editor to the project.

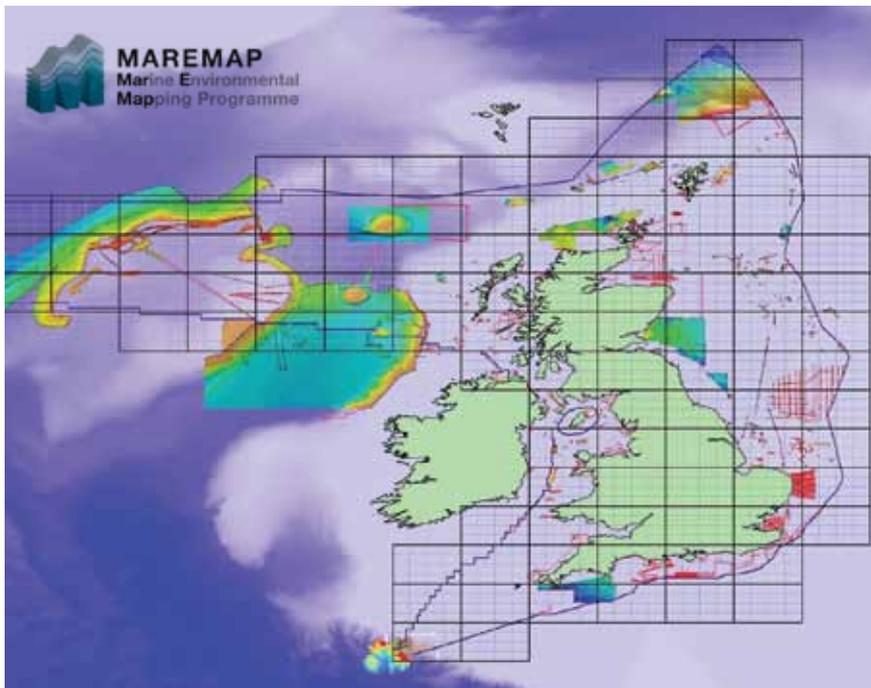
We had the major role in completing Regional Environmental Characterisation studies for areas of the UK seafloor being considered for possible aggregate extraction. This work integrated expertise from geologists, biologists and archaeologists to design common surveys and produce holistic reports to aid environmentally

friendly extraction and transport of primary aggregates. This multidisciplinary work was funded from the Aggregates Levy Sustainability Fund.

Studies on tsunamis continued, examining palaeovolcanic collapse deposits in Hawaii and the Canary Islands and palaeotsunami deposits in the Mediterranean and in the UK, supporting Ph.D. students as well as providing reports on risk for the commercial sector.

Publication of the Faroe–Shetland Regional Geological Report brings together results from a collaborative applied research





project undertaken jointly by the BGS and Jarðfeingi (Faroese Earth and Energy Directorate), with significant support from the oil and gas industry. The report presents a comprehensive geoscientific summary of the Faroe–Shetland Basin and surrounding areas as a whole, rather than separate studies of the national sectors. The integrated approach to the project raises many new geoscientific questions which we are addressing through further co-operative research and partnerships with national geological surveys, the oil industry and academia, including joint research with colleagues at the Universities of Adelaide, South Australia and Keele. ■

The available multibeam echosounder datasets that will be used as the basis for the MAREMAP geological interpretations.

Climate Change

Humans have made such a profound impact on the Earth's environment and ecosystems that many scientists consider we have entered a new geological epoch — the Anthropocene. Human activity is now a primary agent in the functioning and evolution of the water cycle, ecosystems, landscape, oceans and atmosphere and many of our impacts are now widely considered to be irreversible. Anthropocene science is inherently transdisciplinary and is rallying the communities addressing climate change, population increase, food and resource security. It aims to understand how the Earth system has adapted to human influence in the past and apply this knowledge to understanding and reshaping the future of our planet. A diverse and international team of scientists, including Nobel Laureate Professor Paul Crutzen, original proposer of the term Anthropocene, have highlighted the need to formally recognise this geological epoch in a special issue of the *Philosophical Transactions* of the Royal Society of London and at an international meeting at the Geological

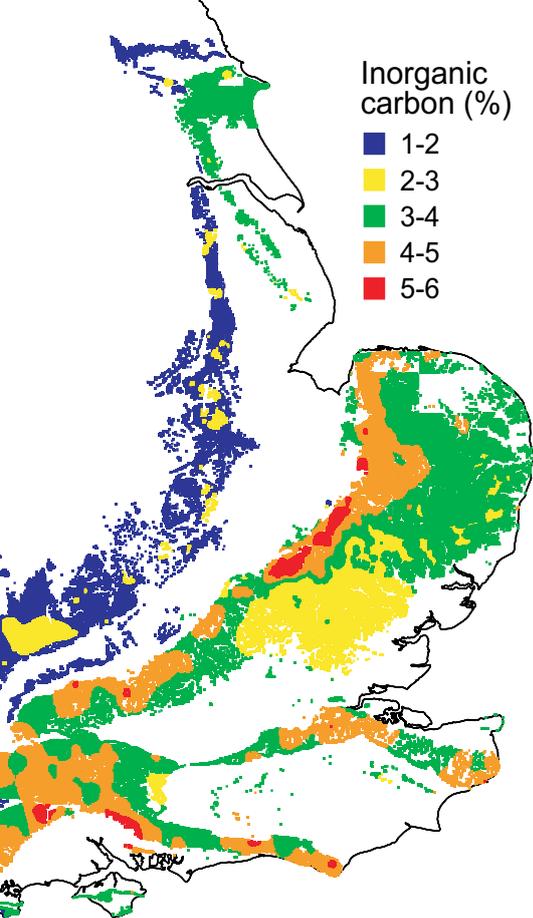
Society of London, coedited and convened, respectively, by BGS scientists. BGS contributions have ranged from developing the concept to diagnosing some of the defining characteristics of the Anthropocene, including geochemical signatures, man-made deposits, stratigraphical successions and climate-change indicators.

The significance of the Anthropocene can only be understood if it is placed in the context of what has gone before. The

BGS is tackling several important episodes of rapid climate change in Earth's recent geological past. The last time atmospheric levels of carbon dioxide were as high as they will be within a decade or two (around 400 parts per million by volume) was about 3.2 million years ago, during the later part of the Pliocene. BGS scientists co-led a special publication that lays out the climate and environment of the Pliocene warm world, and in partnership with the US Geological

An Anthropocene landscape: quintessentially British but almost completely manufactured by humans, both physically, chemically and biologically.





Inorganic carbon (%)

- 1-2
- 2-3
- 3-4
- 4-5
- 5-6

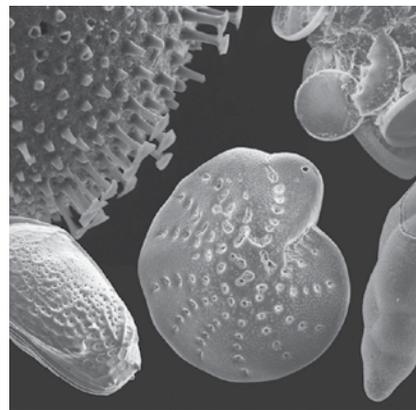
Map of inorganic carbon concentration (expressed as a percentage) in the topsoil across part of England.

Survey's PRISM program, continue to gather data from this critical time in Earth's history in order to test global climate models.

Stocks of carbon held in global soils far outstrip those held in the atmosphere. Increasing the stocks of carbon in soil may be a way of significantly reducing atmospheric carbon. Most proposed solutions have considered sequestration of carbon in organic form, but there are also ways to increase stocks of inorganic carbon within soil minerals. To assess whether such approaches might be effective, we have evaluated the stocks of inorganic carbon within UK soils. In collaboration with colleagues at the Centre for Ecology and Hydrology, we estimate a total of 186 million tonnes of inorganic carbon across large parts of England, about 6% of UK total soil carbon.

For low-lying and coastal communities, sea-level rise will be one of most serious impacts of climate change. Theoretical models forecast that sea-level rise will vary substantially according to location, but need to be tested with good historical and real-time sea-level change observations. BGS scientists and international collaborators are the first to combine

microfossil data with novel biomolecular analyses of salt-marsh successions to enhance precision and dating of local, relative sea-level rise from the past few thousand years up to the present day. Locations analysed include the Thames Estuary and are being used to inform scenario plans for managing future relative sea-level rise in the region. ■



Microfossils used to determine environmental conditions in the mid-Pleistocene climate transition, from cores taken during the IODP Expedition 323 to the Bering Sea.

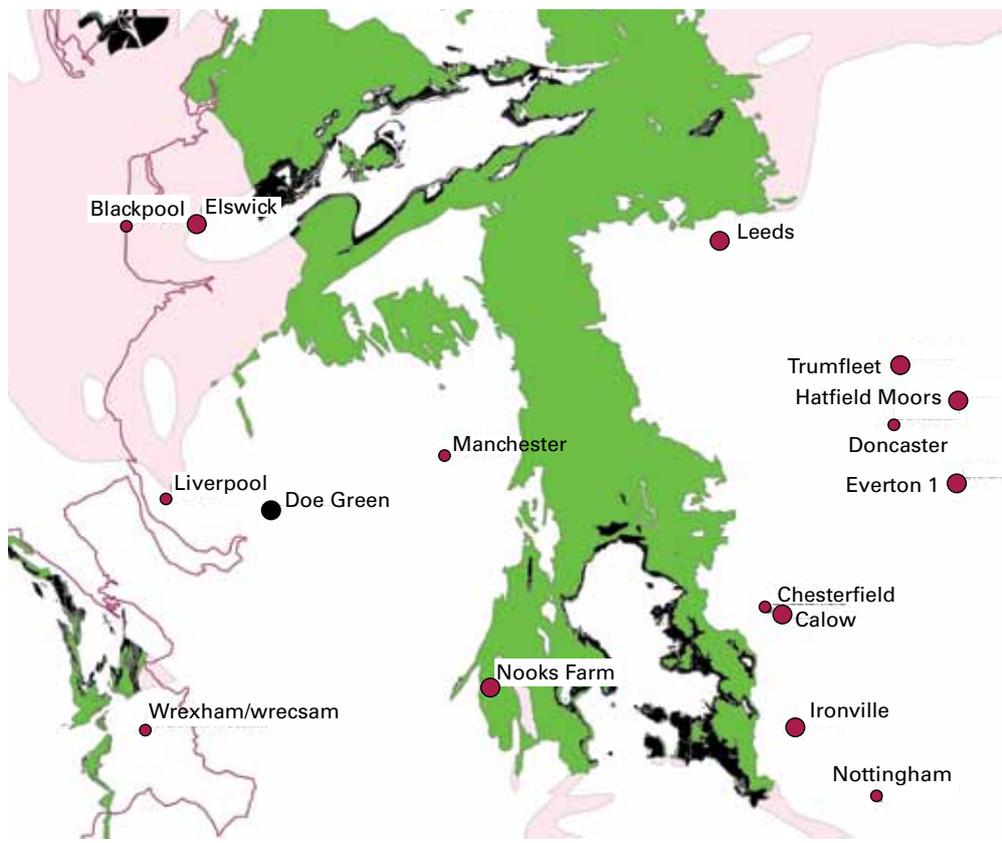
Energy Science

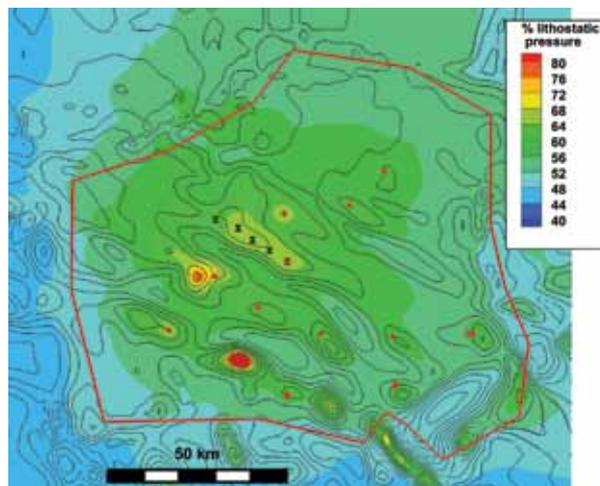
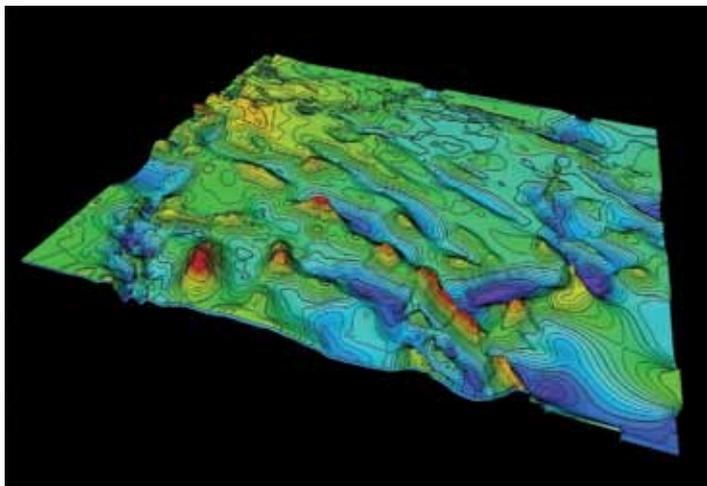
BGS energy scientists have been at the forefront of the national debate on shale gas, contributing to the Energy and Climate Change Committee Inquiry on Shale Gas and giving evidence at the House of Commons. BGS reports on the prospectivity of shale gas and coal bed methane were published by DECC on their *Promote* website (www.og.decc.gov.uk/UKpromote). We are also advising on the drilling of a borehole in Newcastle to investigate geothermal potential alongside our collaborators at the universities of Durham and Newcastle.

Namurian strata in northern England and North Wales, outcrop is shown in green, subcrop beneath Permo-Triassic strata in pink. Large shale gas resources may be associated with this rock succession and the underlying strata, although the best potential is associated with the Bowland Shale Formation (outcrop in black). Red circles indicate gas fields, the black circle is a coal-bed methane field.

We are promoting secure, low-carbon energy by researching Britain's renewable and home-grown energy, and by fostering

carbon capture and storage (CCS). This year we have set up the Nottingham Centre for Carbon Capture and Storage (NCCCS)





Bunter Sandstone pressure model showing the importance of pressure management in CO₂ injection. Left image shows the the Bunter Sandstone in 3D, a likely target for CO₂ storage; colours show depth: red shallow, blue deep. Right image shows the pressure model. The line contours show the shape of the top surface of the Bunter Sandstone and the colour shading shows pore pressure as a percentage of the lithostatic pressure after 50 years of simulated CO₂ injection. The red dots show the locations of CO₂ injection points and the black crosses show the points at which detailed time histories were collected from the model output.

which combines the talents of the BGS's CO₂ Storage Team with capture scientists at the University of Nottingham. The NCCCS has already initiated professional training courses and a Master's course in CCS. Five NCCCS Ph.D. projects will start in 2011 and include research on mathematical modelling, CCS in China and CCS public perceptions.

The CO₂ Storage Team has been successful in securing new funding worth two million pounds through EU Framework Programme 7 projects such as ECO₂, CO₂CARE, SiteChar, SafeCCS, CGSEurope and UltimateCO₂, and through other agencies such as the Geological

Survey of Ireland. The team publishes groundbreaking research on storage processes. Models of the pressure distribution in the Bunter Sandstone in the North Sea go to the heart of the challenge of managing pressure in large-scale CO₂ injection. The team continues to advise the UK Department of Energy and Climate Change (DECC) on the UK full-chain CCS Competition and contributed to the Scottish Government's Regulatory Test in August 2010, through our partnership in the Scottish Centre for Carbon Capture and Storage.

The Edinburgh Anisotropy Project (EAP) uses wave analysis and modelling to

understand fractures in deep hydrocarbon reservoirs. Shale gas has massive potential in China and this year the EAP will turn its expert techniques to quantifying natural fractures in shale in China through a project with the China University of Petroleum (CUP). The EAP has increased its international reach over the years so that it now counts almost every major oil company among its sponsors. The collaboration is particularly strong in China with the result that the EAP's Director, Prof. Xiang-Yang Li, has also been appointed Director of CUP's Geophysical Key Laboratory in Beijing. ■

Minerals and Waste

Global demand for minerals, metals and energy is growing rapidly, as are concerns among policy makers and business regarding security of supply and the impact of resource use on our environment. Working with partners from government, academia and industry, our Minerals and Waste science covers the life cycle of resources, from metal

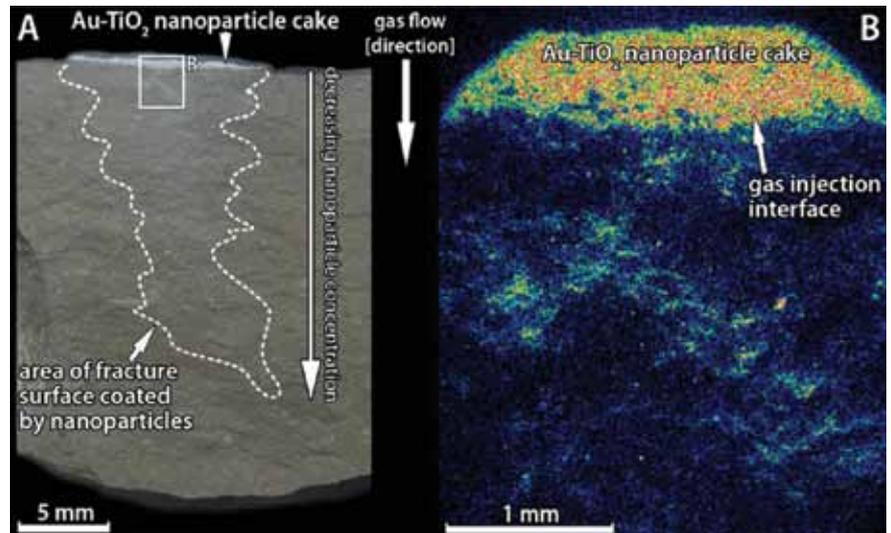
Mountsorrel Quarry, Leicestershire: a nationally important source of aggregate minerals with a finite reserve life. We have provided an evidence base that will assist in identifying future aggregate supplies in England.



concentration and transport processes in the Earth's crust, analysis of global mineral and metal production and trade, through to environmental issues related to the fate of metals in the biosphere and geological disposal of radioactive waste.

Our experts have provided information and advice to UK government, manufacturing industry and investors to inform the development of strategies to ensure secure supplies of critical metals. We co-ordinated the RCUK evidence to the House of Commons Science and Technology Committee inquiry into strategically important metals. New profiles on tungsten and niobium-tantalum have been published, providing key information on these critical metals for which the EU relies almost wholly on imported supplies. In collaboration with Camborne School of Mines, we have commenced research on deposits of critical metals in the UK, focusing initially on rare earth elements in the Caledonian igneous intrusions of north-west Scotland.

Aggregates are key raw materials for construction and thus for the UK's economic recovery. Supported by DEFRA, we have identified when, why and where future shortfalls in the supply of aggregates are likely to occur. This study examines supply from existing mineral sites in England, highlighting specific problems which can be expected to arise in the future. It also examines options for easing the shortfall



Pressure-induced pathways in mudrock are imaged using gold and titanium nanoparticles. The bluish hue in optical image (A) indicates good penetration of the clay by nanoparticle titanium. An elemental map of Ti distribution (B) shows a rib-like pattern which may relate to the intersection of the vertical fracture with the bedding planes.

where supply continuity is likely to be problematic. Findings will be used by policy makers, planners, industry and civil society groups to ensure optimum economic and environmental outcomes from decisions relating to aggregate supply.

Corrosion, water radiolysis and microbial degradation within geological repositories for radioactive waste will result in generation of gas. Clay-based engineered barriers and the character of host rocks can constrain gas movement

and cause increases in pressure. We have pioneered the development of a new technique, utilising the injection of nanoparticles as a tracer, to enable identification and characterisation of pressure-induced pathways. This method represents a completely new approach in the imaging of ephemeral flow pathways, which in turn is providing new insights into the scale and nature of gas migration processes through low-permeability clays and mudrocks. ■

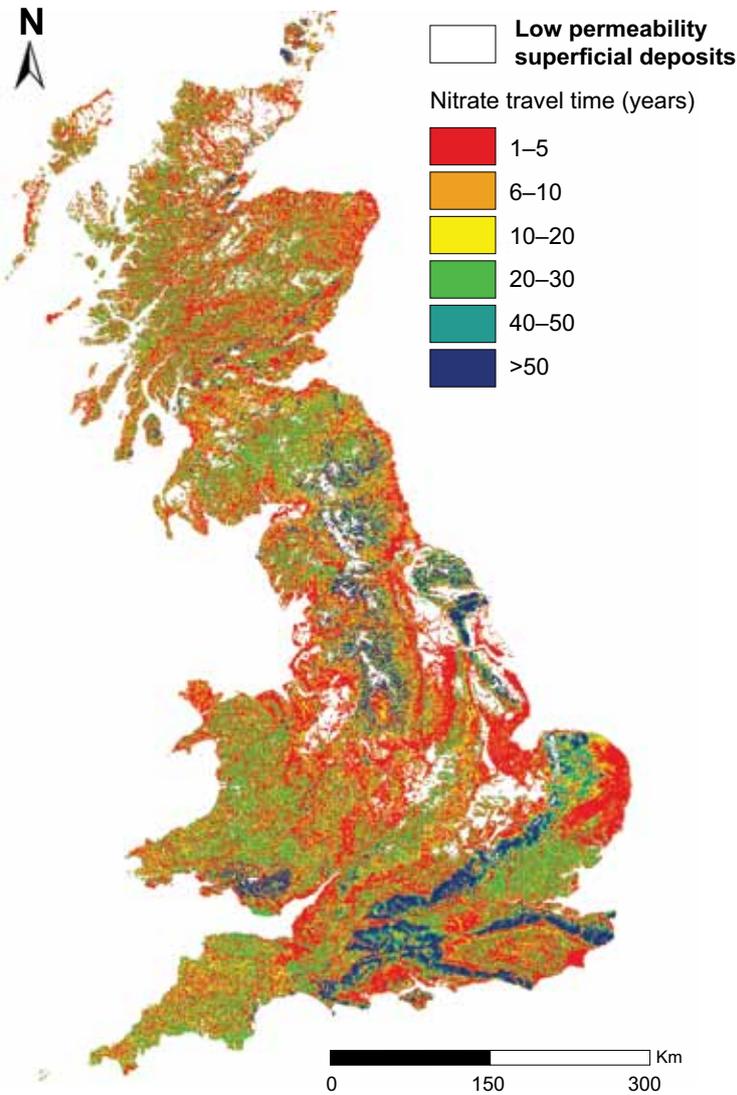
Groundwater Science



The Groundwater Science programme aims to improve our knowledge of groundwater and its interaction with the water cycle. We investigate groundwater resources and quality, and study groundwater processes, as well as applying innovative monitoring and modelling techniques to improve understanding of groundwater issues, in particular its response to environmental change. Our research contributes to the scientific evidence base needed to inform national and international decision making related to water resource management and protection.

Drinking water abstraction from a shallow rural well in central Nigeria.

In partnership with others, we are actively investigating the impacts of climate change on groundwater and have recently published the results of a study modelling the effects of future climate change on the Chalk aquifer — the most important in the UK (*Journal of Hydrology*, Vol. 399, pp 12–28). We also led a study commissioned by the Department for International Development (DfID) to improve our understanding of the response of groundwater to climate change in Africa and the resulting impacts on livelihoods. The project is developing policy recommendations and community adaptation strategies to build resilience to climate change (*Groundwater*, Vol 48 pp 246–256). Results from studies on groundwater flooding funded by the NERC and EU were also published, the



Distribution of predicted nitrate travel time in the bedrock unsaturated zone of Great Britain.

latter describing an innovative early warning system for the Chalk in southern England (*Quarterly Journal of Engineering Geology and Hydrogeology*, Vol 43 pp 185–193).

Land-use activities continue to threaten groundwater quality and we are studying the future risks from emerging contaminants. However, the greatest risk to groundwater continues to be from agricultural sources of nitrate which is also the factor that leads to the highest cost for water supply treatment. This is despite better regulation and environmental management. A recent BGS study of the distribution of nitrate in the unsaturated zone has shown that for around 60% of the Chalk aquifer, nitrate peak concentrations have not reached the water table and they are expected to continue to rise for up to a further 60 years (*Hydrological Processes*, doi: 10.1002/hyp.8164). These observations highlight the need to consider the time lag between implementation of measures and observed environmental improvement.

Our work on developing a better understanding of the interactions between groundwater, surface water and ecosystems continues and we have recently published work on the characterisation of UK lowland groundwater-dominated chalk streams that has direct relevance to implementation of the EU Water Framework Directive (*Hydrogeology Journal*, Vol 18, pp 1125–1141), and on nutrient-phosphorus cycling in the zone of groundwater-surface water interaction (*Water Air & Soil Pollution*, Vol 218 pp 213–226). ■

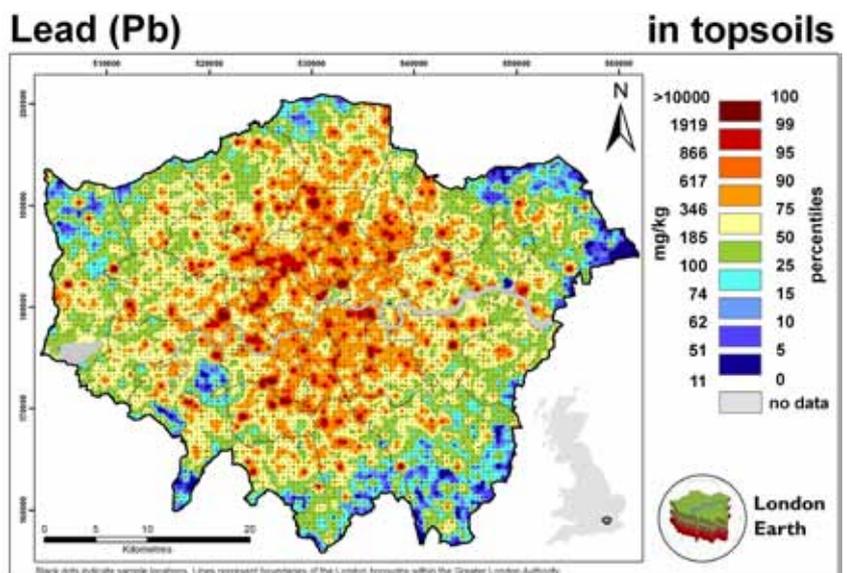
Land Use Planning and Development

Land Use Planning and Development comprises four thematic research teams working closely together:

- Geochemical Baselines and Medical Geology,
- Geotechnical and Geophysical Properties and Processes,
- Urban Development, and
- Shallow Geohazards and Risk.

These teams carry out an integrated programme of mapping, sampling, testing,

Geochemical map of lead in the topsoil of London based on 6600 samples. The highest concentrations are found in densely populated areas and are clearly anthropogenic in origin.



monitoring and modelling to describe the geochemical and physical properties of the UK landmass. Our information and expertise supports decision-making in fields such as spatial planning, extreme event response, sustainable development of cities and environmental health.

Major landsliding in the Jurassic rocks of the North York Moors has been recognised by desk-based interpretation using digital stereo air photography (SocetSet) and 3D visualisation (GeoVisionary). These techniques have improved both survey efficiency and accuracy and allowed fieldwork to focus on ground truthing and detailed investigation of selected landslides. A large part of the Moors has now been surveyed. The national landslides database has been made available to the public as part of the online GeolIndex and the landslide rapid response team continue to be on call to follow-up landslide events across the UK.

The Geochemical Baselines and Medical Geology Team have continued mapping the chemical environment of London and the Clyde Basin. High density sampling (soils, stream sediments and water) is ongoing in the Clyde Basin and determination of about fifty elements will differentiate between the natural and urban chemical backgrounds. In London the data and information have now been released both for download and viewing via the London



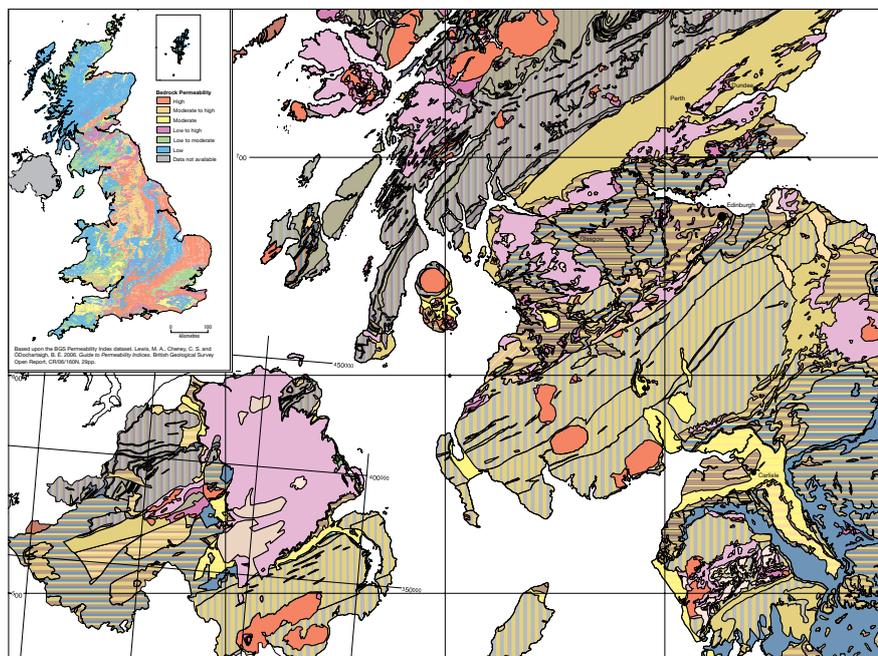
Landslide in the North York Moors. Aerial photograph and Socet Set-derived landslide area (left) compared with ground photograph (top right) and an approximately equivalent view (bottom right) as seen using GeoVisionary with the air photograph draped over the NextMap digital surface model (DSM from Intermap Technologies; air photography in both images © UKP/Getmapping Licence No UKP2006/01; photo Anthony Cooper).

Earth webpages (www.bgs.ac.uk/gbase/londonearth.html). This evidence is informing decisions regarding the contamination of land, guiding environmental legislation and helping to create healthier and more sustainable environments. To help assess potential health risks, the team is also developing analytical methods to determine the fractions of potentially harmful elements

and compounds in soils that are readily transferred to the human body.

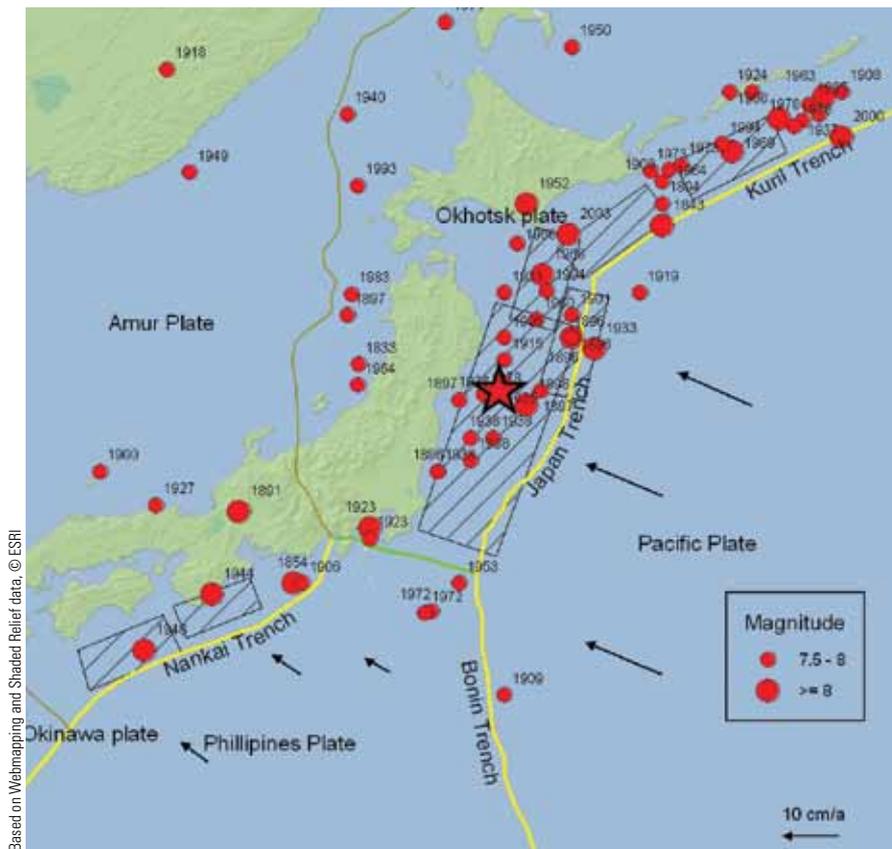
Two new engineering geological maps of the UK have been produced, for bedrock and for superficial deposits, attributed with engineering geological lithologies rather than the traditional lithostratigraphical units. The purpose of these maps is to communicate the key aspects of the geological environment that affect planning, construction and infrastructure and they are aimed particularly at students and early career practitioners in civil engineering and geotechnics. The maps each have a detailed key containing information on engineering considerations associated with lithology. They also include small-scale inset maps, explanatory texts and schematic diagrams on hazards such as landslides, shrink-swell clays, seismicity, mining and sulphates.

Recent changes to legislation in the UK are driving a shift in the way we manage and discharge surface water. In the future, the reliance on traditional piped drainage will be reduced in favour of sustainable drainage systems (SuDS), which manage surface water *in situ* where the rain falls. Infiltration to the ground is a key SuDS technique but relies on suitable ground conditions. To identify such conditions, we have produced a national SuDS infiltration suitability map that provides information on drainage properties, ground stability and pollutant attenuation potential in the subsurface. ■



Extract from the Engineering Geology Bedrock Map of the United Kingdom. The map is attributed with engineering geological lithologies combined, in varying proportions using the stripe system, to create engineering geological map units. This extract shows one of the small-scale inset maps, in this case showing relative bedrock permeability.

Earth Hazards and Systems



Earthquakes with magnitude greater than 7.5 in and around Honshu since 1800. Approximate rupture planes for a number of events with magnitude greater than 8 are shown by the hatched areas. The epicentre of the 11 March 2011 event is marked by the star.

In the past year we were called on to assist the UK government's planning for and response to natural hazard events, highlighting the importance of applying research to assess risk.

The ash cloud produced by the eruption of the Eyjafjallajökull volcano, Iceland coincided with wind conditions that carried the ash towards Europe, disrupting air travel in April and May 2010. BGS scientists were members of the Scientific Advisory Group for Emergencies chaired by the UK government's Chief Scientific Adviser and liaised with the Icelandic and UK Met Offices, other NERC Research Centres, and with university scientists in the UK and Iceland to ensure

Making sun observations in Cumberland Bay, South Georgia. The King Edward Point research base operated by the British Antarctic Survey and the government of South Georgia, and the new BGS magnetic observatory, are to the left in the background.

the availability of up-to-the-minute information.

Christchurch, New Zealand was damaged by earthquakes in September 2010 and February 2011, but these were minor

events in comparison with the magnitude 9.0 Great Tohoku earthquake that struck Japan on 11 March 2011. A segment, 400 km in length, of the plate boundary east of Honshu ruptured, resulting in slip exceeding 50 metres in places and lifting the seafloor by over 3 metres, generating a devastating tsunami. Over 28 000 people were killed or are missing, and many tens of thousands were displaced. The economic consequences of the loss of electricity from the Fukushima nuclear power plant are being felt worldwide. BGS scientists advised the UK government on the seismological context of the event as the nuclear emergency developed.

We contributed oral and written evidence to the case studies on the Icelandic ash cloud emergency and future 'solar storms' considered by the House of Commons Science and Technology Committee inquiry into scientific advice and evidence in emergencies. One concern is the potential for space weather events resulting from solar storms to threaten electricity supplies by damaging transformers. Our scientists have worked with National Grid to model the effects of possible future events.

Our seismic and geomagnetic networks provide real-time observational data. New seismometers were installed in Iceland to improve volcano monitoring, and new stations were added to the UK broadband network. In collaboration with the British Antarctic Survey a magnetic observatory on South Georgia was established to monitor



the Earth's magnetic field in a region where its strength is declining rapidly. The BGS plays a leading role in the European Volcano Observatory Space Services project and is a partner in a consortium supporting the ESA Swarm magnetic survey satellite mission, due for launch in 2012.

We use the data we collect for research and to provide services. For example, the arrival times of local earthquakes recorded at BGS seismograph stations were used to construct a new 3D model of seismic velocity in the Earth's crust beneath Scotland and investment in web services has improved the ease of access to geomagnetic products for the hydrocarbons industry. ■

Collecting ash in Iceland in May 2010 during the Eyjafjallajökull eruption.



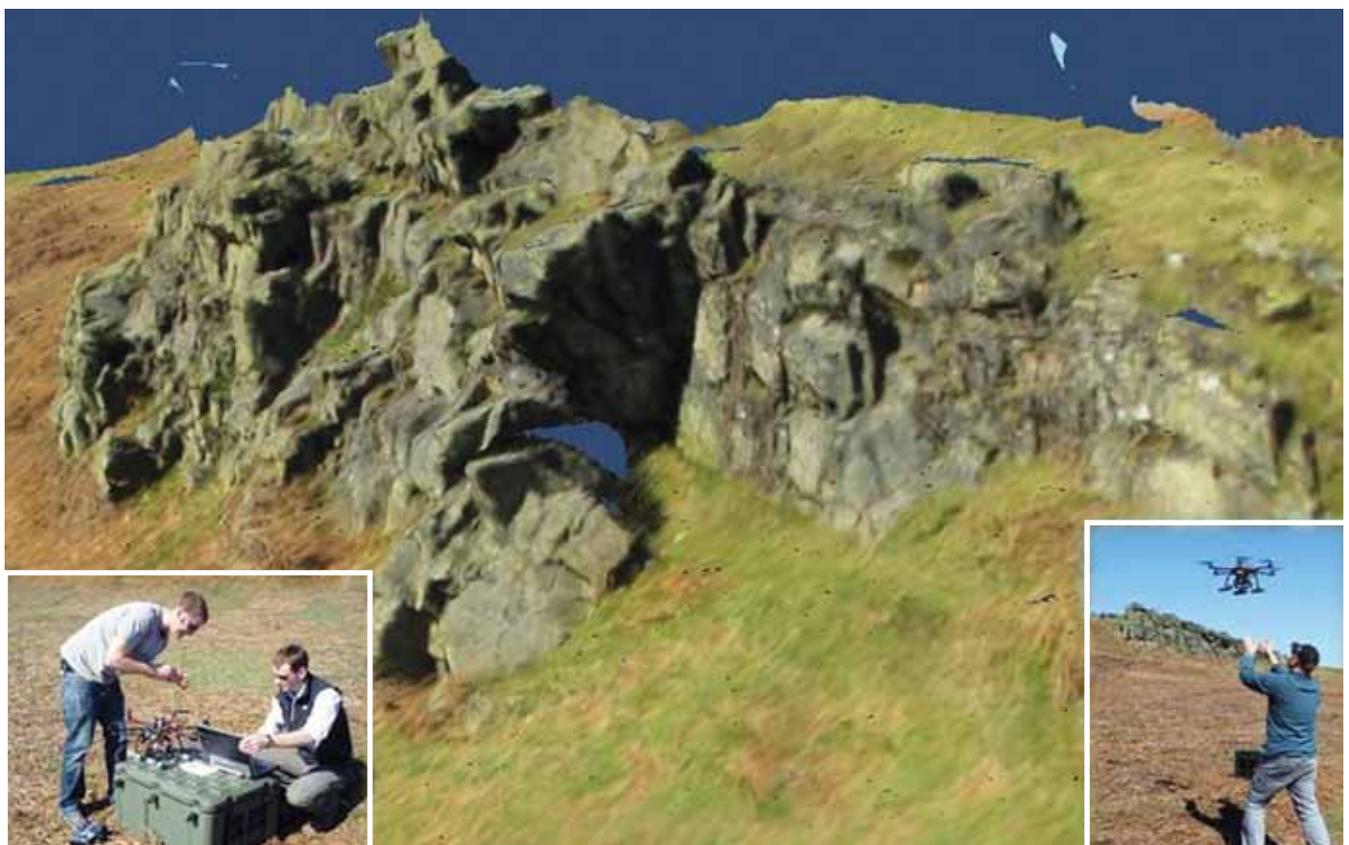
Geoscience Technologies

This theme focuses on technology development for geoscience applications. During the past year, its highlights included novel airborne observation tools, advances in subsurface

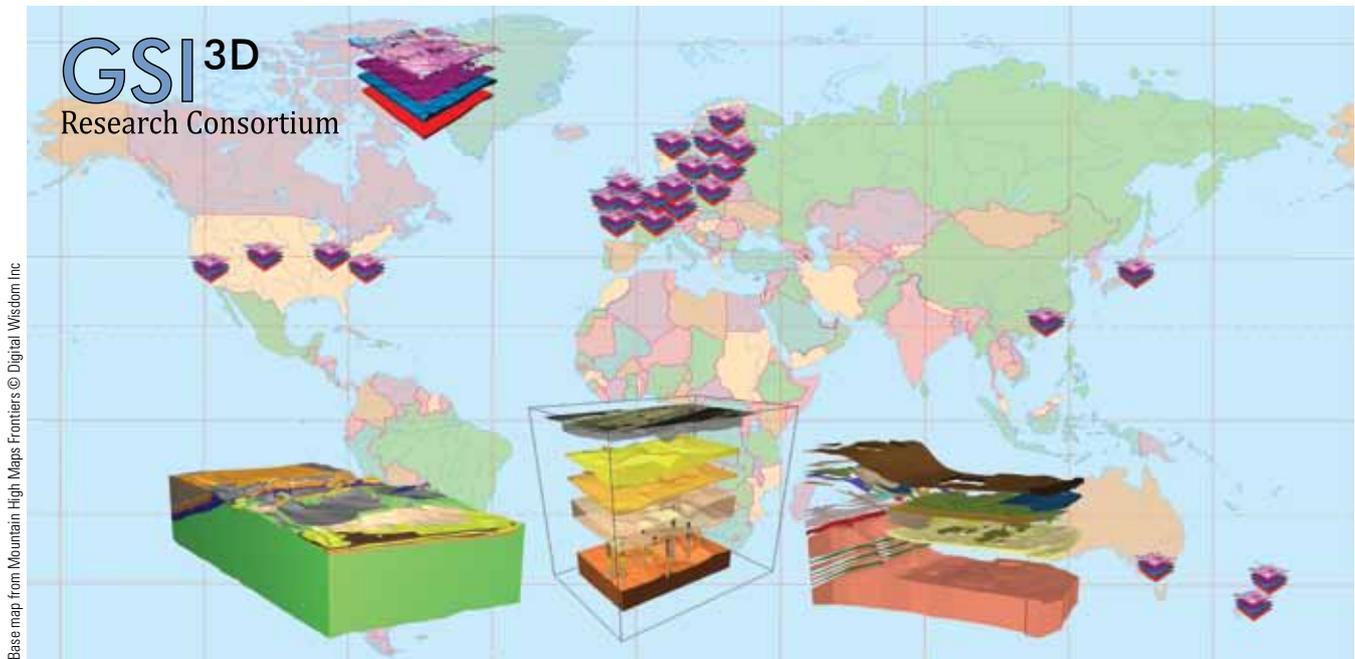
monitoring, expansion of our international consortium on 3D modelling and a first integrated environmental monitoring summit.

Development and implementation of novel, world-leading Earth Observation

(EO), visualisation and digital mapping systems continued apace. There was increased adoption of our digital mapping workflow (SIGMA) within the BGS, while the second release of our digital field mapping



Hexakopter 3D Photofly © 3D model of Precambrian outcrop in Bradgate Park, Leicester using UAV photography. Photofly™ is a product of Autodesk.



Map of GSI3D Research Consortium Members.

system BGS•SIGMAmobile saw global downloads rise to over 1000 licenses. Our GeoVisionary™ 3D visualisation system implemented virtual field reconnaissance projects for both Earth and Mars. Airborne EO capabilities grew, with successful test flights of our unmanned aerial vehicle. Growing external income helped underpin this research and the team also published books, peer-reviewed papers and publications for conferences.

The BGS's achievements in shallow subsurface monitoring were underpinned by developments in technology, theory, and geoscientific applications. Highlights in technology included non-contact imaging for permafrost process monitoring and distributed sensor networks for catchment-scale observations. Developments in theoretical modelling enabled the use of ALERT monitoring technology to sense movement in unstable slopes, and electrical images to be optimised to improve their resolution. These enabled applications to be expanded significantly, to cover climate change impacts, geohazard monitoring, resource evaluation, infrastructure assessment, groundwater investigation and carbon dioxide sequestration. BGS funds were enhanced by grants (NERC Technology Proof-of-Concept, EPSRC, Defra), commissions (BAE Systems, Sellafield Ltd) and university collaborations.

The Geological Modelling Systems Team (GMS) builds and supports the software tools which underpin the BGS strategy to

produce digital 3D geological models. We have established a not-for-profit research consortium in partnership with INSIGHT GmbH to offer 'GSI3D', our flagship in-house geological modelling software, to the global geoscientific community. Our aim is to build a user-community through support and training, then further develop the software with that community. This approach has now attracted more than 25 memberships from around the world, including geological surveys from Europe, Hong Kong, Japan and Australia.

The BGS co-convened the successful 'Integrated Environmental Modelling (IEM) Summit' at the USGS's Washington headquarters in December 2010, bringing together European and North American

IEM researchers. We also supported the OpenMI Association's chair and secretary. IEM and OpenMI were used to couple an InfoWorks-RS river model to a BGS ZOOMQ3D groundwater model for Oxford's floodplain. The resulting model was used to simulate the July 2007 flooding, improving understanding of integrated river-aquifer systems' responses to extreme rainfall. We also collaborated with the University of Hull to develop further the landscape evolution model, CAESAR. PropBase's physical property data compilation was displayed at the September 2010 All Hands E-science meeting and the population of the East Midlands regional 3D model with physical properties was presented at the Geological Society of America in November 2010. ■



Researchers attending the Integrated Environmental Modelling (IEM) Summit in Washington.

Information and Knowledge Exchange

The management of digital and analogue geoscience data, creation of national spatial geoscience data-sets, delivery and exploitation of BGS science in the community, publications, and the provision of IT systems and network infrastructure services are the responsibility of the Information and Knowledge Exchange Directorate.

The release of the ten-year NERC strategic framework for integrated national capability environmental science late in 2010 will create new priorities for BGS's Information and Knowledge Exchange programmes. Combined with expected budget reductions these new priorities will require significant reprioritisation of the existing work programmes in the coming years.

The relocation of the UK continental shelf oil and gas exploration cores, cuttings and other data from Gilmerton in south Edinburgh to Keyworth has been the main focus of our information management teams throughout the year. The proposals to relocate these

collections proved controversial. A special, independently chaired Core Advisory Group was set up to devise a methodology suitable for the packaging and transportation of these unique assets, and following public consultation this methodology is now being followed rigorously in the relocation process.

Notable successes of our spatial geoscience data-set programme include the long-awaited release of a new version of the UK seabed sediment data-set and an entirely new seabed substrate data layer. Together these data-sets will be of considerable value in the planning and installation of offshore infrastructure such as wind farms and pipelines.

Our first mobile application — iGeology — released in September 2010 has been an outstanding success that has greatly exceeded initial expectations. Through this mobile 'app', users are able to access our 1:50 000 scale geological map (and related) data anywhere in the UK. Less than a year after its release it is clear that the app has resulted in a manyfold increase in the use of the BGS's geological map data.

The commissioning of a new, power-efficient computer room has provided a start-of-the-art facility to accommodate future growth in the BGS's and NERC's information systems requirements. The excess heat from this facility is piped to the core store extension, resulting in both cost savings and lower greenhouse gas emissions. The installation of two, one-gigabit links to the Keyworth site also provides much faster and higher resilience connections to the wide area network and World Wide Web.

Staff continue to play active and prominent roles in representing the BGS, NERC and Research Councils on national and international information-related organisations and bodies. These include the UK Location Council, the IUGS Commission for the Management and Application of Geoscience Information, the Association for Geographic Information, European INSPIRE-related working groups and data specification drafting teams, and the Geological Society of London's Information Management Committee. ■

Information Management



Consolidation of UK hydrocarbon sample archives: one of the core storage aisles at BGS Gilmerton, showing just a fraction of the 300 km of core and 5 million cuttings samples.

The decision to consolidate the substantial but disparate core holdings that the BGS manages into a single 'state-of-the-art' facility at Keyworth is providing a unique opportunity to photograph and audit the DECC UK continental shelf hydrocarbon archive of over 172 000 boxes of core and cuttings from over 8000 wells. An independent 'Gilmerton Core Move Advisory Group' oversaw the development of a transfer methodology and continues to monitor progress. Adoption of a production-line technique, coupled with extensive use of barcodes and database systems, is enabling the core to be imaged at high resolution, audited, and stabilised for transport at a rate matched to the demanding schedule. Quality control inspection of the core on arrival at Keyworth has detected no transfer damage.

The relocation of the Gilmerton holdings into a single facility in Keyworth also involved moving the analogue collection of well data and additional supporting information. Data representing the equivalent of approximately 2.5 km of

shelving has been transferred to Keyworth to date and is now available as a resource to support the core collection. The transfer enabled the data to be reviewed, storage to be improved where necessary and an improved process for monitoring locations implemented. Planning the move of the remaining information such as seismic data and track charts is well under way.

A consolidated and integrated Core Store database system has been designed, implemented and populated with our core data holdings. The system incorporates a totally new database design, plus a series of applications which enables our entire core collections to be searched, indexed, managed and attributed. Applications for data entry and capture, scanning and attribution of core photos, quality assurance/management and external presentation via the World Wide Web to the public and scientific community have been built and implemented. This is a key resource, located at the hub of our centralised corporate database system, and allows our important and unique core collection to be related to the wealth of geoscientific information we hold.

The workflow for the Gilmerton core transfer operation was subjected to an internal quality assurance assessment before the main photography phase began in March 2011 and an assessment by the external auditors (BSI) in June when the



The Gilmerton photography and stabilisation packaging workstation.

process was in active operation. It was evident that the processes examined had benefited from trial runs; ideas for improvement having been identified and implemented. The views of interested parties had been considered during the planning and a real effort made to make the process both transparent and effective. ■



Typical high-resolution core photograph.

Information Products

Information Products develop and maintain key national datasets in geology, soils, chemistry and energy. These underpin research and knowledge exchange across NERC.

Baseline products are core datasets that provide the starting point for many geoscientific research activities. There have been significant new releases of five digital datasets this year. DiGMapGB-10 and DiGMapGB-50 have each been updated with a substantial number of new sheets and amendments. DiGMapGB-50 underpins the new releases of GeoSure and the Soil-Parent Material Model and this year has formed part of the new NERC Soil Portal. The portal offers users easier access to soil-related datasets created by the BGS and CEH. In offshore products, we have a new release of DiGSeaBedSediments-250, which now incorporates high-resolution multibeam data. It is jointly released with a new data layer: DiGHardSubstrate-250. Together, these provide invaluable information about the nature of the seabed in our coastal and marine environments.

Derived products deliver a range of geoenvironmental information for the shallow subsurface. Potentially harmful chemical elements (PHEs), occur in the environment and under certain circumstances can be harmful to plants, animals or people. A significant proportion of the urban landscape in Great Britain has naturally elevated ambient surface soil concentrations of these PHEs that exceed the Environment Agency soil guideline value (SGV). An Urban Soil Chemistry dataset covering 24 urban centres including London has been developed. These spatial datasets will help to inform planning decisions and aid environmental consultants, developers, householders and their legal representatives. A new method of mapping urban soil chemistry has been developed for elements with a strong geological control such as aluminium. This is particularly important for

The BGS designs a range of geological illustrations for Harvey British Mountain Maps such as this one showing the geology around Torridon in the north-west Scottish highlands, draped over NEXTmap Digital Terrain Model (© Intermap Technologies).

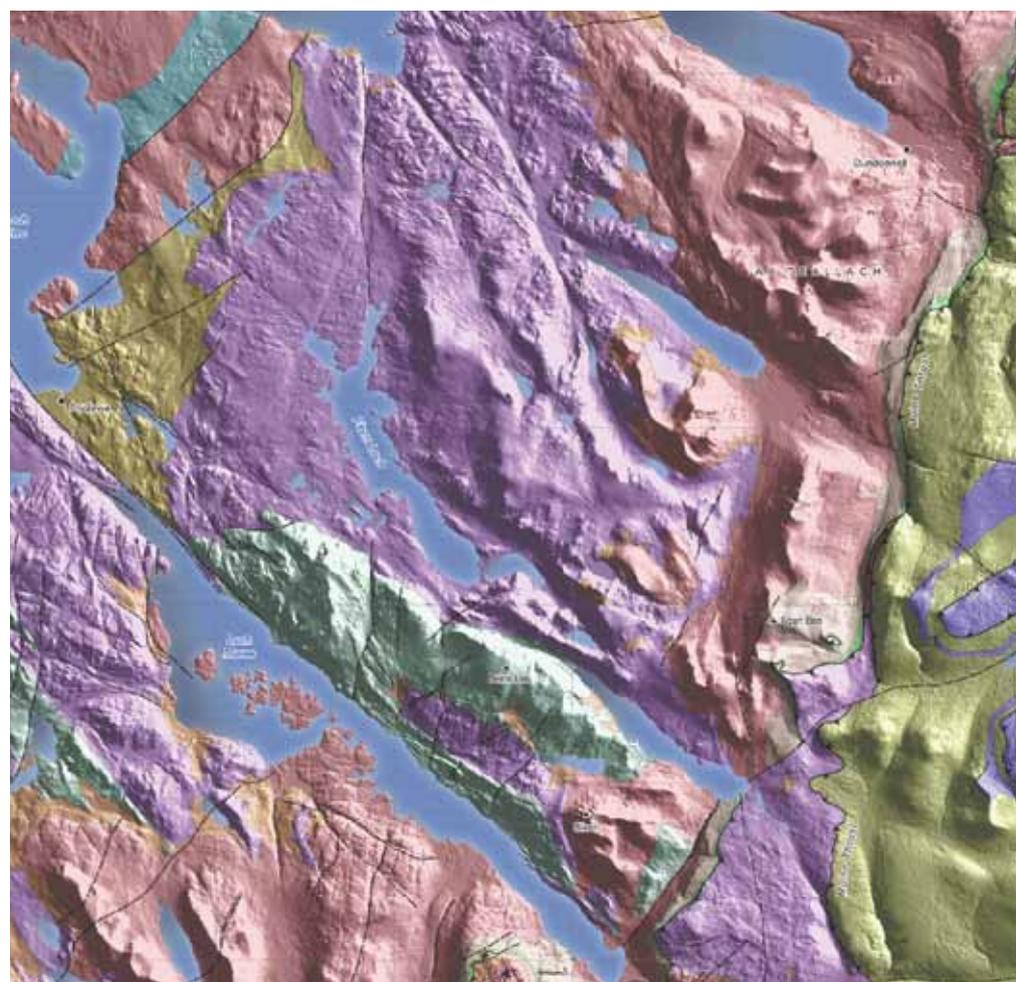


The new NERC Soil Portal.

accurately mapping soil arsenic derived from ironstones, such as the Northampton Sand Formation (NSF).

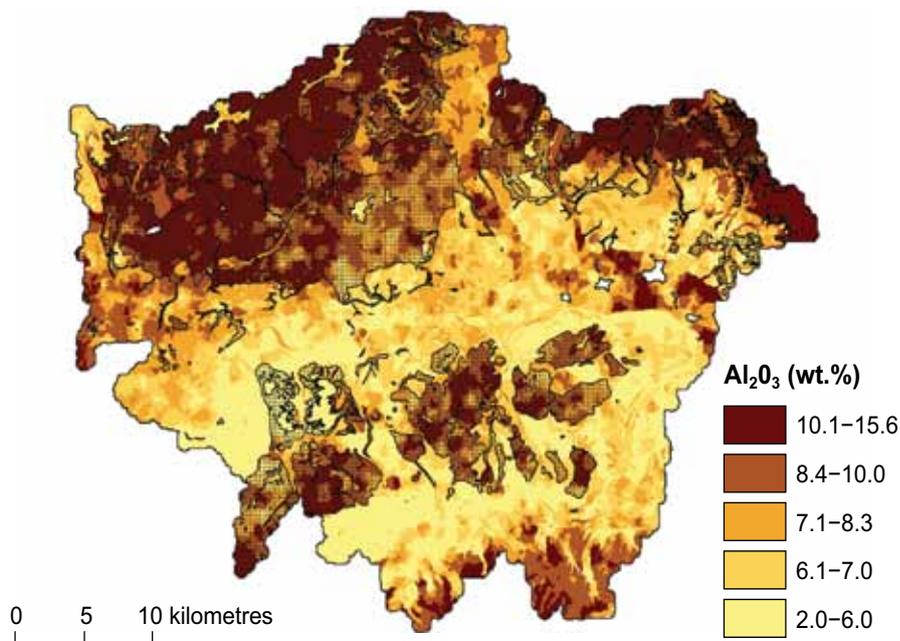
All products developed within the programme undergo a rigorous data

validation process. An assessment of factors, from GIS issues (such as geometry, attributes and data structure) and consistency in approach results in improved products released externally. This



gives confidence that the final outputs are scientifically sound and enhances the quality of our national datasets.

This year saw the formal incorporation of the CartoGIS service within the Data Capture and Best Practice team. The service is responsible for the generation and output of a wide range of products, mostly associated with the Geology and Landscapes and Information Products areas. A major piece of work is the capture of survey scale geological mapping data, realising over 10 000 square kilometres of new data. Cartographers simplify these data into one of the BGS flagship outputs, with 10 geological maps published at a scale of 1:50 000. The data are incorporated into DiGMapGB-50. The service also completed over 800 high-quality illustrations for BGS and peer-reviewed publications, as well as maps and booklets for external clients. Innovative products representing a move towards full digital data delivery includes an interactive map for Anglesey. Support was also given to GSNI, resulting in the finalisation of digital survey scale data for 90% of Northern Ireland. ■



Topsoil aluminium concentrations in the Greater London urban area interpolated to a 100-metre parent material grid. The stippled area indicates the outcrop of the London Clay Formation. High aluminium is also associated with clay-with-flints in the south and alluvium in the Lea and lower Thames valleys.

Knowledge Exchange

The Knowledge Exchange programme continued to innovate with new web and communication technologies to link BGS science to the public, research and business communities. The iGeology mobile application ('App') is a leading development, and was a world-first in delivering intelligent geological maps to street-level detail, free of charge for private, research and educational users. Since its launch in September 2010, the iGeology App has been downloaded over

50 000 times from 56 countries around the world. It was featured on Radio 4's Material World, became the No.1 free educational app on iTunes when launched and has been acclaimed in the geographical information industry and education sectors.

iGeology is part of the continuing highly successful and award-winning OpenGeoscience web service. This year a considerable amount of new open access material has been added to the

OpenGeoscience web portal, including, over a million borehole record scans from the National Geoscience Data Centre and numerous other photograph, record, map and digital database collections. Alongside this increased open access drive, the KE programme continued to provide a range of successful commercial information services for the business community, including working with 17 value-added resellers and issuing hundreds of copyright and digital data licences.

The Communications team has used the power of the web increasingly for communicating our science and for providing authoritative geoscientific advice on natural emergencies across the globe, such as the Japan earthquake and Iceland volcanic eruption. The BGS received over 3000 online media hits in the year. The official BGS Facebook, YouTube and Twitter channels were expanded to serve a broadening online audience made up of media professionals through to the general public. The BGS website

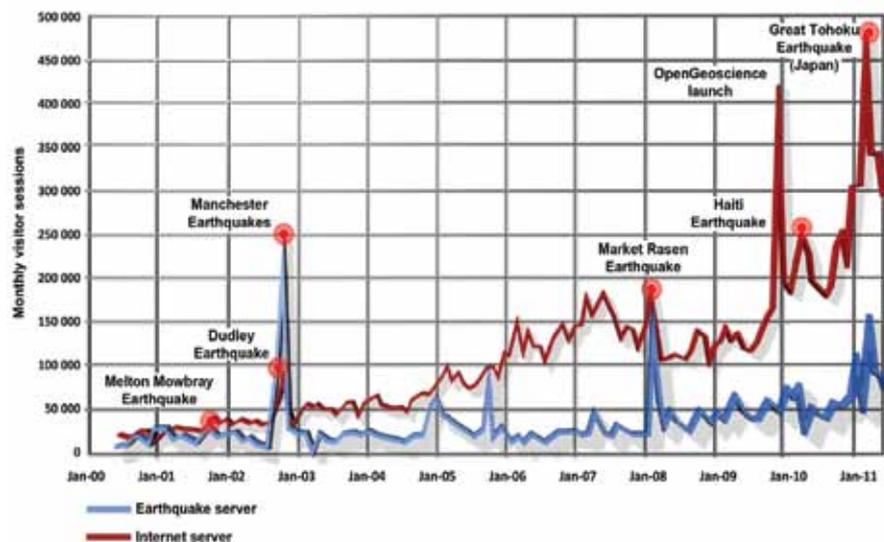


School children enjoying geology during National Science and Engineering Week.



BGS scientists carry regular press interviews; here Dr Andy Bloodworth is interviewed on Countryfile regarding coal resources.

has been kept up to date with dynamic science content on key geoscientific issues relevant to modern society, such as climate science, groundwater flooding and shale gas; over 130 new science web pages were released as a



The BGS website has shown a dramatic increase in use over the past 10 years, with peaks in demand during natural disasters; the OpenGeoscience launch has also significantly boosted interest in BGS web services.

result. The BGS press office continues to be very busy, dealing with 546 media enquiries in the year and co-ordinating many television and radio appearances for our leading scientists, including the BBC's *Men of Rock*

series, *Countryfile* and *The One Show*. The strong programme of outreach activities was continued, including the School Seismology Project and a BGS-run session at the British Science Festival. ■

Systems and Network Support

Systems and Network Support (SNS) provides specialist scientific and general IT support to BGS staff as well as support for some of the NERC's corporate IT systems. Management of computer rooms, local area networks, systems administration and maintenance, database administration, IT security, and provision of IT equipment are just some of the areas SNS covers.

SNS staff are regularly seconded to other sections of the BGS and NERC. They contribute skills and expertise to areas including project management and planning, development and installation of IT systems and networks both in the UK and overseas. A recent example is the move of National Oceanography Centre's (NOC) email system from University of Southampton to the NERC corporate email system.

The new computer room at Keyworth, which received an award for its contribution towards reducing the NERC's carbon footprint.

SNS work in a close relationship with NERC Information, Systems and Technology (IST) staff. This has been a beneficial and efficient change and further savings are expected.

Construction of a new computer room at Keyworth to house BGS and NERC corporate IT equipment was completed in October 2010, and is regarded within the NERC as a key IT infrastructure resource for both present and future use.

Reduced energy consumption and increased reclamation of heat from exhaust air will contribute to improved efficiency and reduce the NERC's carbon footprint. Waste

heat is being collected and used to heat the extended NGDC core store.

Email services for the whole of the NERC are provided by SNS staff. This year one focus of work in this area has been improvements to email and staff calendars. Management of the underlying Active Directory and infrastructure is a joint effort between SNS staff and NERC IST staff.

Wireless network access is now available throughout Murchison House for both staff and visitors, and the Keyworth site has a steadily increasing level of coverage, governed largely by the continuing construction works on the site. ■





Resources and Business

Towards the end of 2010/11, the previous Resources and Business Directorate along with Administration and Finance were deconstructed to be reformed as the Resources and Operations Directorate. This resulted in the establishment of a Resource and Operations Directorate (ROD) bringing together the administrative and finance functions with human resources (HR), staff resourcing, learning and development and project support. The new structure was implemented from 1 April 2011.

A significant priority over the past year has been to ensure, through workforce planning, that skills shortages are identified and addressed by retraining or recruitment. These processes are managed by HR in conjunction with the Skills Leaders. HR also manages transactional relationships with the Shared Services Centre (SSC) and provides day-to-day HR consultancy services to the BGS as a whole. Our People Plan was further developed, our policies and procedures

continued to be reviewed and any required training was delivered.

Science and information staff are co-ordinated by a Head of Skills along with the Skills Leaders who manage career development, training and staff allocations to projects. A key function is to ensure that staff and certain physical resources are directed in the most appropriate manner to meet the requirements of the BGS's work programme. Within the organisational matrix, multidisciplinary teams are brought together to focus on specific tasks or projects.

We place staff training and development high in our objectives and an active Learning and Development (L&D) team co-ordinates and delivers training to our staff, as well as to geoscientists from beyond the BGS through the GeoSchool. The manager of the L&D team is responsible for delivering the L&D plan to meet staff development needs across the organisation.

The UK Business Development (UKBD) and International Business

Development function is responsible for corporate marketing, co-ordination of grant applications, supporting the Senior Leadership Team, maintaining links with clients and stakeholders both in the UK and internationally and managing large, multidisciplinary overseas projects. These sections work closely with all parts of the BGS to promote our capabilities, understand market needs, and engage with clients and stakeholders, as well as to prepare bids and tenders.

The Grantsmanship team is responsible for co-ordinating the Survey's activities in Europe and, in particular, helping to win EU-Framework grants. It also prepares the ground for the BGS to bid into future NERC calls for Research Projects. Over the past year this involved extensive classification of current activities, training in how to write grant proposals, and identification against the NERC's Theme Action Plans of priority areas for the development of skills and capabilities. ■

International Projects

Hungarian red mud catastrophe

On 4 October 2010 approximately 700 000 cubic metres of red mud — a waste product from aluminium production — escaped when a tailings dam collapsed near Ajka in Hungary. This disaster killed 10 people and seriously affected nearby villages, rivers and 40 square kilometres of land.

The UK government via the Chief Scientific Advisor offered technical and scientific help to Hungarian authorities resulting in a team from the BGS and Newcastle University visiting the site in November 2010. The BGS team along with Professor Paul Younger, Newcastle University, were part of the British assistance to Hungary promised by the UK government. The scientists included experts in engineering geology, geochemistry and hydrogeology. As part of this visit the team worked with Hungarian counterparts from the Ministry of Rural Development, Geological Institute of Hungary (MAFI), Research Institute for Soil Science & Agricultural Chemistry of the Hungarian Academy of Sciences (RISSAC), and Budapest University of Technology and Economics (BME).

Following this visit the BGS and Newcastle University produced a visit report and offered technical assistance in a number of geoscientific fields, such as geological and



(above) Staff of the Geological Survey of Scotland, early winter of 1910: H B Maufe is second from the left, back row (with pipe), while Ben Lightfoot sits cross-legged on the ground, right; H S McVey, standing to the left of Maufe, was also subsequently to join the Southern Rhodesian Survey as draughtsman.

(left) CD-ROM produced by BGS to celebrate 100 years of the Zimbabwe Geological Survey (as well as our own 175th anniversary).

groundwater modelling, physical property attribution and the simulation of the uptake of metals by human consumption (e.g. soil and dust ingestion).

Celebrating 100 years of the Geological Survey of Zimbabwe

The arrival of Herbert Brantwood Maufe at Bulawayo, Southern Rhodesia, in September 1910, may be said to mark the foundation of the present Zimbabwe Geological Survey Department, now based at Harare. Maufe had been on the staff of the Geological Survey of Scotland, and his relocation to what was then the British colony of Southern Rhodesia was undertaken at the invitation of the British

South Africa Company. Maufe immediately began an examination of the Enterprise gold field east of Salisbury (now Harare), as appears from his first progress report as Director of the Geological Survey, dated February 1911. In May of that year he was joined by M E V Zealley and Ben Lightfoot, the latter having been one of Maufe's colleagues in the Scottish Survey (see group portrait). The BGS thus played no small part in assisting the establishment of the present Zimbabwean Survey.

To commemorate this event, we have produced three new compilation maps of the whole country in digital format. The maps were compiled at a scale of 1:1 million and show: (1) base metals, gems, industrial minerals and hydrocarbons; (2) precious metals, and (3) tectonic structure. The work of compilation was undertaken by Peter Pitfield, who presented a CD-ROM to the Zimbabwean Survey at a commemorative symposium in October 2010. Copies of the CD-ROM are freely available to bona fide enquirers. ■

Recording the depth that the red mud plume reached in Devescer, approximately five kilometres down-gradient of the collapsed tailings dam.



NERC Isotope Geosciences Laboratory

The NERC Isotope Geosciences Laboratory (NIGL) is a facility for the study of stable and radiogenic isotopes focusing on environmental change, chronology, and science-based archaeology, in a collaborative research environment, including a strong focus on Ph.D. student training.

The NIGL comprises two groups of analytical facilities complemented by a skilled scientific and technical staff:

- **Stable Isotope Facility:** isotope analysis of waters, carbonates, biogenic silica, phosphates, biomass in both organic and inorganic materials for the isotopes of H, C, N, O, S, and Si by gas-source stable isotope mass spectrometry.
- **Radiogenic Isotope Facility:** high-precision and high-spatial resolution U-Th-Pb geochronology; isotope ratio (U, Pb, Hf, Nd, Sr) analysis of a wide variety of geological and environmental materials.

Scientific highlights during the year included the publication of research into changes in the freshwater composition of the upper ocean west of the Antarctic Peninsula. In recent decades, the west Antarctic Peninsula has warmed more rapidly than anywhere else in the Southern Hemisphere. Associated with this, there has been a marked shortening of the sea-ice season, a retreat of the majority of glaciers, and an increase in precipitation. Each of these changes in the freshwater system has the potential to exert significant influence on the ecosystem. This investigation used a time series of hydrographical and isotope data to quantify



Used with permission of Mike Meredith, BAS

Sea-ice melting to the west of the Antarctic Peninsula.

the prevalence of meteoric freshwater (*Progress in Oceanography*, Vol 87, 127–143)

In another study we used lake sediment studies from Sweden to illustrate how Holocene age oxygen isotope records from lakes located in different hydrological settings can provide information about climate change. In particular, these included changes in precipitation and water balance related to changes in atmospheric circulation and negative phases of the North Atlantic Oscillation. (*Climate of the Past*, Vol. 6, 46–62).

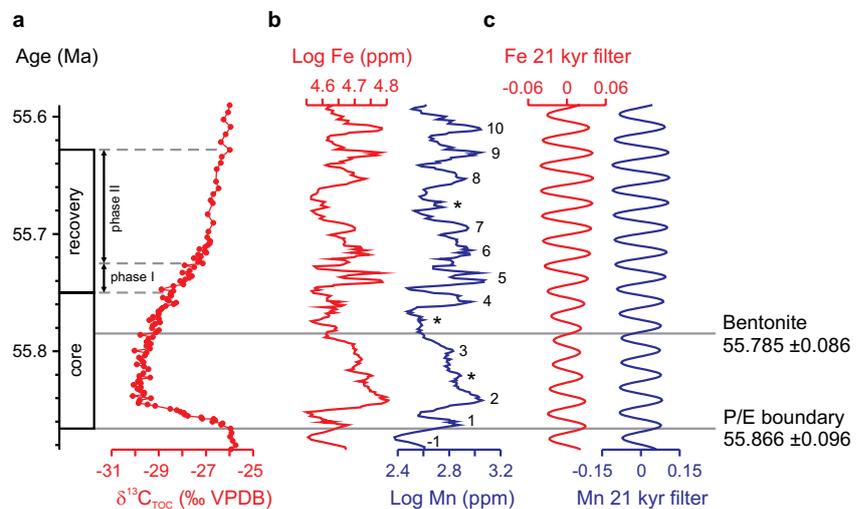
A combined radioisotopic dating and cyclostratigraphical study for the carbon

isotope excursion at the Paleocene/Eocene boundary in Spitsbergen has allowed us to determine its age directly and improve our understanding of its geological context. Combined radioisotopic and cyclostratigraphical datasets give an age ranging from 55.728 to 55.964 Ma for the Paleocene/Eocene boundary which defines the onset of the Paleocene–Eocene thermal maximum (PETM). Given the Paleocene Epoch spans twenty-five 405ka cycles, our new age for the boundary suggests an age of about 66 Ma for the Cretaceous/Palaeogene (K/Pg) boundary. (*Geochemistry, Geophysics and Geosystems*, DOI: 10.1029/2010GC003426). ■

Northern Swedish lakes contain climate information through the last 10 000 years.



Used with permission of Gunnhild Roseqvist, Stockholm



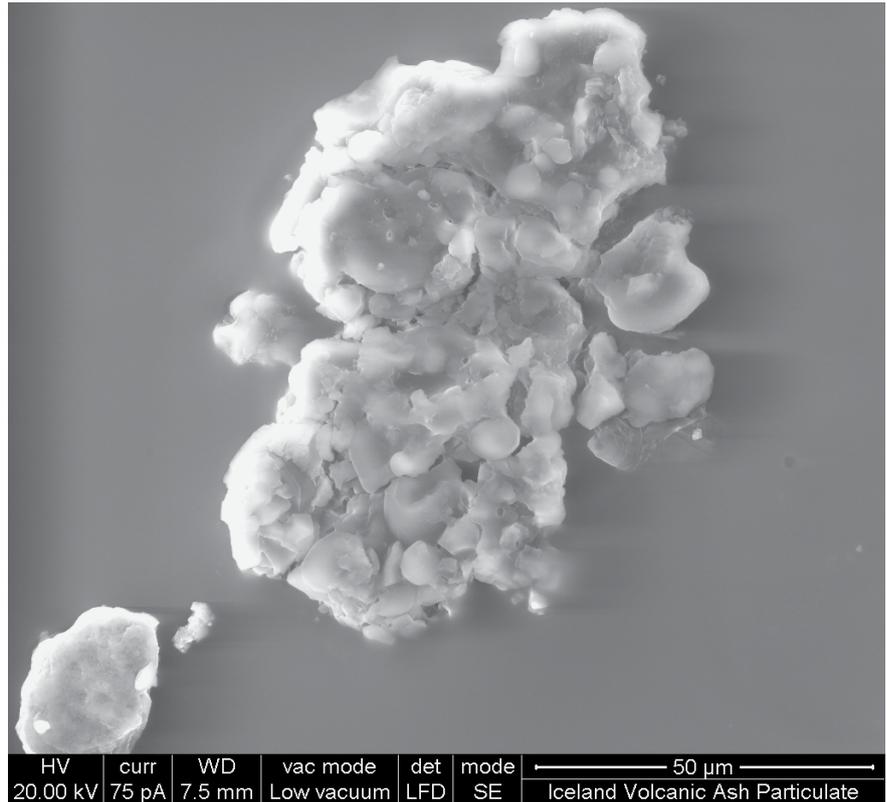
Geochemical information over the Paleocene/Eocene boundary in Spitsbergen.

Science Facilities

The Science Facilities programme is responsible for the strategic and operational management of all the BGS's science facilities, ensuring that they provide a high-quality, cost-effective and scientifically well-aligned input to the core strategic and commissioned programmes. The facilities encompass a wide range of laboratory facilities within the Analytical Geochemistry; Mineralogy, Petrology and Biostratigraphy; Physical Properties; and Fluid Processes Research disciplines. The programme also manages marine and engineering operations; a drilling facility; downhole geophysical logging; geophysics equipment; geophysical observatories; i3DVF and image analysis laboratories.

Highlights for 2010/11 include:

- The K-Block laboratories have been refurbished, creating a showpiece for the National Physical Properties and Processes Laboratories. As part of the programme of investment in this centre of excellence, a new rock-testing system has been designed and installed to carry out specialist geotechnical and geomechanical research. The hydrates and ices laboratory has also been upgraded to include a purpose-built, walk-in cold room for large-scale freeze-thaw cycle tests over the range -20°C to +60°C.
- There has been significant investment in new equipment associated with the



SEM image of ash from Eyjafjallajökull volcano eruption in Iceland.

National GeoEnvironmental Laboratories. This includes: cathode luminescence imaging system for the environmental scanning electron microscope (ESEM), cryogenic chamber for the X-ray diffractometer, mass spectrometer for thermal analysis, mercury injection porosimeter, state-of-the-art ICP-mass

spectrometer (the first of its kind in the UK), ion chromatograph, and new analytical techniques for determination of noble gases in water, organic matter in solids by pyrolysis, and ²¹⁰Pb gamma dating.

- The BGS's XRF facility was acquired by leading analytical X-ray company PANalytical (Almelo, the Netherlands). The establishment of the PANalytical laboratory on the Keyworth site is seen as the start of a geoscience business cluster at the BGS head office aimed at building external partnerships to improve the quality, reach and impact of our science.
- The Geophysical Logging Facility carried out gamma, caliper and temperature logging of a new trial geothermal borehole in Newcastle to a depth of about 950 metres — the deepest work conducted since an upgrade of the facility's digital system.

The Dando team drilling the Llanfihangel Moraine near Abergavenny.





Lithium brine resources evaluation in Olaroz Salar, Argentina.



Geophysical logging, optical imaging and pump testing at a petroleum refinery.

- The Marine Operations and Engineering facility successfully deployed, for the first time, the new BGS Survey Vessel *White Ribbon* and completed projects in the Forth, Loch Eriboll, the Clyde Estuary and Windermere.
- The BGS Geophysical Observatories provided 100% coverage of geomagnetic

activity within the UK, with 99.7% of real-time data processed and delivered to customers within four minutes. ■

Learning and Development

During 2010/11 we continued to provide staff training and development opportunities in support of the delivery of our science programme. Emphasis was placed on addressing skills gaps in growing areas of BGS science as well as on providing a range of development activities which contribute to a policy of continuing professional development.

Areas of skills development addressed through learning and development activities included the following:

- Communicating BGS science to both specialist and non-specialist audiences with training courses covering the communication of science to the public, media and presentation skills, creating podcasts, and scientific and technical writing.
- 3D modelling and visualisation systems supported through training in GoCad, GeoVisionary and GSI3D.
- The dissemination of mathematical skills for data processing, analysis and interpretation through courses in Matlab, basic statistics, multivariate statistics using the R programming language and geostatistics.
- The interpretation and visualisation of spatial data and imagery with training courses in ArcGIS and SOCETSET.
- Introductory and more advanced management principles and practices addressed through courses which will form components of the NERC Management Development framework.
- Leadership development for senior staff through a series of workshops and specialist modules under the ongoing NERC corporate L4N programme.
- Improving the quality of grant proposal applications through courses and workshops on grant proposal writing and making the best of EU funding opportunities.
- Parallel programming techniques and the use of high-performance computing.
- Geochemical data analysis, interpretation and presentation through a series of geochemical baselines workshops.
- The use of specialist laboratory techniques and instrumentation.
- Helping staff to develop their careers and fulfill their potential through the BGS mentoring scheme.

Increased emphasis was placed on using technical coaching and on-the-job training as an effective way of providing timely and highly focused knowledge transfer between staff, especially for new recruits, staff returning to work after a period of absence and those needing to acquire new skills due to a change of job. ■

Developments in BGS funding

The NERC funding model continues to develop and to impact on BGS funding. The table (right) summarises key trends in income and expenditure for Resource (annual expenditure and income) and for Capital over a three-year period. The overall size of the BGS has shrunk year on year from 2008/09 (adjusted for the IODP cruise programme) and continues to do so into 2011/12. This is shown by the reduction in total resource expenditure and in the reduction in staff costs (reductions in staff numbers are discussed in the HR pages). Staff costs have not reduced in proportion to the reduction in staff numbers as the cost of employing each member of staff continues to increase. Employer pension contributions increased by 5% from 2009/10 to 2010/11 and National Insurance contributions have increased over this period and continue to do so into 2011. The resource allocation increased by £1m between 2009/10 and 2010/11 to compensate for the increased costs in this area. These increased staffing costs are reflected in our charge-out rates, making our staff more expensive.

The NERC Resource allocation to the BGS continues to shrink from £26.9m in 2008/09 to £25.26m in 2010/11 to £24.2m in 2011/12. In particular this is because the allocated Research Programme funding is being ramped down each year. The underlying reduction in allocation is not clearly demonstrated in the table because other items are included in the resource allocation, such as the additional allocation for pensions (£1m mentioned above) and the inclusion of resource expenditure on capital schemes being

Summary of income and expenditure	2008/09 £M	2009/10 £M	2010/11 £M
Income			
NERC resource allocation	26.90	23.85 ¹	25.26
External income	20.14	22.14 ^{1,2}	20.20
Internal income	1.51	2.57	2.81
Total income	48.55	48.56	48.27
Expenditure: staff costs	31.59	32.59	31.80
Expenditure: operating costs	16.57	15.71	14.75
Internal trading expenditure	0.34	0.22	1.27
Gross expenditure	48.50	48.52	47.82
Over/(under) spend	0.05	0.04	0.45
Capital			
NERC capital allocation	7.67	8.87	8.08
Gross expenditure	7.67	7.24	8.08
Over/(under) spend	0.00	1.64	0.00
Notes			
1	In 2009/10 commercial income from previous years was recognised amounting to £2.526 m, the NERC reduced their allocation to the BGS by this sum. The external income figure has been reduced and the resource allocation increased by this amount to reflect the underlying trends.		
2	All external income figures exclude the International Ocean Drilling Programme payments to external partners.		

included in 2010/11 (£763k). The funding won from competitive Research Programme and Responsive Mode grants has increased by a smaller amount — this is shown by the increase in the internal income line.

Externally won income continues to provide a significant element of our funding. In 2010/11 we earned £20.2m from research commissioned by external partners and customers and from chargeable services, products and data licensing. The externally funded projects accounted for £16.6m of the £20.2m external income. These projects enhance the NERC allocation through funding, ideas, data and review as well as making a vital contribution to our infrastructure.

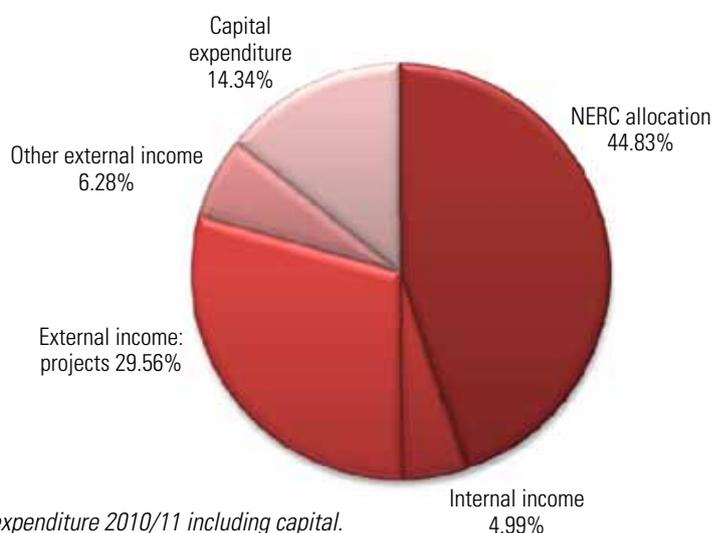
Overall we have managed our finances well within our different funding streams and achieved a near-balanced budget. Our

figures for 2010/11 are not yet finalised and we anticipate that the currently reported £450k underspend will be reduced.

The capital figures show the considerable investment (£23m) being made in particular on the BGS sites in Keyworth and Edinburgh over the three-year period (see Estates below) for details of this programme).

Introduction of the RCUK Shared Services Centre

The financial year 2010/11 saw the introduction of the RCUK Shared Services Centre (SSC) to deliver many of our financial transactional services. The centralisation of finance processes and introduction of an integrated enterprise resource planning (ERP) system has meant that the BGS is working in an increasingly standardised way with the rest of the NERC and to an extent with the rest of the Research Councils. The much-reduced finance team at the BGS (from 35 full-time equivalent posts in 2009 to 14 in 2011) now works to agree new working methods and resolve issues with the rest of the NERC finance team across its research centres together with the SSC. Teething problems with the SSC meant that the delivery of financial services was not as smooth as previously with, in particular, large numbers of supplier invoices being delayed or on hold. These issues are now being resolved with help from the retained finance team and the NERC year-end accounts will be presented to Parliament after the recess. ■



Estates, Environmental Management, and Health & Safety

Following completion, on budget, of the William Smith Building at Keyworth, we were successful in gaining funding for a further development of the site. Permission was granted for a new 100-person open-plan building, conference centre, reception area and exhibition space.

The new James Hutton Building will be a modern, flexible, open-plan office space designed to improve both energy efficiency and use of space. The conference centre and reception area will replace the current outdated facilities.

The project began in the third quarter of the financial year and has progressed within budget. The L-Block refurbishment, which includes the reception, conference centre and exhibition facilities, will be handed over in September 2011. The James Hutton Building is due for completion in December 2011.

Once the new developments are complete, several of the site's old and inefficient buildings will be demolished and the area landscaped on a geological theme.

The core store extension completed in 2009/10 is now in use. The transfer of cores from the Edinburgh facility to Nottingham has begun and is on target for completion in 2012. Once the project is complete, we will be in a position to dispose of the building at Gilmerton, raising revenue for the NERC and reducing our ongoing costs.

The new computer suite is in use and achieved an 'excellent' Buildings Research Establishment Environmental Assessment Method (BREEAM) rating. It also received a commendation at the LABC Building Excellence Awards in the Best Sustainable Development category. It is expected that NERC services will continue to transfer to this central facility.

The William Smith Building is now occupied by 200 staff who were previously housed in old office stock. The main contractor ceased trading shortly after completion which caused a delay in dealing with defects but this was remedied early in

2011 and work to address the outstanding items has started.

Other projects carried out by Estates included:

- An extensive refurbishment of our K-Block laboratory suites.
- Upgrades of the fire alarms at both the Keyworth and Edinburgh sites.
- Upgrades to the Buildings Management System at the Keyworth and Murchison House (Edinburgh) sites. This enables the systems in both buildings to be controlled via software and provides accurate energy usage data.
- Replacement of electrical distribution boards at Keyworth.
- Refurbishment of the sash windows to the three listed magnetic observatory buildings at Eskdalemuir in Scotland. This involved more than eighty window sets. The project not only addressed the deterioration of the original windows but also provided draught proofing in order to reduce heating costs.
- Creation of a Core Teaching Facility at Murchison House which will house 2000 cores and ensure that Scotland retains this valuable resource.

Environmental management

The NERC's ongoing commitment to the environmental accreditation standard BS EN ISO14001 means we continue to audit

both internally and externally. During the year 2010/11, we achieved reaccreditation following an external audit.

This year saw the introduction of the Carbon Reduction Scheme and we contributed fully to the successful implementation and subsequent monitoring. A key aim of all new works is to reduce energy consumption in order to meet the aim of a 40% reduction in carbon emissions over a ten-year period.

Voltage Optimisation Devices were fitted at our two largest sites this year which step down the voltage from 240V to 220V. It is predicted that this will reduce electricity usage by between 7% and 10% but will have no detrimental impacts on equipment.

In addition, our Environmental Committee has introduced a programme of campaigns to promote the reduction of energy usage.

A review of the vehicle fleet operation this year has recommended that the service be outsourced to a spot-hire contract in 2011/12.

Our video conferencing facilities are well used at all sites. This facility, along with telephone conferencing, is actively promoted and use of both systems is expected to continue to rise, further reducing the number of business journeys undertaken.

We have extremely robust recycling programmes and both the Keyworth and Murchison House sites quantify recyclable

The new James Hutton building at Keyworth begins to take shape, February 2011.



waste and landfill. For instance, 80% of all waste produced on the Keyworth site is recycled.

A pilot project at Keyworth to replace individual office bins with recycling stations proved to be successful and will be rolled out during the next financial year.

A composter now handles all of the food waste from our Keyworth restaurant along with other kitchen waste from around site.

The current round of building and refurbishment has continued to disrupt the biodiversity at our Keyworth site. The work is expected to be completed during 2011/12 after which the landscape will be improved with larger areas of planting and grassland intended to encourage even more wildlife. Biodiversity at our other sites remains stable.

Health and safety

Health and safety systems continue to be developed and implemented in line with the NERC's policy and to ensure that the requirements of current legislation and best practice are met. Staff are encouraged to report accidents and near-misses and a new online accident reporting system was successfully introduced during the year. All accidents, significant near-misses and occupational health occurrences are investigated and reported at both BGS and NERC level. Our aim is to drive down the number of dangerous occurrences and accidents in line with the Health and Safety Executive's targets. Appropriate training is arranged for all staff to improve their skills and competencies where gaps are

identified and online training packages were purchased in order to enhance our training systems.

We provide occupational health support and advice via external professional suppliers. This has proved an effective way to deliver the service and the Health and Safety team work closely with Human Resources to ensure that cases are identified and suitable action taken.

The Health and Safety team have a timetable for inspection and carry out regular audits along with Trade Union advisers. Areas for improvement raised on inspection audits are subject to appropriate timed action. This visible work helps to raise the profile of health and safety while ensuring that safe standards are maintained for all our staff. ■

Human Resources

The start of the year saw the transactional functions of finance, procurement and human resources (HR) moved to the RCUK Shared Service Centre (SSC) with self service being adopted by the BGS staff. This resulted in a restructuring of those functions and a reduction of 24 people (21 full-time equivalents) who left on redundancy terms as part of the process. The retained HR team saw a reduction of 58% from the original complement. As there was limited direct training for staff in the live environment a number of BGS staff were identified to coach colleagues through the initial transition period. The HR functions were introduced in phases and, initially, recruitment and appraisal were

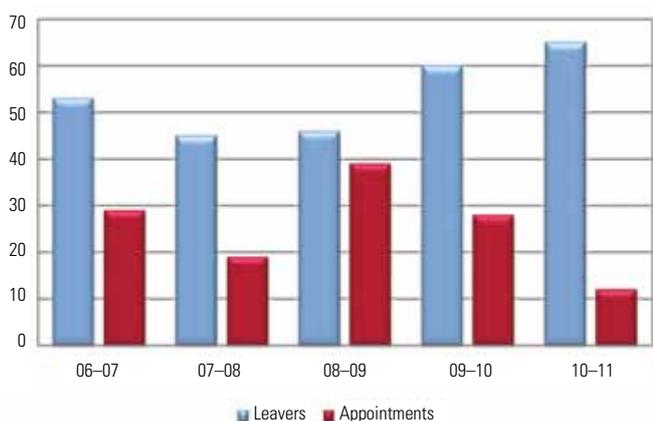
retained within the NERC pending redesign of the system to meet the needs of individual Research Centres. Payroll went live in October and the initial transfer was successful with only a limited number of cases needing to be resolved. Work continued with the SSC throughout the year to develop and improve the reliability of the service and this had an impact on the retained team moving into the business partner model we will be adopting.

The announcement of the 2010 Comprehensive Spending Review led to a further review of workforce planning and the start of long-term reshaping of the workforce. The Department for Business, Innovation and Skills introduced a recruitment freeze which required us to be imaginative and flexible with

resources. However, over the previous five years there had been a steady reduction in our staff complement resulting from rationalising and refocusing our resources to meet our strategy. The figure below breaks down staff turnover during this period and shows a total of 98 appointments and 216 leavers. A series of reviews will be carried out, both centrally at the NERC and within the BGS. The first of these was a review of the Estates function and the resulting recommendations will be implemented in 2011/12 and 2012/13.

During the year, career development discussions commenced as part of the NERC 'Deal' initiative. Within the BGS, our Skills Leaders have regular discussions with staff about their long-term career aims and the

Appointments and leavers for the period 2005/6 to 2010/11



	Appointments	Leavers
Applied & Survey Geology	7	29
Business & Operations	17	59
Geochemistry, Mineralogy & Hydrogeology	18	31
Geophysics & Marine Geology	27	28
Information Resources & Collections	11	15
Information Systems and Infrastructure	7	21
Minerals, Engineering & Hydrogeology	3	6
NERC Isotope Geosciences Laboratory	4	3
Spatial & Information Technologies	1	11
Senior Management	3	13

expectations of the organisation. However, the Deal discussions in some cases also enabled employees to meet more senior staff to discuss strategic scientific aims within the context of their career development. Those involved have reported positively on these discussions and there will be a programme of further interviews during 2011/12 with an aim of completing them in 2012/13.

Having implemented a Research Associate Programme the previous year, we appointed a further four Associates within the modelling discipline which is an area we need to grow. Further appointments are expected after the more detailed workforce planning exercise.

The year saw two Directors retiring from their roles on the Senior Leadership Team and that team reshaped to meet the future

challenges of the NERC National Capability integration programme. A new post of Director of Corporate Strategy was created and Dr Mike Patterson was appointed at the end of the year. Professor Randy Parrish was appointed Director of Science Facilities. ■

Business Support

The Business Support team provides support and guidance for project management and business systems, as well as responsibility for governance and audit duties that relate to quality assurance, project risk management and business performance.

Governance and quality management

Review and audit undertaken during the year by the British Standards Institute (BSI) has resulted in ongoing accreditation to the ISO 9001:2000 quality management standard. Continuing UKAS accreditation for our laboratory operations has also been achieved.

We have continued to drive towards a more holistic approach to audit. A closer liaison between the Quality Assurance Committee and the BGS internal audit team has been formed. Progress has been made towards a more joined-up approach to the execution of our internal and external audits. Environment and corporate business activities are now assessed in parallel, reducing the number of audit days across

the organisation. Additional benchmarks of performance against external and internal standards are being established and reported. External audits this year have provided evidence of the technical competence of the internal audit process.

Work to ensure the management systems we employ are both relevant and transparent in their application continues. A previous objective of establishing a business assurance 'roadmap' to demonstrate best practice in governance and quality management has been established. Further development of this will complement and enhance our capacity for excellent science.

Resource and project management systems

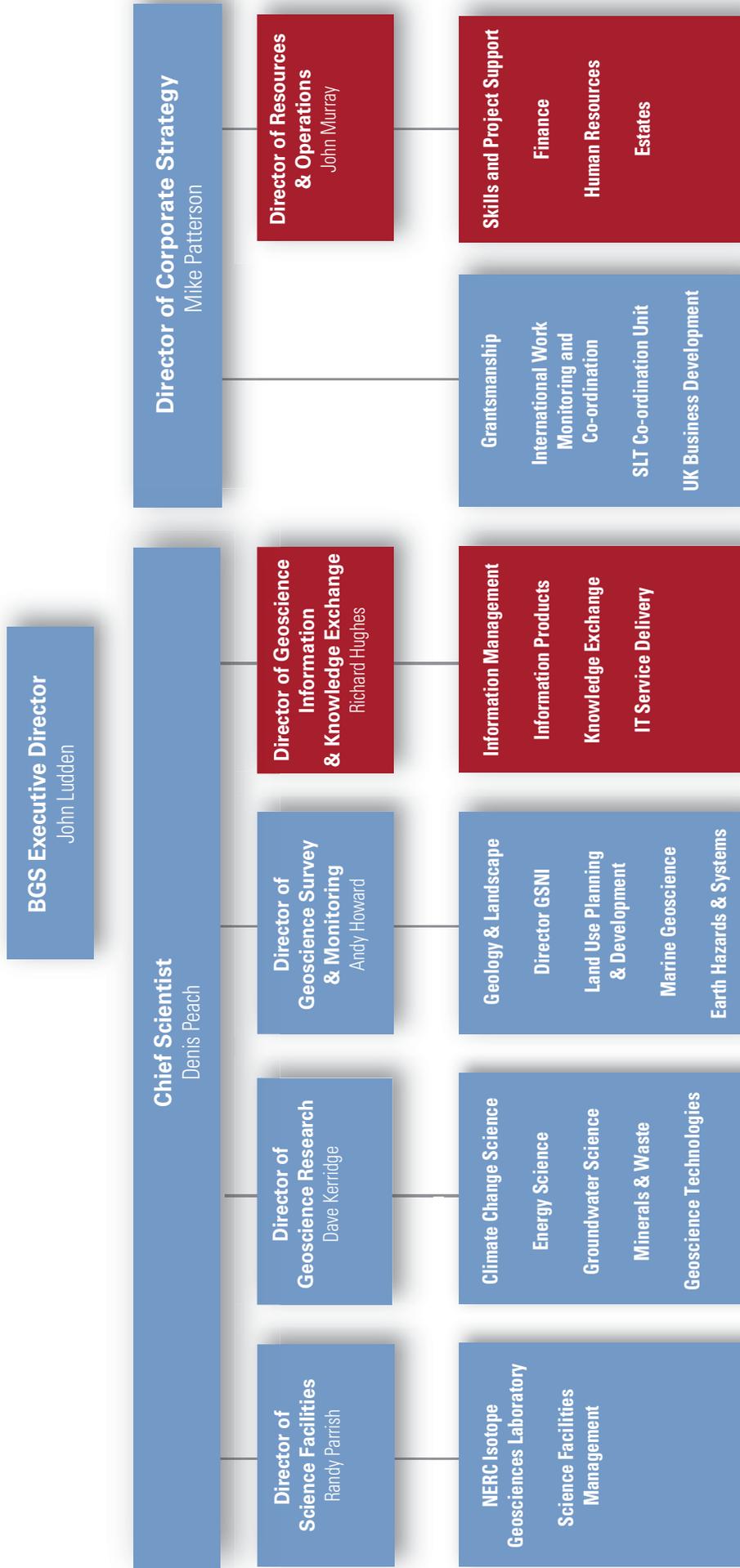
All duties relating to the NERC system for Resource and Project Management (RMS) have been successfully delivered. It has been a challenge to ensure that the business outputs from the RMS system interact successfully with the wider business systems now being delivered by the RCUK Shared Services Centre (SSC).

Work in this area is ongoing, but the core project management activities relating to bid preparation, project set-up and project delivery have been established and successfully delivered.

An internal review of the BGS project management process resulted in the delivery of a revised RMS workflow to ensure better system performance and simpler procedures in 2010/11. Further added-value management reporting has been developed this year with a number of regular reporting initiatives now undertaken. These enhance the wider resource management, marketing and risk management functions.

Progress and success in delivering a professional project support 'office', together with support for NERC systems is evidenced through the positive feedback project support receives from its 'customers'. Looking ahead, initiatives to establish a NERC-wide standard platform for all business systems, and the key objective of determining common NERC system process, will impact greatly on all BGS project management activities. ■

BGS structure from April 2011



BGS and NERC offices



**British
Geological Survey**
NATURAL ENVIRONMENT RESEARCH COUNCIL



**NATURAL
ENVIRONMENT
RESEARCH COUNCIL**

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