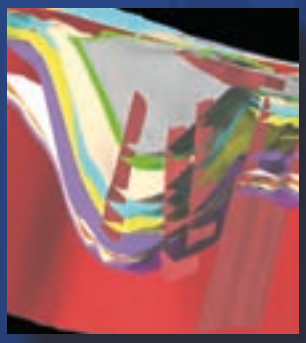
British Geological Survey

Strategy 2009–2014



Applied geoscience for our changing Earth

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

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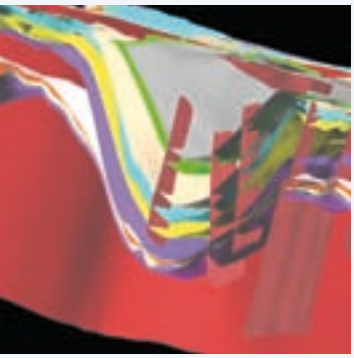


British Geological Survey

Strategy 2009–2014

Applied geoscience for our changing Earth

Our **vision**

To be a world-leading centre for applied geoscience

BGS mission

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

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

It is 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.

Contents

Introduction

The British Geological Survey (BGS) is a world-leading supplier of objective, authoritative and up-to-date geoscientific expertise and information supporting decision-making for government, commerce and the public.

In the next five years we will focus our activities on key strategic issues related to energy and environmental change. We will address complex environmental challenges requiring decisions in the short- and medium-term, including carbon capture and storage, radioactive waste management, natural hazards, resource security and environmental protection.

BGS will play a major role in the delivery of the Natural Environment Research Council (NERC) strategy — 'Next Generation Science for Planet Earth' and the 'Living With Environmental Change' (LWEC) programme. Through surveys, monitoring and research, in collaboration with the national and international community, BGS will develop a more holistic focus on modelling and the prediction of environmental change and its impacts.

'BGS will develop a more holistic focus on modelling and the prediction of environmental change and its impacts'

BGS will deliver applied geoscience knowledge and services for the UK's national good. We will engage proactively with central and local government, their agencies, universities, the commercial sector and the public to meet their data and information needs, and become a major hub for environmental knowledge to inform policy, planning and regulation. We will further enhance our culture of commercial innovation to ensure that our knowledge is shared and exploited to deliver societal and economic impacts and benefits.

We will continue to improve the digital geoscience model and knowledge base of the UK and will endeavour to communicate more effectively their significance and benefits to our diverse stakeholders through excellent communication and leading-edge web delivery and visualisation technologies.

'We will continue to improve the digital geoscience model and knowledge base of the UK'

We will participate in and, where appropriate, lead major international projects, and will give priority to work in developing countries to exchange know-how and build capacity for alleviating resource poverty and living with environmental hazards. We will play a leading role in geological and environmental surveys of the UK, the North Atlantic region and Africa.

Successful delivery of our strategy will be founded on a pro-active and inclusive approach to developing our skills and a timely response to changing drivers and needs. We will build on our national knowledge, capability and facilities to participate in the vibrant and interdisciplinary scientific and knowledge-exchange partnerships needed to understand and model our changing Earth and find solutions to the major environmental challenges facing present and future generations.

NERC Strategy

Next Generation Science for Planet Earth

The BGS Science Strategy 2009–2014 will deliver a significant part of the NERC Science Strategy 'Next Generation Science for Planet Earth'. The six challenges outlined in the new BGS strategy, demonstrate how we focus our applied geoscience on the 'zone of human interaction with Planet Earth', and address the seven NERC strategy themes highlighted in this figure.

The **context** and the **drivers**

This BGS Strategy is part of the NERC Strategy and aims to deliver the geoscience survey, monitoring and research needed to support the nation.

Change

Change is the common thread running through the global challenges facing mankind and thus the factors that drive our strategy. Global changes are diverse and substantial. They include population growth, urbanisation, poverty alleviation, technology development, food supply, energy demand, water resources, security, infectious diseases and, compounding them all, climate change. These changes operate at global, regional and local scales and take place over periods from minutes to millennia. They present considerable challenges for society and are the overriding priority for the environmental research, regulatory and industrial communities.

Geoscience and BGS play a pivotal role in providing solutions for many of the problems these changes present. However, we need to understand, at a greater level of detail and complexity than currently exists, how the Earth's system works and how human development is changing that system. We need to use this knowledge to predict and manage the impacts on the planet, its ecosystems and people.

'Geoscience and BGS have a pivotal role to play in finding solutions to many of the problems these changes present'

Stresses on the Earth and its resources

The increasing influence of emerging economies has changed the balance of economic power and control of natural resources, increasing demands on the Earth's limited assets of energy, water and minerals. The need to mitigate the impacts of rapid climate change, while ensuring continuity of energy supply, is driving urgent investigation of the geological containment of carbon dioxide and radioactive waste. At the same time society will need to continue to be protected from natural hazards and environmental stress, which may become increasingly severe as our climate changes.

Understanding environmental change, including climate change and sustainable use of natural resources, requires holistic knowledge of our planet and an appreciation that both surface and subsurface systems are dynamic. The plans and decisions of governments, regulators, industry and individuals depend on our ability to predict and communicate these dynamic Earth processes as accurately and effectively as we can.

Informing decision-making in the 21st century

Technology, and in particular the Internet, presents us with new opportunities to do and deliver our science. New legislation relating to public sector data and knowledge, for example the INSPIRE Directive, and the need for evidence-based policy and decisions makes it imperative that we do so effectively.

BGS has been in existence since 1835 — over 170 years. In that time it has continually adapted its mission to meet the needs of the nation, from providing the essential platform of geological mapping, to assessing mineral and energy resources, planning for the disposal of waste and delineating environmental hazards. This new strategy sets out how BGS will, with our partners, deliver a unique and major contribution to understanding our dynamic Earth, so that society can make the right choices to live responsibly within the environment and with changes to that environment in the 21st century and beyond.

The **challenges** for BGS

The BGS programme over the next five years will address six priority challenges

The societal outcomes from meeting these challenges will include strategies, policies and actions for the management of our environment, hazards and natural resources, onshore and offshore, rural and urban, both in the UK and internationally, and greater public understanding of the issues.

Challenge 1

Acquire, interpret and enhance the UK geoscience knowledge base and make it accessible and interoperable

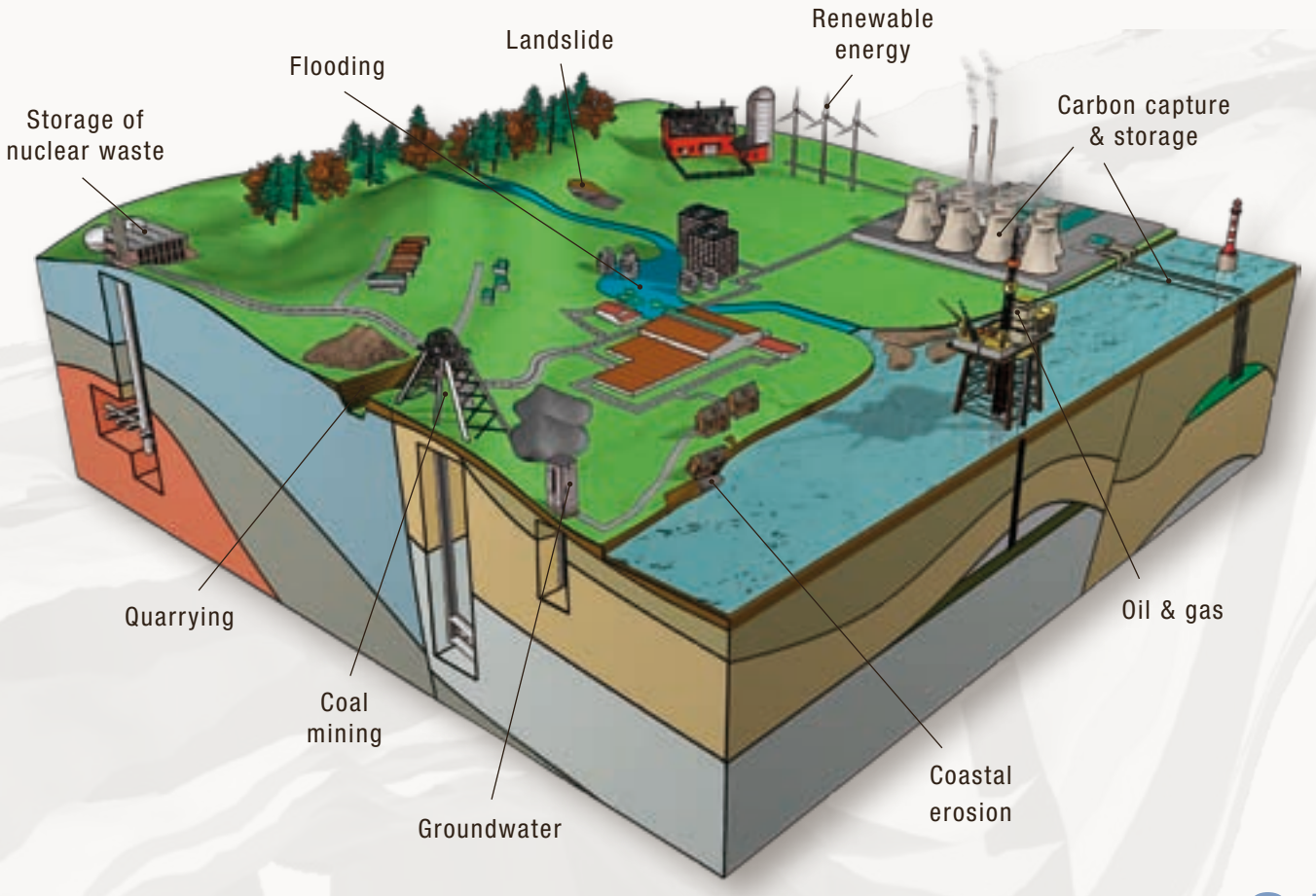
This is the core function of a national geological survey, whose mission is both long term and responsive. BGS holds extensive geological and geo-environmental data, information and knowledge for the UK but will in future need to focus especially on the 'zone of human interaction'. Improved understanding of this dynamic environment will require an integrated approach that is dependent on data that can be exchanged across the physical, chemical and biological sciences and improved teamworking across BGS and the wider geoscience community.

Deliver strategic baseline data, survey and monitoring

BGS must direct its acquisition of digital geoscience data in the areas that policy drivers require, and in particular underpin the NERC Strategy. The challenge for the programme will be to deliver strategic geological surveys, baseline geophysical

The Earth's 'zone of human interaction'

Many human and natural processes come together in a region known as the Earth's 'zone of human interaction'. This zone ranges from the tops of the forest canopy to depths of one or two kilometres below the surface. Processes in this zone may be linked over timescales ranging from minutes to millennia. Monitoring and modelling the processes that operate in this zone will provide environmental scientists and engineers with the key knowledge required to predict the impacts of environmental change and design carbon dioxide storage and radioactive waste repositories. Catchment and urban observatories to monitor and measure the processes, interactions and feedbacks and deeper crustal observations from remote sensing will link to international and European initiatives like 'Global Monitoring for Environment and Security' and the 'European Plate Observing System', so placing the UK at the heart of geoscience to address environmental change issues.



and geochemical data collection and 3-dimensional modelling for energy resources, carbon storage, water resources, mineral resources, natural hazard prediction and environmental protection. On the UK continental shelf there is a need for a national sea-bed mapping programme and in addition the integration of offshore and onshore geological knowledge.

Create the models

The construction of digital 3-dimensional geological models has greatly improved our knowledge base. We must now develop and extend these to allow interdisciplinary research and better decision-making on environmental change and natural resource issues. We need to combine the technological and cultural progress made in geological modelling with a step change in process modelling, so that, for example, we can better predict stability in soils under changing climates, groundwater response to extreme rainfall or drought, rates and impacts of coastal erosion and landslides, or the capacity of deep saline aquifers to store carbon dioxide.

One thing is clear: there will be an increasing demand to combine data from multiple disciplines to address Earth system science challenges, with minimal barriers to exchange, reuse and re-purposing.

Challenge 2

Improve the communication of geoscience knowledge so that it can better support policy and decision-making by government, commerce and society

Geological surveys exist in most countries of the world. They fulfil a fundamental role in providing continuity and reliability of access to a national geoscience knowledge and expertise base which can improve quality of life and the sustainability of the environment. With its cutting-edge digital data capture, information management, geological modelling, and visualisation technologies, BGS is a world leader in the capture, delivery and exploitation of geoscience knowledge and plays a full role in setting international standards. The challenge will be to maintain and improve that position in the face of changing socio-economic, technological and legislative opportunities, challenges and demands.

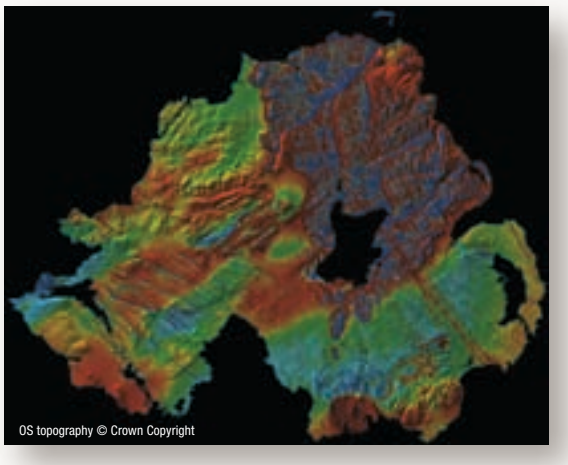
Delivering science for the public

To continue to deliver our national-good role and underpin NERC science we must improve the way we communicate geoscience and in particular the uncertainty of that science, so that we provide more useful and usable knowledge for all our

stakeholders — central government, local authorities, utilities and regulatory authorities, universities, other NERC centres, schools, the commercial sector and the public.

Exploiting the Web

In this Internet era, user expectations of the accessibility and quality of public-sector data, information and knowledge are changing rapidly. This, along with mixed public perceptions of science, will place increasing demands on our communication skills and resources. Indeed harnessing the enormous potential of the Internet to best effect is a major challenge in itself, especially in embracing the participative opportunities whilst at the same time remaining an authoritative source of knowledge.



It is evident that our data and knowledge base must continue to support a spectrum of users and usage, from members of the public who may require a simple immediate response, to educators who seek to improve understanding, and scientists who may need complex and comprehensive data to underpin delivery of the BGS and NERC science strategies.

Challenge 3

Enhance external partnerships to improve the quality, reach and impact of our science

A common theme within the previous two challenges is the need for BGS to be more inclusive in the way it will work in the future. Complex problems, the solutions to which transcend traditional science domains, require a multidisciplinary approach. New technologies and specifically the evolution of the Internet as a sharing and participative tool, highlight this imperative. The NERC Strategy and new ways of funding environmental science positively promote it.

Consequently, BGS needs to increase its interaction with the academic, education, government and commercial sectors at all levels, nationally and internationally. BGS must position itself to engage with collaborative centres as well as NERC's Research and Responsive mode programmes and external research grant opportunities, such as EU Framework programmes and Living With Environmental Change. Relationships with government departments need to be strengthened and in some cases re-established if we are to effectively help define and meet their agendas. The hybrid nature of the BGS business model has encouraged excellent links with commerce, but the rapidly changing economic landscape means that new partnerships and ways of working will be required.

Working with partners

Almost all the challenges facing BGS are similar to those faced by geoscience organisations around the world; indeed many of these challenges require transnational solutions. As never before we operate in a global context. To optimise synergies

BGS in partnership

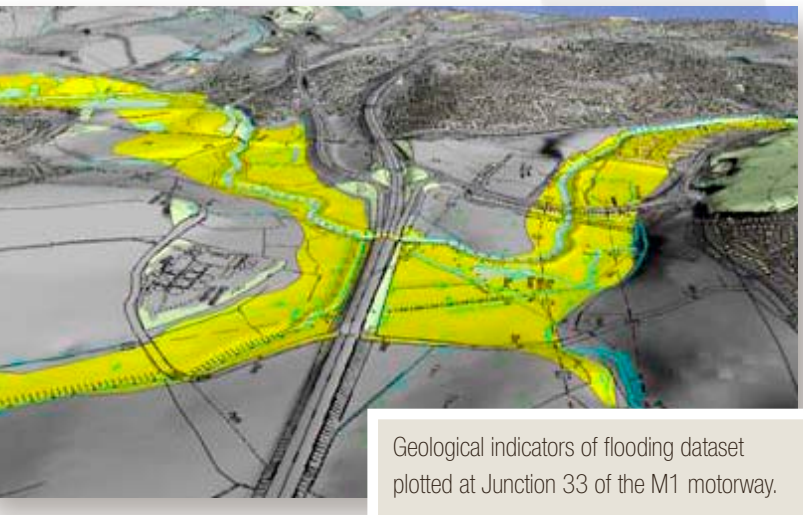
- playing a leading role in the growth of collaborative geo-environmental science, including global programmes
- listening to and working with government and commercial stakeholders
- being a partner of choice for university researchers
- fostering a knowledge-exchange culture internally and in the wider world
- disseminating geoscienific knowledge and understanding

and interoperability and minimise duplication and wasted effort we need to ensure we collaborate with our peers. We must also be prepared to take a lead in coordinating international collaboration, whether pursuing data harmonisation, for example OneGeology, or tackling the prediction of a generic geological risk. Last but not least, we must proactively listen to and understand the needs of those in the developing world and wherever possible, share our know-how.

Challenge 4

Apply a whole-systems approach to our science and improve understanding of the nature and sustainable use of natural resources and the potential impact of hazards

In recent years it has become apparent that geoscience, in common with other sciences, is best able to influence and present solutions to problems caused by environmental change and depletion of scarce resources if it also considers the associated human and environmental impacts and consequences of those changes. Thus a 'whole-systems' approach to developing appropriate knowledge is needed in the way BGS will work in the future. This will mean a significant increase in the amount of work we do in partnership and thus we need to establish new relationships with different disciplines, for example, sociologists, economists, ecologists and engineers, in other research centres, universities and in industry.



NEXTMAP Britain elevation data from Intermap Technologies

Geological indicators of flooding dataset plotted at Junction 33 of the M1 motorway.

Improving prediction to reduce human and economic loss

Hazards, including landslides, ground instability, ground shrinkage, cliff instability, flooding, droughts, earthquakes, natural radon and anthropogenic hazards like pollution, have significant effects over a range of timescales and at local to international scales. Existing models do not adequately predict the occurrence and intensity of these processes or events and their socio-economic or ecosystem impacts. Development of reliable predictive tools and deployment of these tools operationally is a critical scientific challenge.

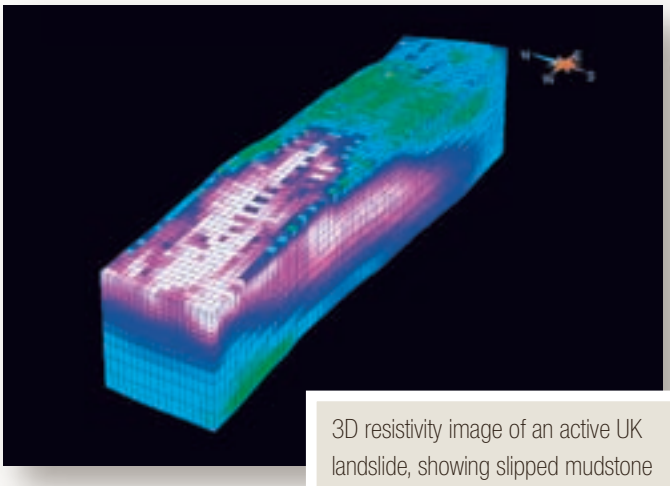
The UK faces many pressures on land and resources that will require improved geoscience knowledge and understanding. The issues are many and include enhanced oil recovery, renewable energy sources, underground energy storage, carbon capture, radioactive waste disposal, processing and supply of minerals, groundwater resource evaluation and the safe end economic development of land resources.

These issues and their impacts on the environment and economy are complex and interlinked and require a holistic and collaborative approach to research that will better inform policy. The challenge for BGS is to ensure that it exploits its twin core assets of geoscience expertise and comprehensive national databases effectively and makes a full contribution to improving prediction and characterisation

of hazards and resources from the local to the national scale.

Learning from the record of past environmental change

Many of the records of pre-historical impacts of environmental and climate change, catastrophic events such as volcanic eruptions, earthquakes, storms and floods, and the growing influence of human development are preserved in landscapes and the sea floor, and in the rocks and fossils of the geological record. In collaboration with our research partners, we will acquire and apply new knowledge and understanding of past events to help predict the impacts of future change.



3D resistivity image of an active UK landslide, showing slipped mudstone material at the surface of the model and underlying sandstone.

Challenge 5

Understand, quantify and predict the response of the Earth's 'zone of human interaction' to future environmental change

Human and natural processes interact in a zone referred to as the Earth's critical zone or the zone of human interaction. This can range from the forest canopy to depths of several kilometres below the surface. At these depths processes are still coupled to those at the surface but timescales may vary from minutes to millennia. Across this zone a wide range of physical, chemical, biological and anthropogenic factors operate. The complexity of the processes and interactions present major challenges for science if we are to predict the impacts of climate and other environmental change and the consequences of planning policies and major development initiatives.

Developments such as construction on floodplains or building of new coal-fired power stations have major consequences and impacts on this zone. Where changes in climate alter the frequency and magnitude of precipitation, an understanding of the interaction of processes will enable the prediction, for example, of the transport and fate of contaminants and the consequent impact on human health.

Helping us live with a changing environment

Within this zone it is crucial that we enhance the collection of time-series data through the creation of observatories in representative environmental settings. This will allow geological processes to be measured and predicted under changing natural and anthropogenic influences. To examine the human dynamics in this system, holistic and probabilistic predictive geo-environmental impact models that link these processes will need to be developed. Such models must be capable of operating at a variety of time and spatial scales and take account of the specific characteristics of a region and the needs of relevant research or decision-making communities. This is a significant challenge and one in which BGS can play a leading developmental role with research partners in NERC, the UK and internationally.

Challenge 6

Increase the economic impact and relevance of our work

The UK Government places clear expectations on UK research councils and their research centres, to deliver a step change in increased social and economic impacts from their investments in publicly funded science.

BGS has a strong track record in exploiting its science in the commercial arena and is regarded as an exemplar within NERC. The sustained performance over 25 years of its programme of commissioned research for the private sector and government agencies, and the development of vibrant added-value information services over the last eight years, testify to this.

Improved performance in these areas will require continued development of novel information and knowledge products and services, which must move into the difficult areas of prediction and risk. We will also need sustained investment in business development and marketing to promote our capabilities and the benefits of our science. Our human resource strategy must therefore prioritise these skills so that we have the expertise to prepare highly rated research proposals, negotiate effectively with clients and protect our intellectual property.

Creating wealth

Increasing the economic impact and benefits of our work through commercial exploitation will require BGS to move to a culture in which commercial innovation becomes accepted practice. Increased commercialisation will inevitably carry risks to reputation, control, resources and public funding and will create conflicts of corporate and personal priorities. To make this change we will need to introduce sound procedures for ensuring balance in our programme, managing risk and optimising the availability of limited expertise within project schedules.

Accurately assessing the economic impacts and benefits of our science has always proved problematic; we need to develop and introduce independent evaluation to gauge the tangible success of our initiatives.

Echosounder data of sea-bed

Regional analysis of the landscapes and sea floor of northern Britain and the adjacent continental shelf is unravelling the timing of the advance and subsequent retreat of the last British Ice Sheet, which will help us understand and predict the response of modern polar ice sheets to climate change.

Image © NERC based on OLEX AS bathymetric data and NEXTMAP Britain elevation data from Intermap Technologies

NEXTMAP Britain elevation data from Intermap Technologies

Objectives to make a difference

We have four major strategic objectives, designed to address the six challenges. Because we are a national geological survey with a long-term mission these objectives have a lifespan beyond the five-year scope of this strategy.

Our objectives are articulated as an integrated workflow of best practice in delivering the function of a national geological survey — in effect a value chain. As a geological survey our role and competence is to use the unique combination of our extensive expertise and information base to link each of these objectives, to ensure their coherence and to add value. These objectives provide a natural spine for our strategy and within each there are several elements. Each element is amplified in the proceeding section which describes how and what we will deliver. They will be specified in much greater detail in component strategies produced by each of the BGS directorates and through this will provide the basis for planning the BGS annual programme over the next five years.

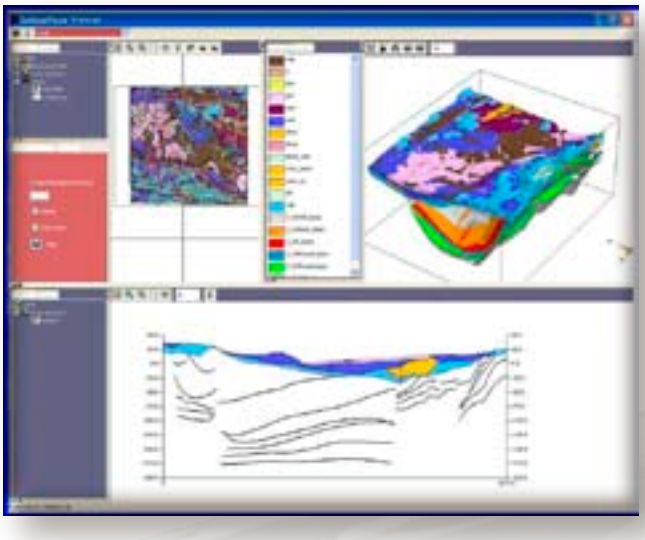
To achieve these objectives BGS will work in a way which maximises the skills and flexibility within our internal matrix but we must also become significantly more integrated and in tune with the needs and capabilities of our clients and collaborators.

Making the observations — enhancing the strategic knowledge base

This objective is designed to enhance the strategic geoscience knowledge base of the UK and other parts of the globe. It is a fundamental part of the mission of a geological survey and embodies the geological, geochemical and geophysical survey, monitoring and mapping carried out by BGS as a contribution to the NERC National Capability programme. The priorities will be driven by stakeholder needs and the goals are to ensure our geological maps and 3-dimensional models are up to date, that we acquire modern airborne geophysical and high-resolution geochemical data for targeted areas and to develop our national marine geological mapping programme.

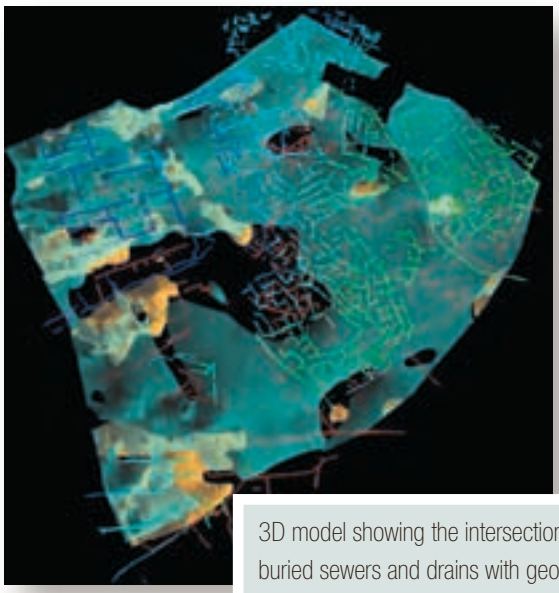
We aim to enhance long-term monitoring through use of improved and up-to-date methodologies and equipment, including satellite and sensing systems. A specific goal is the continued development and deployment of state-of-the-art digital field data capture technology. The national seismological network and earth magnetic field monitoring will be developed with industry and regulators. Long-term measurements of ground stability and coastal erosion rates will be integrated within an observatory network that will also incorporate hydrogeological measurements.

Effective partnerships with all BGS stakeholders (government, their agencies, universities, commerce and the public) are critical so that we can continue to acquire, collate and provide comprehensive and authoritative geoscience data and knowledge as a basis for the research and modelling carried out by BGS and others.



Making sense of the observations — developing an environmental impacts modelling platform

Through analysis and interpretation we aim to develop spatial models of the geology of the UK and key strategic areas internationally. These models will be at a variety of resolutions with national and regional models providing a framework for more detailed models. They will delineate the 3-dimensional distribution of lithology, stratigraphy and structure and be attributed with physical and chemical properties. A key goal is to develop new methods of evaluating and communicating uncertainty in data and interpretations and incorporate these within the models.



3D model showing the intersection of buried sewers and drains with geological surfaces, produced in collaboration with the Environment Agency.

There is a critical need for improvement in the modelling of Earth processes. The changes we are experiencing in our climate only serve to reinforce the dynamic nature of our environment and underscore this need. Our goal is therefore to develop significantly more extensive and sophisticated time-series models. The aspiration is to build on the platform of our spatial models and improve understanding of many Earth processes, such as landsliding, erosion, deformation, weathering, sedimentation, the movement of groundwater and contaminants and the influence of human activity on all of these.

To develop the spatial and process modelling systems and workflows we will apply leading edge multidisciplinary science and technology. This will need national and international collaboration and leadership with funding from across the range of BGS/NERC income streams, including the injection and redirection of capital. The models will be driven by end-user applications and needs and will include carbon dioxide storage, radioactive waste containment, groundwater and minerals security, and natural hazards.

Geological model of London.

The process of creating models will involve and integrate many geological survey functions and we intend this to drive the ongoing collection and interpretation of data from a range of geoscience disciplines, including geophysics, geotechnical engineering, hydrogeology and geochemistry. To understand and evaluate the impacts of environmental change and secure strategic energy, mineral and water resources we must integrate our models with those developed by others. Our partners in this endeavour will include sister research centres and environmental regulators. Only in this way will coupled and interlinked processes across the geosphere, hydrosphere, cryosphere, biosphere and atmosphere be properly understood.

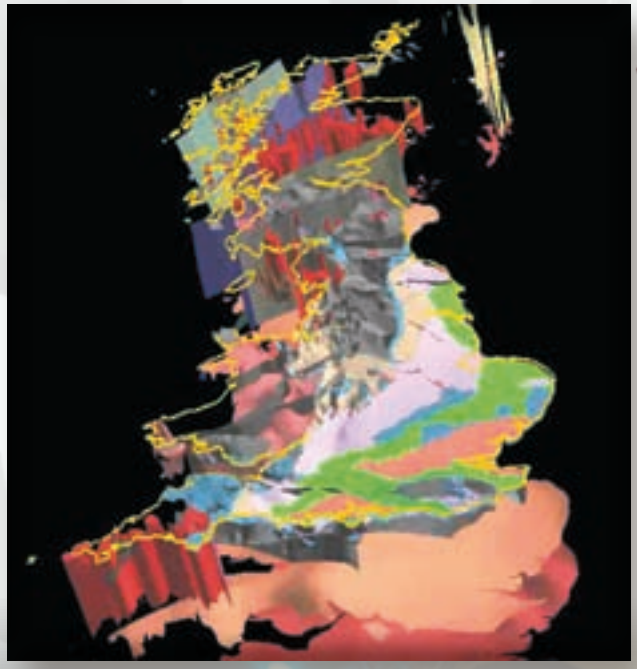
To model these dynamic earth processes and to recognise their impacts beyond the level of understanding that currently exists, we will, with partners, develop an 'Environmental Impacts Modelling Platform' for the UK. This would be a joint development involving other NERC research centres (in particular the Centre for Ecology and Hydrology), universities, regulatory agencies and the planning communities. As a part of this we foresee the establishment of regional test beds in mixed, urban and rural, UK catchments where considerable data and experience already exists.

'We must integrate our models with those developed by others'

Managing the data, information and knowledge—interoperability and accessibility

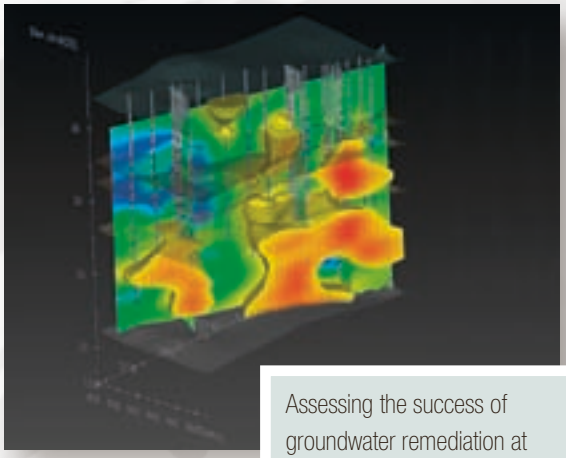
BGS houses the National Geoscience Data Centre and is designated as a Place of Deposit by The National Archives. Our unique and irreplaceable collection of many millions of analogue and digital records, photographs, and rock and fossil samples is the core of the BGS knowledge base, underpinning not only our national good but also NERC and international programmes. Our aim is to manage that knowledge base well and maintain our international leadership in the domain.

Cutting-edge work in the field of geoscience informatics and in particular on improving the accessibility and interoperability of our data is a priority. We will review and



Lasgit (Large Scale Gas Injection Test) is a full-scale experiment of gas transport in compact bentonite performed 420 m below ground at the Äspö Hard Rock Laboratory (HRL), Sweden (operated by SKB). The test simulates conditions in a deep geological repository for spent nuclear fuel.

refresh our information management strategy to ensure that BGS's accessions policy is balanced and our data are professionally indexed, discoverable and accessible, and meet the requirements of UK and European regulation. In addition to continuing to convert analogue records to digital formats, a specific target is to investigate and develop systems to store and provide continuity of access to the complex digital interpretations produced as BGS's modelling programme progresses.



Assessing the success of groundwater remediation at the SABRE research site using temporal 3D visualisation.

We aim to improve the security of our collections and resilience of the systems that house them through the introduction of more professional business continuity planning. Our plans for data and knowledge management include a major investment in modern digital storage and network systems to improve internal and external access to our data.

Exchanging and exploiting our knowledge —increasing social and economic impact

BGS's aim is to engender a culture of knowledge exchange excellence across the organisation and establish itself as a 'hub' for the multiway flow of geoscience data, information and knowledge to serve research, governmental, regulatory, commercial and public engagement goals. The intention is to improve the effectiveness of our knowledge exchange programme and the take-up of BGS science outputs into policy and regulation. We will do this through collaborative research into systems and processes for optimal communication of information and knowledge with government, its agencies and the wider community.

One of our key goals is to enhance the range of information services and baseline and derived datasets that respond to societal needs and to deliver socio-economic benefits through the exploitation of our intellectual property and expertise. Our recent policy of relaxation of intellectual property and copyright has yielded significant benefits and we intend to continue this approach, which protects the value of our information assets while making more resources available free of charge for non-commercial uses.

Government expects the research councils to significantly improve the economic impacts of their investments. BGS plans to give priority to maximising the economic benefit of its assets. We will explore and progress the creation of one or more companies, through spin-out or an alternative model, to promote the growth of a thriving business culture that delivers benefits to BGS and the wider economy.

The importance of public engagement in science, and the need for informed public debate on major environmental issues, has never been greater. Improved public engagement in BGS science is a key aspiration. Our goals are to boost the use of our data and expertise in universities and engage children of all ages through education and outreach, so that they not only have the opportunity to understand their personal environmental footprints and impacts, but also to ignite their interest in science.

A priority is to harness the potential of the web to raise the visibility of BGS data and information assets and increase the amount of data and information accessible to computer-to-computer application programming interfaces. BGS has substantial capacity and expertise in geoscience informatics and we will take the lead in UK and international partnerships to develop new knowledge-delivery technology.

What **we will do** and **deliver**

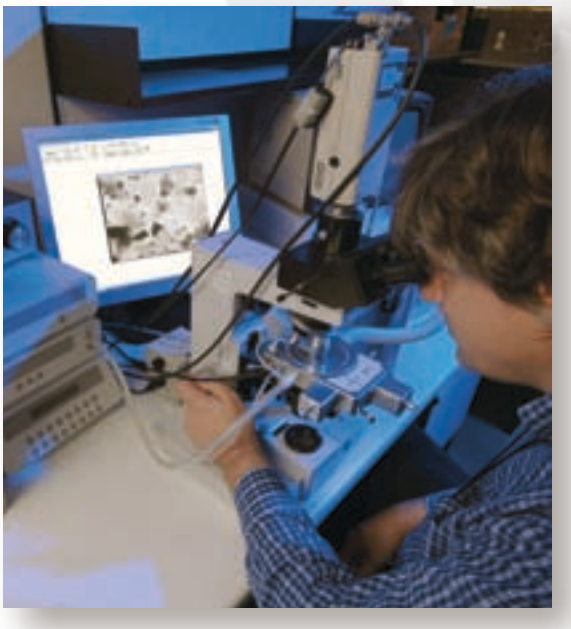
Our over-arching objectives break down into many actions and deliverables which are summarised in four corresponding sections here. Over the next five years we will change the way we operate and move to a much more internally and externally joined-up way of working.

Observe and monitor

We will:

- Resolve remaining gaps and major inconsistencies in our existing geological knowledge base at appropriate scales. This will require strategically targeted geological mapping, geochemical sampling or airborne geophysical surveys, but we will also deploy new mathematical interpolation and extrapolation methods to help fill these gaps.

- Enhance our laboratories and research facilities to build a national centre of excellence for analysing and measuring the physical, chemical and hydrogeological properties of the geosphere, and promote our laboratories collectively as a focus for research community and practitioner involvement and collaboration.



National Physical Properties and Processes Laboratory

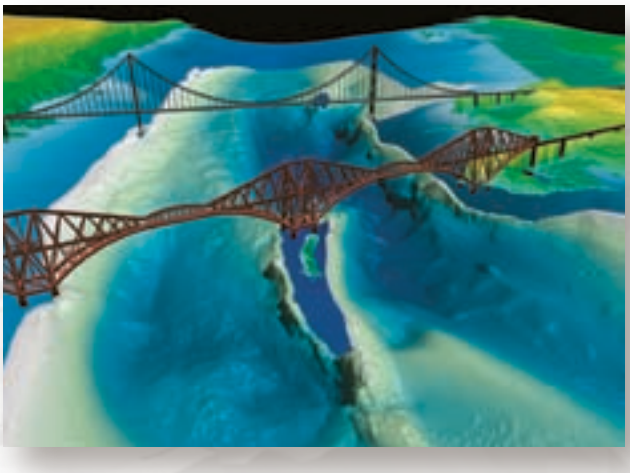
BGS intends to establish a national centre of excellence for physical properties and processes research in the subsurface. The facility will extend the capabilities of BGS and collaborative partners in universities, industry and government. It will benefit research in key science challenges such as radioactive waste disposal, carbon capture and storage, clean coal technologies, groundwater and pollution modelling, and engineering hazards.

Geo-environmental Tracer Laboratory

State-of-the-art environmental geochemistry laboratories are essential to understand, quantify and predict environmental change in the 'zone of human interaction'. Sensitive environmental indicators involving hydrogeochemistry, biogeochemistry, geomicrobiology and organic fluorescence are required to understand environmental change over different timescales. We will develop such a facility in close collaboration with the NERC Isotope Geosciences Laboratory (NIGL).

- Implement a national marine mapping and modelling programme, including sea-floor surveys, benthic habitat and basin analysis. This programme will, as a priority, address the difficult problem of the discontinuity between onshore and offshore information and knowledge.

- Develop and implement new sensors and techniques for observing and measuring time dependent processes within, on and across the boundaries of the geosphere. These will augment existing networks, for example our seismic and geomagnetic monitoring systems, to provide information



on processes such as ground motion and subsidence, coastal erosion and cliff recession, landslide movement, groundwater levels and subsurface migration of contaminant plumes. Our observatories will, wherever possible, contribute to national and international networks and sensor webs to broaden the scope and application of the data and encourage collaborative involvement in interpretation.

Model our dynamic environment

We will:

- Advance our capability for modelling the dynamic Earth system. This will combine spatial models of the lithology, stratigraphy, structure and properties of the geosphere with time-series observations, real-time monitoring and mathematical and conceptual models of processes. In combination with other environmental information, for example climate data and river flows, they will provide predictions and scenarios of future changes, events and impacts.
- Extend and refresh the modelling skills and capabilities of our scientists, for example in key techniques such as stochastic and numerical modelling, and help them to work with others across disciplinary and national frontiers.
- Develop new methodologies for determining and communicating uncertainty in our models so that we maximise their application for risk-based decision-making by end users.
- Add to our capabilities and acquire scientific understanding of environmental processes in areas where international locations provide the best place for study, for example permafrost in the Arctic and volcanism in the Antilles and environmental change in the African Rift Valley.
- Obtain, adapt or develop new software and associated methodologies for geological, mathematical and process modelling, and comply with international standards when developing our modelling architecture and protocols.
- Implement an experimental monitoring programme to quantify the present state and response of the zone of human interaction to external and internal drivers, which will include local and whole catchment monitoring of geohazards, hydrogeological and other geological processes over time intervals from days to decades.

Secure and enhance the geoscience knowledge base

We will:

- Acquire, generate and manage data, information, collections and records within the National Geosciences Data Centre in accordance with UK and international standards to ensure it is available to support BGS and NERC research in environmental science and the wider needs of our stakeholders. We will publish an information management report on the status of our knowledge base annually.
- Implement best practice in information management through a corporate policy and framework. This will address the issues of accession and disposal of UK onshore and offshore and international geoscience data, the discovery and visibility of that data, the storage of spatial models and datasets and disaster-response planning.
- Play a leading role in progressing interoperability through GeoSciML and other international and UK initiatives and ensure that as much of our data and information as possible are in digital formats, allowing their exchange and integration with data and information from other science disciplines.

- Advance our information systems, technologies, infrastructure and skills to support and facilitate our information management and continue to carry out horizon-scanning through an Information Futures Team, including widening the scope of the team to include other NERC research centres and organisations.

Exchange our knowledge

We will:

- Encourage a culture of knowledge-exchange excellence within BGS and NERC.
- Establish BGS as a 'hub' for the multiway flow of geoscience data, information and knowledge to serve research, governmental, regulatory, commercial and public engagement goals, primarily in the UK but also internationally.
- Improve the take-up of BGS science into policy and regulation through collaborative research into systems and processes for communication of information and knowledge to government, its agencies and the wider community.
- Work with external experts to improve the public understanding of geoscience and its associated hazards and risks and deploy innovative web systems to facilitate interactive dissemination of BGS science, its outputs and outcomes.
- Increase the range and amount of data publicly available and implement forward-looking intellectual property rights policies that promote the use and reuse of our data and make more resources available free of charge.
- Develop new information products and services and improve the quality and resolution of existing ones; for example, new geochemical data, and enhancements to the resolution of national ground-stability and flooding data.

- Deliver improved economic and social impact from our science and measure and publish the outcomes.
- Establish a Commercialisation Panel, including representation from commerce, NERC and across BGS to search out, consider and support commercialisation opportunities.
- Implement a programme of innovative public outreach activities to improve the understanding of geoscience and work in collaboration with the university sector to encourage the use of our data, information and expertise in support of teaching and research, so contributing to the flow of well-qualified graduate scientists.
- Contribute to the preparation of the data specifications and implementing rules of the INSPIRE Directive. We will be an early adopter of its requirements to provide discovery, viewing and downloading of interoperable environmental spatial data.

Work across boundaries

We have picked out four major cross-cutting projects that exemplify the approach.

In the future, science that 'makes a difference' is likely to be delivered by multidisciplinary and international collaborations. To contribute to and lead these, BGS will integrate its science more effectively across disciplines, and build vibrant partnerships with researchers, funders and stakeholders. This section describes how we plan to conduct integrated multidisciplinary programmes and to illustrate this we will carry out a number of flagship projects, which will not only provide test beds for our new modelling methodologies and platforms, but also meet the highest priority national drivers and needs for geoscience knowledge. Each project will have sufficient critical mass to draw together a wide community of interdisciplinary research collaborators, funders and sponsors with common goals. They will be supported by a wide range of knowledge-exchange activities, including workshops, conferences, community websites, training, education and public engagement.

Here we describe in more detail four of the projects designed to develop, test and exploit our dynamic earth modelling and collaborative knowledge approach in areas of national priority. The projects here are intended to illustrate our approach and other initiatives in the international arena are also being actively considered. These will include shared research to support implementation of the new technologies and regulation associated with carbon capture and storage, multinational surveys of the continental shelf of north-west Europe or the Irish Sea and establishment of an observatory within the African Rift Valley to understand the processes of volcanism, tectonics and environmental change in a way which is not possible in the UK.

Many parts of BGS already have an excellent track record in leading and participating in collaborative ventures but our intention is that such ventures become central to the way we

Addressing our science challenges

Focused interdisciplinary and collaborative projects

The four cross-disciplinary initiatives described here embrace all the BGS challenges. They take forward the survey, measurement and monitoring of crucial geoscience parameters and integrate these data in geological and environmental models to help understand processes and make predictions. They provide the information systems that will underpin this interdisciplinary and collaborative approach.

A whole-systems approach requires new thinking and joint thoughts. We cannot do this alone, but BGS will provide a unifying geoscience knowledge base upon which the environmental, engineering, social science and economics community can build. We must work together to find the solutions to the challenges presented by our changing Earth.

Battlegrounds of environmental change – cities, catchments and coasts *(Example Project 1)*

Dynamic models will be developed and implemented in regions where the legacy of past industrial development, future land use and resource pressures combine to create a highly sensitive natural environment with major challenges for sustainable development. As part of this we will develop methodologies and applications and use these for predictions and scenarios of environmental change impacts. These regions will, progressively, include areas such as London and the Thames Catchment, Glasgow and the Clyde Basin, the South Wales Coalfield and the major conurbations of the Midlands and north of England. The projects in these regions will conduct baseline geoscientific surveys and 3-dimensional modelling and combine this with process research to inform solutions to issues such as ground instability, sea-level rise, coastal erosion, droughts, flooding, ground and surface water contamination and conflicting land-use pressures on development and resources.

Strategically valuable rock formations for secure and sustainable resources *(Example Project 2)*

Three major rock formations, Permo-Triassic sandstones, Upper Carboniferous Coal Measures and Upper Cretaceous Chalk, will play a crucial role in meeting the UK's future requirements for strategically secure, sustainable energy and water resources. Each formation will be studied in a series of multidisciplinary research and modelling projects that will invite cofunding from government and industry, and research collaborations with national and European partners. The first project will focus on Permo-Triassic rocks, which include sandstone, mudstone, gypsum and halite deposits of major strategic importance to the national economy. Outcomes will include predictions and scenarios of the potential impact of climate change and urban development on groundwater within the sandstone aquifers, strategic evaluation of offshore capacity for geological storage of carbon dioxide within the sandstone, and assessments of the potential for storing natural gas resources in underground caverns within the halite deposits. Research collaborations will focus on understanding and modelling fluid movement and fluid–rock interaction within the sandstone reservoirs, and on the integrity of the impermeable mudstone cap rocks that seal the carbon dioxide and natural gas storage repositories.

operate in future so that we add more value, relevance, quality and visibility to the science delivered by BGS and our partners. These projects will provide a NERC best-practice approach to join up strategic and applied national-capability science with the curiosity-driven and commercial research of our partners to provide mutual, national and international benefit.

Data and applications for environmental modelling *(Example Project 3)*

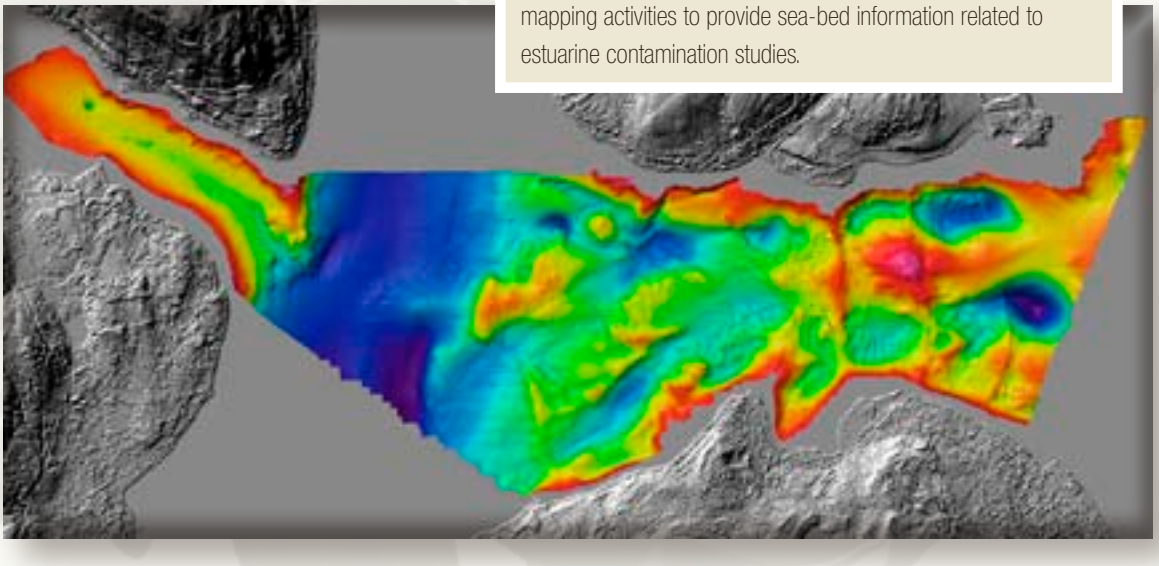
Development, application and operational deployment of dynamic geoscience models is at the leading edge of geoscience informatics. It requires complex and sophisticated technological development, especially in the fields of data architecture and standards, spatial informatics systems and knowledge management. This project will build on the technological advances of earlier BGS projects in the fields of data architecture, information management, digital map production, digital field data capture, Geographic Information Systems and 3-dimensional modelling and visualisation, to develop a data architecture and applications environment that supports the generation of spatial and process models. We will encourage wider community involvement in their testing and application and existing international collaboration, for example in developing world-wide geoscience data and mark-up languages and exchange formats, will be taken forward to incorporate methodologies and best practice for development and use of subsurface models. To maximise their effectiveness and range of applications we will adopt a policy of making our capture and modelling software and systems available to the wider community for testing, research and educational use.

Sea-bed geology for sustainable marine management *(Example Project 4)*

BGS will focus its marine geology programme on a new generation of maps and digital products based on multibeam data and designed to underpin marine spatial planning. The results will form the first new map series since the reconnaissance sea-bed mapping programme around the UK during the 1970s and 1980s. Multibeam data, when combined with new and existing sea-bed samples, cores and seismic profiles will provide a cross-disciplinary link between geologists, hydrographers, biologists and archaeologists to support marine research. BGS will continue to work closely with government, universities and industry.

Managing our seas without a sound knowledge of the sea-bed environment and the processes that shape the sea-bed characteristics makes it difficult to conserve key areas, maintain biodiversity and economically develop our marine resources, including renewable energy, in a sustainable way. Recent developments in marine landscape mapping, data delivery and visualisation techniques provide timely, proven technologies for developing a cost-effective and authoritative dataset

Multibeam echosounder data from the Firth of Clyde, from the Holy Loch in the east to the area north-west of Greenock. The data were collected as part of the BGS marine geological mapping activities to provide sea-bed information related to estuarine contamination studies.



NEXTMAP Britain elevation data from Intermap Technologies

Making it **happen** – our **people** and **resources**

A world-class vibrant scientific organisation interconnected with the world community

People are the vital resource of a scientific organisation. BGS is people-centred and has the culture and values needed to deliver the ambitious challenges and goals set out in this strategy. We will fully embrace the NERC 'People Action Plan' and through this will attract and develop people with the skills and values we require to deliver innovation. Our organisational culture drives the whole BGS skills spectrum. This culture is defined as: innovative; inter-connecting; collaborative; entrepreneurial; sensitive; well-led; and dynamic. BGS employs and recruits people who can interact with the community in research centres and universities, as well as with the global network of scientists, social scientists, economists, government decision-makers, industrialists and the public.

BGS understands that science and technology skills are in short supply and has to attract and retain staff within a competitive market place. A healthy organisation requires regular skills refreshment as well as in-house skills development. The newly launched NERC Research Associate Programme focuses on newly-qualified scientists to work in exciting scientific areas for 1–3 years and gain a range of high-quality training experiences. BGS will also recruit highly regarded mid- to mature-level career scientists to assist with a rapidly changing science funding landscape.

Increasingly complex scientific challenges demand new whole-systems approaches. BGS acknowledges it cannot be the

'BGS understands that science and technology skills are in short supply and has to attract and retain staff within a competitive market place'

There will be an emphasis on leadership from the boardroom to the field and laboratory, from the senior scientist and administrator to the most recent recruit. The highest-level leadership must set the cultural tone and organisational values through example. Organisation-wide embedded leadership will empower individuals to grow and realise their potential. BGS needs senior scientists to develop and grow specific science areas. Project and people management is an essential skill set which BGS values highly. Team members will be recognised for the positive impact they have on colleagues, the organisation and external collaborators.

sole provider of skills and solutions; this recognition brings the freedom to re-invigorate the organisation, connect with and influence the wider community through diverse collaborations. Key skills will be found within other science organisations, universities, industry and government. Some skill areas may only be required by BGS on a time-limited basis and we will increasingly adopt a variety of 'skill-filling' solutions to enable geoscientists, sociologists, economists, planners and others to develop inter- and cross-disciplinary approaches.

The new BGS strategy requires skills to evolve over time. BGS's national capability role demands a range of skills; from observation, data generation and monitoring, to interpretation, modelling, visualisation and data management. There will be a constant requirement for the application of excellent, relevant geoscience for society, and an entrepreneurial understanding of client need and market opportunity. Our scientists will need to attract research grants from NERC and other sources to enable the organisation to pursue cutting-edge science. The skills required to secure these grants is key to a future funding stream and will be developed as a priority. BGS will strive to offer a range of development opportunities including bespoke in-house courses, educational opportunities from NVQ to PhD level and funding conference attendance and external courses. All staff will have individual training and development plans and will be encouraged to engage in continual professional development activities. BGS and NERC will seek to offer more placement and secondment opportunities.

The UK is a multicultural country with a rich mix of ethnicity, religious affiliation, and language. The scientific community has not, as yet, fully harnessed the skill opportunities present within our diverse communities. BGS promotes an open, welcoming, mutually respectful and tolerant work culture that aims to attract excellence regardless of gender, skin colour, sexual orientation, age or disability. We will actively work with a range of communities within schools, colleges, universities and the general public to promote science as a career choice.

The crux of our people strategy is summarised as: developing an organisation that is vibrant and innovative, that will act as a hub and a catalyst for whole-community collaboration and interaction, producing excellent and relevant applied geoscience.

BGS University Funding Initiative and GeoSchool

The BGS University Funding Initiative (BUFI) will provide a collaborative science platform at the PhD and Postdoctoral level between BGS and the UK higher education sector. In the next five years BUFI will play a pivotal role in increasing the BGS international scientific profile by being one of the key avenues linking BGS scientists to the UK and international academic communities. It will also encourage collaboration between geoscience, social science, IT, planning and economics departments. BUFI will enable BGS to be recognised nationally and internationally as a centre of excellence for training the next generation of applied earth scientists.

BGS will launch a new initiative, GeoSchool, that aims to develop and deliver a programme of geo-education, professional training, institutional strengthening and scientific collaboration courses and training experiences, based on the BGS and NERC science, information, leadership and public engagement missions. The target audience includes

students, academics, industry, and society in the developed and developing world and the emerging economies. The GeoSchool concept recognises the current global skills shortage in earth science and aims to make a relevant and sustainable contribution to the problem.

GeoSchool initiative

This initiative will enable NERC centres like BGS to harness skills, knowledge and expertise held uniquely within our institutions and simultaneously twin with universities in areas of mutual interest and skills overlap.

An international focus

BGS intends to expand its research and capacity building programmes worldwide, but specifically in Africa, support for which is given a high priority in the G8 countries. We will build on our long history of international geological mapping and the transfer and exchange of knowledge and skills in developing economies. Our work will include research on the African Rift Valley and its impacts on environmental change in the region and beyond. We will look into setting up a monitoring base in the region to facilitate this, and other types of research.

Estates

We will review our estates and buildings in order to target investment to maintain and, where necessary, improve or consolidate accommodation, meeting and laboratory facilities. Facilities will provide flexibility and adaptability to underpin changing scientific priorities. Our plans include the following developments:

- On completion and occupation of the new William Smith Building in 2009 we would like to initiate a second new building to provide modern office accommodation for the remainder of our staff. This will allow us to extend the benefits to organisational culture and communication which team and open-plan working can bring.
- The current meeting and conference facilities at Keyworth no longer meet the needs of BGS and NERC and we propose to redevelop these to create a venue that will be a flagship venue for BGS and NERC events.

The William Smith building under construction in Keyworth.

- There is a recognised need to rationalise BGS collections and archive facilities at Gilmerton, Loanhead and Keyworth and we plan improved facilities with increases in capacity to meet anticipated demand.

- Information systems and technology underpins all BGS activity. We are nearing the limits of our current capacity and resilience. We are developing plans for a new server centre that could also host pan-NERC IT infrastructure.

- The development of a National Physical Properties and Processes Laboratory, together with a state of the art Geo-environmental Tracer Laboratory will be a major investment. This will require redesign of existing facilities and possibly new build but could potentially incorporate other national laboratory equipment pools, providing a facility which would be open to UK and international scientists.

- The GeoSchool proposal and the BUFI programme intend to provide in-house training. Dedicated training facilities are foreseen, which, ideally, would also include a residential facility for visitors.

Administration

The introduction of the RCUK Shared Service Centre will have a major impact on BGS which will require us to reconfigure

many established processes. It is a challenge that provides an opportunity for new skill sets and development opportunities for retained support staff. We will continue to drive down overhead costs; investment in and rationalisation of our estate will be key to this. We will, wherever possible, increase the balance of funding in favour of science and knowledge exchange.

Laboratories

BGS will continue to improve research and service facilities across the geoscience domain. However, we will move towards grouping key facilities to create a number of centres of excellence, for example, a Geo-Environmental Tracer Laboratory and a National Physical Properties and Processes Laboratory; these are described on page 15. Our aim is to make BGS laboratories increasingly visible and influential, with close linkages to other NERC community laboratories and a more significant role in delivering the BGS science strategy.

Information Technology infrastructure and publishing services

BGS staff will continue to have access to world-class Information Technology infrastructure, services and support. A dedicated group of staff will ensure that this infrastructure meets organisational needs. The infrastructure will evolve in parallel with the roll-out of NERC's information technology and systems strategy so as to address the requirements of the wider NERC community. We will continue to develop our state-of-the-art cartographic, publication and graphic design capability. The increasing emphasis on Internet delivery of our mapping, modelling and other outputs will be based on the highest standards of design and technology.

BGS in 2014 – a forward look

In five years time we look forward to:

An enhanced role within a joined-up UK environmental science landscape that will embrace the full science spectrum — from discovery and research, to problem-solving and knowledge-transfer.

Being recognised as the national centre for applied geoscience that will host NERC national geoscience capability. In partnership with the higher education sector, NERC research and collaborative centres, government and industry BGS will contribute to practical solutions to UK and global environmental and sustainable-resource challenges.

Delivering quality assured predictive models to underpin advice to stakeholders and especially government, for the socio-economic development of the UK. We will be making a proactive contribution to the deployment of technologies for carbon capture and storage and the exploitation of energy and groundwater resources and will ensure we contribute to providing the best geoscience evidence for the safe disposal of radioactive waste.

Continuing to lead the world in the management and delivery of geoscience data, information and knowledge and set the standard for environmental data management in NERC. The UK geoscience knowledge base will be accessible to stakeholders through state of the art Internet delivery ahead of compliance with public sector data regulation and will be available through a variety of national and international portals, including OneGeology.

A network of observatories of Earth processes developed by BGS in collaboration with other NERC research centres. These will be linked to European and international programmes of satellite observation and data-transfer networks and will provide fundamental data so that we can model processes of environmental change.

Completing a second phase of building renovation at Keyworth and ***create a site acknowledged as an international centre of excellence in the geosciences and a focus of applied environmental science nationally.*** We will have exploited all our sites and assets to the full to enrich links with universities and industry.

A GeoSchool providing professional training to meet NERC, UK and international needs for applied geoscientists equipped with practical skills.

'Delivering quality-assured predictive models to underpin advice to stakeholders and especially government, for the socio-economic development of the UK'

Developing high resolution BGS models of the sea floor to underpin development of the offshore shelf of the UK and with our neighbours, focus on generating science to facilitate infrastructure development within the North Sea. Playing a leading role in creating a geoscience framework for the North Atlantic gateways through enhancing our industrial consortia and collaboration with geological surveys and research institutions in northern Europe.

Taking a lead in major geoscience projects that require expensive infrastructure and collaboration between multiple partners, interdisciplinary science and data interoperability. We will have worked with other NERC centres to establish an operational science base in Africa.

Being an organisation that attracts and retains the best staff who possess the range of skills, professionalism and flexibility to address the societal and environmental challenges faced by our changing Earth.

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Glossary

Anthropogenic
Caused by humans

Benthic habitat
An ecological habitat at the lowest level of a body of water

BGS University Funding Initiative (BUFI)
An initiative supporting collaborative science between BGS and the higher education sector

Carbon capture and storage (CCS)
A method of capturing carbon dioxide and storing it in geological formations instead of releasing it into the atmosphere

Centre for Ecology and Hydrology (CEH)
A NERC research centre for research in the land and freshwater environmental sciences

Cryosphere
The region of the Earth that is perennially frozen

European Plate Observing System (EPOS)
European initiative to support and develop research infrastructure and E-science on earthquakes, volcanoes, surface dynamics and tectonics

Geographical information systems (GIS)
Systems for capturing, storing, analysing, managing and displaying data which is linked to a spatial location

GeoScience Mark-up Language (GeoSciML)
A global geoscience interchange mark-up language to improve interoperability and sharing of geoscientific data

Geosphere
The solid mass of the Earth

Infrastructure for Spatial Information in Europe (INSPIRE)
The European Commission Directive on spatial data infrastructure

Interoperability
The ability of diverse systems and organisations to exchange and utilise each other's data

Global Monitoring for Environment and Security (GMES)
European programme to implement an Earth observation service system

Living With Environmental Change (LWEC)
A major UK interdisciplinary research and policy partnership to tackle environmental change

National Capability (NC)
NERC National Capability funding will enable the UK to deliver world-leading environmental science to support national strategic needs, and to respond to emergencies. It is mainly about long-term investment and will rarely be subject to open competition. NERC research centres, collaborative centres and other providers of services and facilities, play a leading role for the UK in managing and delivering this capability.

National Geoscience Data Centre (NGDC)
NERC's designated data centre for earth science data and information

National Good
A subset of National Capability. The main driver for a National Good activity is the need of society rather than science priority

NERC Isotope Geosciences Laboratory (NIGL)
One of the largest facilities in Europe for studying naturally occurring isotopes

Oceans 2025
A NERC marine science programme to increase knowledge of the marine environment

OneGeology
A global initiative to improve the accessibility of geological map data

Public sector research establishment (PSRE)
UK Government research establishment which includes Research Council Institutes such as BGS

Research Councils UK (RCUK)
A strategic partnership between the seven UK research councils

Research Programme (RP)
The funding stream to support time-limited research programmes that address the science priorities defined by NERC's strategy

Responsive Mode (RM)
The NERC funding stream for blue skies research

Zone of human interaction
A zone extending from the forest canopy to depths of one or two kilometres below the surface; It is sometimes referred to as the Earth's critical zone

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

The British Geological Survey (BGS) is a Public Sector Research Establishment within the Natural Environment Research Council (NERC), which is the UK's main agency for funding and managing research, training, and knowledge exchange in the environmental sciences. NERC reports to the UK government's Department for Innovation, Universities and Skills.

BGS was founded in 1835 and is the world's oldest national geological survey. In addition to our work within the UK we also undertake an extensive programme of international research, surveying and monitoring, including major institutional strengthening programmes in the developing world. Our scientists have expertise across the geoscience disciplines and our work is underpinned by unrivalled geoscience collections, comprising millions of records and samples.

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Nottingham, NG12 5GG
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Murchison House, West Mains Road,
Edinburgh, EH9 3LA
☎ 0131 667 1000

Maclean Building, Crowmarsh Gifford,
Wallingford, OX10 8BB
☎ 01491 838800

London Information Office, Natural History Museum,
Cromwell Road, London, SW7 5BD
☎ 020 7589 4090

Columbus House, Greenmeadow Springs,
Tongwynlais, Cardiff, CF15 7NE
☎ 029 2052 1962

Geological Survey of Northern Ireland,
Colby House, Stranmillis Court,
Belfast, BT9 5BF
☎ 028 9038 8462

NATURAL ENVIRONMENT RESEARCH COUNCIL

Natural Environment Research Council, Polaris House,
North Star Avenue, Swindon SN2 1EU
☎ 01793 411500
www.nerc.ac.uk

NERC's research centres

British Antarctic Survey (BAS)
☎ 01223 221400
www.antarctica.ac.uk

Centre for Ecology and Hydrology (CEH)
☎ 01491 838800
www.ceh.ac.uk

Proudman Oceanographic Laboratory (POL)
☎ 0151 795 4800
www.pol.ac.uk

NERC's collaborative centres

National Centre for Atmospheric Science (NCAS)
☎ 0113 343 5158
www.ncas.ac.uk

National Oceanography Centre, Southampton (NOC)
☎ 023 8059 6666
www.noc.soton.ac.uk

Plymouth Marine Laboratory (PML)
☎ 01752 633100
www.pml.ac.uk

Scottish Association for Marine Science (SAMS)
☎ 01631 559000
www.sams.ac.uk

Sea Mammal Research Unit (SMRU)
☎ 01334 462630
www.smru.st-and.ac.uk

BGS includes the following national and international facilities and services:

National Geosciences Data Centre
www.ngdc.co.uk

National Hydrocarbons Data Archive
www.bgs.ac.uk/nhda/home.html

National Seismological Archive
www.earthquakes.bgs.ac.uk/archive/Archive_home.htm

National Groundwater Level Archive
www.ceh.ac.uk/data/nrfa/groundwater.html

NERC Isotope Geosciences Laboratory
www.bgs.ac.uk/nigl/

Minerals UK
www.mineralsuk.com

UK Integrated Ocean Drilling Programme
www.bgs.ac.uk/iodp

European Consortium for Ocean Research
Drilling Science Operator
www.ecord.org

OneGeology
www.onegeology.org

World Data Centre for Geomagnetism
www.wdc.bgs.ac.uk

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