# GEOSCIENCE

## TOWARDS A SMARTER ECONOMY

The potential economic impact of Geoscience up to 2020

GSI

Department of Enterprise, Trade and Investment

Geological Survey of Northern Ireland

RIA

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# EXECUTIVE SUMMARY

■ Geoscience is integral to our economy's future success and the benefits of investment are significant. Its economic contribution is great but it risks being undervalued.

■ Geoscience already forms a key sector of the economy in both Ireland and Northern Ireland, and can contribute significantly to economic recovery and quality of life in both jurisdictions.

■ Recent additional investment, through the National Development Plan (2007-2013) in Ireland and the TELLUS project in Northern Ireland, has reinforced the impact of Geoscience (through services, research, education and outreach). It is reaping rewards.

■ Ireland's and Northern Ireland's reputation in Geoscience is based on a long-established reputation for excellence in research and innovation. This enviable standing would undoubtedly suffer from future underinvestment which could threaten the capabilities and strengths already achieved.

■ In 2006, the Geoscience sector contributed €3.3 billion, or 2.24% of GNP directly to Ireland's economy. In addition, the Geoscience sector made a substantial indirect contribution to GNP (because of the low import contents of its inputs) and the combined direct and indirect contributions of the sector to the 2006 economy was €4.24 billion, or 3% of GNP.

■ In 2006, the Geoscience sector employed over 30,000 people. The sector also makes a valuable contribution to balanced regional development because it provides attractively-paid work in rurally-based enterprises. These include mining, quarrying, natural gas production and environmental services.

■ The majority of private Geoscience businesses reported strong growth trends over the five years prior to 2008. While some of the extractive industries are cyclical in nature, there is underlying stability in the sector driven by international, EU and Irish regulatory requirements.

■ Many other countries are investing heavily in Geoscience in an effort to develop their own capacity. We cannot afford to be complacent.

■ Ireland and Northern Ireland together have within their grasp the potential to establish a strong Geoscience cluster or hub based on attracting innovative multinational and home-grown entrepreneurs.

■ As we emerge from recession, our Geoscience can build a significant hub with:
a) Increased exports of knowledge-based services;
b) Increased inward investment for priority research and educational services.
c) Targeted government, industry and academic partnerships to support entrepreneurial activity.

■ Over the past 20 years increased investment in biotechnology and Information and Communications Technology (ICT) has driven accelerated growth in these sectors, creating wealth and knowledge-intensive employment. We believe the time is now right to extend similar investment to Geoscience.

■ What has already been achieved in biotechnology and ICT can now be extended to Geoscience.

■ Given our recent economic climate, we must be prepared to compete on quality grounds and the strength of our innovative environment. In the future, Ireland's and

Northern Ireland's small scale and collaborative research landscape will provide unique advantages that could assist in creating a dynamic environment with a strong growth strategy.

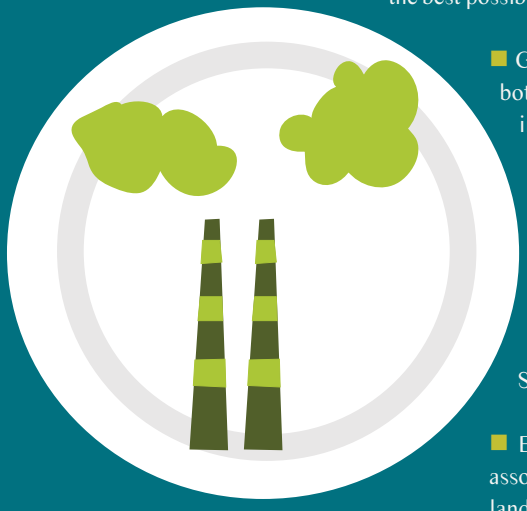
■ Extending Geoscience services, research and capabilities would make the country more attractive for foreign direct investment in new industries such as equipment manufacture and technology development.

■ Geoscience is fundamental to the future of the island of Ireland's mineral and energy resource industry and to its development – the comprehensive and accurate identification of their scale and location is a prerequisite for harnessing economic gain.

■ Geoscience underpins, for example, our metallic minerals research. The commercial dividend is clear. In 2006, Ireland's zinc mining industry accounted for 60% of West European zinc production, or €317 million turnover. Of this, the investment on essential R&D was just 3.2%.

■ Continued exploration and ongoing inventory of our resources will be essential to advancing their development.

■ For Ireland and Northern Ireland to secure energy supplies for future generations, research and essential knowledge produced by the Geoscience sector will be critical – from identifying under-explored offshore areas for hydrocarbon resources to pinpointing the best possible locations for renewable energy forms such as wind and wave.



■ Geoscience research and services will thus be essential to support both Governments' challenging 'climate change' objectives of increasing the renewable proportion of the energy mix to 40% within the next 10 years.

■ Geoscience is already making a major contribution in improving our understanding of the causes of climate change and its impact on our landscape. It is also at the forefront in assisting the development of new technologies designed to lessen the effects of climate change such as Carbon Capture and Storage.

■ Equally, our understanding of the cause and effect relationships associated with natural hazards, such as floods, coastal erosion and landslides can only be based on our knowledge of modern research processes that are supported by statistically-based geological records of past events.

■ Groundwater – the source of up to a fifth of the water we drink – will need to be closely monitored as the more extreme weather events predicted by climate change studies accelerate constraints on water quality and quantity. Geoscience will play a central role in this, and in Ireland's ability to comply with components of the EU Water Framework Directive.

■ As Ireland and Northern Ireland have already demonstrated during the decade behind us, where there is science and innovation, business opportunities, jobs and improved quality of life follow. For us to improve our economic fortunes, Geoscience must continue to play a central role in the decade ahead.

# GEOSCIENCE IN IRELAND AND NORTHERN IRELAND IN 2020: A VISION

- A small number of research centres of excellence that have critical mass and world-class expertise in key research themes, playing a prominent role in international research programmes.
- Excellent Geoscience services delivered through an interactive network of government, private sector and academia. These services show strong growth in overseas markets.
- Ireland and Northern Ireland are preferred destinations for the location of multinational research, services and consultancy facilities, with increasing direct foreign investment in extractive sectors.
- Geoscience education is regarded internationally as first class and its graduate throughput exceeds twice the 2008 numbers (with a significant proportion being non-EU).
- Public attention is captured to ensure a flow of talented students backed by satisfactory resources.

# INTRODUCTION

Geoscience is the collective name for the sciences – such as geology, geography or geochemistry – that deal with the Earth.

This publication sets out the priorities for Geoscience research, services, education and outreach to 2013 and the impact these may have in the period to 2020. In Ireland, it is guided by the National Geoscience Programme (2007-2013), published jointly by the Royal Irish Academy (RIA) and the Geological Survey of Ireland (GSI), and additional guidance available in the Government Strategy for Science, Technology and Innovation (2006). In Northern Ireland, it is based on the Department of Enterprise, Trade and Investment (DETI) Corporate Plan, the British Geological Survey (BGS) Strategy and the Natural Environment Research Council (NERC) Strategy.

It was further developed through a process undertaken during 2008 by the RIA, GSI and Geological Survey of Northern Ireland (GSNI). It comprised two public seminars, the first held at Parliament Buildings, Stormont, in June 2008, the second at the RIA, Dublin, in December 2008. The results were published on the websites of the three organisers[1]. It takes account of the feedback received by the organisers since the start of the process, including through the Consultative Committees of GSI and GSNI, the Geosciences Committee of the RIA and the Committee of Heads of Irish Geoscience Institutes (CHIGI). The section on energy priorities also drew on the submission to Government following the RIA Energy Conference (2007) while that on marine was informed by the Seachange (2007-2013) foresight document of the Marine Institute.

The programmes of, and list of presenters at, the public seminars are contained in Appendices 2 and 3. Individual seminar presentations where available can be accessed on the RIA website[2]. The organisers wish to thank the speakers, chairpersons, and participants for their commitment and contribution to making this process a success.

The presentations at the Stormont seminar reviewed the current state of Geoscience in Northern Ireland and Ireland. The seminar also considered perspectives from European professional geological organisations (the European Federation of Geologists and Eurogeosurveys) and from a Scottish perspective (British Geological Survey).

The Dublin seminar sought to identify and establish support for the key Geoscience objectives and priorities for the next five years. It also discussed the key implementation issues in such an augmented Geoscience programme. Both meetings engaged providers and users of Geoscience knowledge in a valuable debate on the contribution that Geoscience makes to society and on the key conditions required for success.

[1] www.ria.ie; www.gsi.ie; www.detini.gov.uk; see also: http://www.gsi.ie/News/Defining+Geoscience+Priorities.htm
[2] www.ria.ie

The Geoscience sector can continue to make a significant contribution to economic recovery and quality of life in both Ireland and Northern Ireland.

## Ireland

In 2006, Ireland's was a small but flourishing open economy, with a Gross National Product (GNP) of €149.1 billion and a population of 4.17 million. The Geoscience sector made a significant contribution to this economy, its total direct added value being €3.3 billion, representing 2.24% of GNP. In addition, the Geoscience sector made a substantial indirect contribution to GNP (because of the low import contents of its inputs) and the combined direct and indirect contributions of the sector to the 2006 economy was €4.24 billion (3% of GNP).

# BACKGROUND

In 2006, the Geoscience sector employed over 30,000 people (1.4% of total employment). The sector makes a valuable contribution to balanced regional development because it provides attractively paid work in rurally-based enterprises. These include mining, quarrying, natural gas production and environmental services. The majority of private Geoscience businesses reported strong growth trends over the five years prior to 2008. While some of the extractive industries are cyclical in nature, there is underlying stability in the sector driven by international, EU and Irish regulatory requirements.

In recent years, third level institutions in Ireland and Northern Ireland received €7.9 million annually in funding for Geoscience research. In 2007, Geoscience received an additional funding boost, amounting to €43 million, under the Geoscience Sub-Programme of the National Development Plan (2007-2013).

However, funds provided to Geoscience by the key funding mechanisms, Programme for Research in Third Level Institutions (PRTLI) and Science Foundation Ireland (SFI), amount to no more than 5% of the budget of these mechanisms. Yet in 2008, Geoscience lay 11th in a list of 17 research fields whose research impact (measured by citations per paper) placed Irish universities in the top 1% of research institutions in the world[3]. This strongly suggests that Geoscience remains undervalued.

The Geoscience sector, as summarised here, is profiled in *Geoscience: Gaining Ground,* available on the GSI website[4].

## Northern Ireland

An independent UK-wide study on the Economic Value of the British Geological Survey published in 2003 concluded that in 2001 the total value added of national output to which BGS contributed was in the range £34-61 billion, representing 5-8% of total UK (gross value-added) output. In 2007 it was estimated that the extractive industries in Northern Ireland represented 2.4% of GDP (£350 million).

GSNI has close linkages with industry and academia, and collaboration between government, industry and academia is at an all-time high, with more than 20 PhD, MSc and other research projects currently being undertaken. Many of these projects involve the world class TELLUS data sets and several are funded by British Geological Survey grants.

## International

Finland, recognising the impact funding Geoscience has in underpinning economic development, allocates ten times more public funds on a per capita basis than Ireland and Northern Ireland. At approximately US $1 per capita in both UK and Ireland, it is clear that reducing public sector Geoscience spending is not an option if we are to meet demands such as the supply of natural resources, the mitigation of climate change and the need for balanced environmental and socio-economic development.

[3] Data sources: http://sciencewatch.com/dr/cou/2008/08decALL/ and http://www.in-cites.com/countries/ireland.html
[4] http://www.gsi.ie/

## Ireland

In 2007, the Geoscience sector was awarded €43 million over the period of the National Development Plan (NDP) to 2013. The funding was based on the priorities of the National Geoscience Programme as set out in the publication 'Putting our Knowledge of the Earth to work for Ireland'[5]. The funding is being invested through the GSI, under the Geoscience Sub-Programme of the NDP, in research that impacts on Government priority areas including Energy, Marine, Environment and Transport. Geoscience knowledge is critical to environmental protection, climate change, energy security and infrastructure planning.

The funding was invested to address the following priority areas:

**INFOMAR Project:** The benefits from this survey are placing Ireland at a competitive advantage – through leveraging of international funding for offshore energy exploration, fish stock management, habitats conservation, aggregates and renewable energy sources. INFOMAR is the long-term marine mapping programme which succeeded the Irish National Seabed Survey. Designed to complete nearshore and coastal mapping of Ireland's seabed, it is jointly managed by GSI and the Marine Institute. €28 million in funding has been allocated.

**Infrastructure Support Projects:** A coordinated national study to provide a full suite of products to support infrastructure development (e.g. groundwater protection and aggregate potential mapping). €5 million in funding has been allocated.

BUILDING MOMENTUM

**Geoscience RTDI:** The Griffith Geoscience Research Awards scheme is designed to build Geoscience research capacity at universities in Ireland and Northern Ireland. Funding of €10 million is provided to underpin strategic Geoscience research in key areas and to develop the undersized research sector. The Irish Geoscience Graduate Programme, incorporating island-wide networked teaching resources (as well as additional research infrastructure) in a holistic training environment, will support this initiative.

**The Resource and Environmental Survey of Ireland** will provide an integrated national baseline survey of Ireland using state-of-the-art airborne geophysical surveying techniques complemented by ground geochemical surveys. To date only pilot surveys have been undertaken and no specific funding has been allocated. Data (extending the existing TELLUS coverage in Northern Ireland) will assist in the discovery of new mineral and aggregate resources, help delineate new groundwater resources and inform planning decisions.

## Northern Ireland

**TELLUS Project:** The positive impact of this survey on natural resource exploration, environmental awareness and infrastructure planning continues to grow. From an initial investment of £6 million, exploration/research programmes totalling a minimum of £20 million are underway. Should any of the natural resource related projects prove successful this expenditure could increase exponentially. The impact of the datasets has stimulated local, national and international research and exploration opportunities in an ever increasing range of disciplines, including mineral exploration and new ways of assessing environmental hazards.

**Energy Projects:** Through the Northern Ireland Innovation Fund, GSNI has investigated the geothermal potential of Northern Ireland and the potential for natural gas storage offshore. These projects contribute new information to support the Northern Ireland Energy Strategy.

Important progress has been made on all these priorities and it is essential funding continues to ensure successful implementation. They form a sound foundation on which to support key areas outlined below.

[5] www.ria.ie ; www.gsi.ie

Geoscience research develops essential knowledge to support the provision of secure and efficient energy. This includes wide-ranging evaluations including hydrocarbon exploration, renewable energy (especially geothermal), underground energy storage and the role of carbon-capture-and-storage (CCS) to underpin the future use of fossil fuels. Geoscience contributes to discussion of energy issues, ensuring there is public understanding.

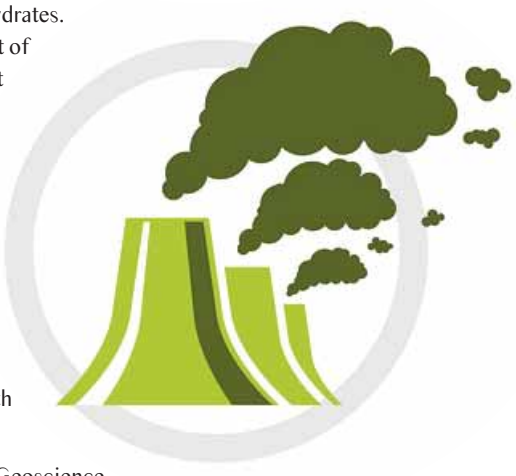
## ENERGY

1) **Hydrocarbons** will continue to supply a substantial proportion of our energy demand for many decades, yet our offshore remains under-explored and poorly understood. The Petroleum Infrastructure Programme (PIP) has made an important contribution in recent years (see "Industry Support", Appendix 1) but the following objectives will remain important in addressing this situation.

- Improved 3D architecture of both onshore and offshore basins in Ireland and Northern Ireland to maximise resource recovery, identify new targets and stimulate new exploration.
- Enhanced understanding of petroleum potential in frontier basins off Western Ireland through regional syntheses, basin analysis and deep seismics.
- Strategic environmental evaluation, including seabed surveys such as INFOMAR, are an essential basis for eco-friendly and secure hydrocarbon exploration and production.

2) **Carbon Capture and Storage (CCS)**: The 2008 evaluation of island-wide possibilities is an important start, but requires significant further study (*Assessment of the potential for geological storage of carbon dioxide for the island of Ireland.* CSA Group. 137 pages)[6]. The following are essential in order to successfully develop CCS:

- Regional offshore assessment of CCS potential as a basis for evaluating options, developing a CCS strategy and informing decision-making on commercial proposals; a joint UK-Ireland Irish Sea study is supporting this objective.
- Assessment of specific options such as depleted gas fields, saline aquifers, un-mined coal seams, mineral carbonation and methane hydrates. For example, the ongoing assessment of the Clare Basin study (a joint Environmental Protection Agency-GSI study) aims to test the potential of saline aquifers in the vicinity of Moneypoint coal-fired power station.
- Research on the fluid flow characteristics in offshore geological formations is a necessary precursor to successful CCS and work has already begun under Griffith Geoscience Research Awards.



3) **Renewables**: Increased levels of Geoscience research and services are essential to support both Governments' challenging objectives of increasing the renewable proportion of the energy mix to 40% by 2020. Key Geoscience inputs are:

- The use of geothermal energy depends upon depth. Deep sources (several kilometres), utilising both hot dry rocks and aquifers, can potentially be used in electricity generation. Medium depth sources (100s of metres) may provide warm water for domestic, industrial and agricultural uses. The exploration of deep and medium depth sources requires that

[6] www.sei.ie

suitable regulation and incentives are in place. Shallow sources exploit air-ground temperature differences through the use of Ground Source Heat Pumps (GSHP).

■ Modelled data suggests that electricity generation may be feasible in selected locations. However, progress has been through the development of small scale examples of medium depth schemes and larger scale exploration has taken place in both west County Dublin and Northern Ireland where GSNI has been a key player. The uptake of GSHPs is increasing in both Ireland and Northern Ireland, with subsoils databases providing valuable Geoscience information to identify suitable sites.

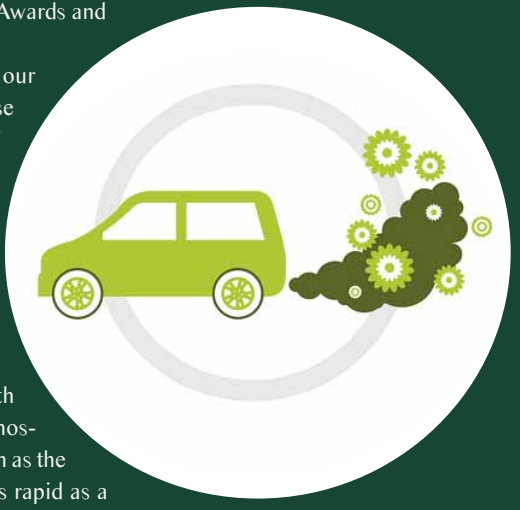
■ Geoscience provides valuable datasets to support the development of renewable energy projects such as wind and wave. Offshore bathymetry (multibeam data) and onshore landscape (remote sensing) are used to generate GIS-based knowledge for informed decision-making. Related Geoscience studies identify good environmental practice and can help prevent hazards such as flooding and landslides. The Marine Institute is leading international research on ocean energy while GSI and GSNI datasets support both onshore and offshore wind projects.

# CLIMATE CHANGE

Climate change and shifting demographic patterns are increasing the pressures on our environment. Geoscience contributes to a greater understanding of the impact of climate change as well as effective mitigation strategies.

Geoscience is key in the following areas:

1) **Groundwater resources:** Climate change is predicted to cause more extreme weather events leading to civil defence emergencies. Geoscience must develop models to simulate impacts on the quality and quantity of groundwater resources. Current initiatives include groundwater protection schemes (GSI and Northern Ireland Environment Agency (NIEA)), groundwater monitoring (EPA and NIEA) and third level research (including under Griffith Geoscience Research Awards and GSNI projects with Queen's University Belfast).



2) Archives of **past climate change** are extensive in our landscape, rocks and soils. With suitable analysis, these have the potential to provide high resolution records of past climates, allowing comparisons with the output from general circulation models that in turn will inform the development of models of future climate change. The links between climate and North Atlantic circulation, and atmospheric circulation patterns such as the North Atlantic Oscillation, suggest that change can be as rapid as a few years so there is a need for vigilance.

3) **Carbon Capture and Storage (CCS)**: can be an important ameliorating technology to manage greenhouse gas emissions while continuing to utilise fossil fuels.

4) Develop high resolution assessments and monitoring networks for **natural hazards** arising from climate change. These require prioritised onshore and offshore surveys, which allow the development of systematic databases as baselines for future modelling. Examples include the TELLUS and INFOMAR datasets (see Natural Hazards).

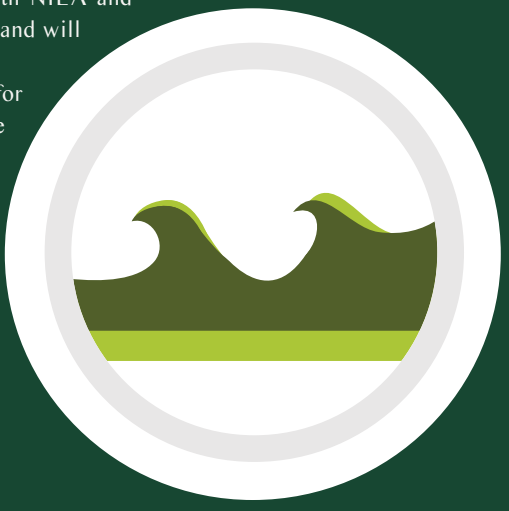
# MARINE

Ireland has an extensive marine area, approaching ten times the land area, with associated opportunities to develop leadership in knowledge management and to support policy and regulation at national and international levels. There are significant cross-links between Geoscience and marine science which enrich the application of both.

The important Geoscience elements are set out below:

1) The integrated work programme of **INFOMAR**[7], jointly managed by the Marine Institute (MI) and GSI, is focused on the near shore to provide support for an improved marine environment, navigational safety, energy and infrastructure projects, coastal flooding, fisheries, heritage (including shipwrecks) and business development. In Northern Ireland, recent work by both NIEA and GSNI has provided new seabed data and will support a wide range of initiatives.

2) **Monitoring the seabed** as a basis for modelling environmental and climate change. Sensors on, above or below the seabed can provide important Geoscience datasets. MI leads this development and others, including the Dublin Institute for Advanced Studies, have key roles.



[7] www.infomar.ie

# MINERAL RESOURCES

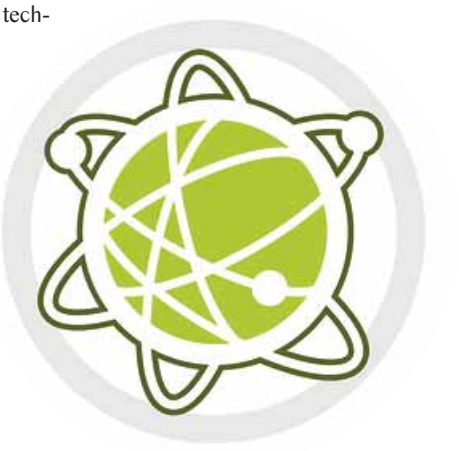
Mineral resources encompass a wide range of commodities. For example, the National Geoscience Programme emphasised objectives relating to aggregates but there is also a need to prioritise objectives in support of metal mining. Ireland's zinc mining industry accounted for 60% of West European zinc production in 2006, (€ 316.5 million turnover) and its R&D spend (exploration) amounted to 3.2% of turnover. Mines are based on finite ore reserves and in order to sustain production the industry must identify additional reserves urgently. Typically, new discoveries have a 6-10 year lead time to production.

Geoscience is of key importance to metallic minerals research, and can make a significant input to economic recovery. While historical relationships between the minerals industry and universities have not always maximised home-based opportunities, there are now new opportunities to do so.

The proposed programme will improve our understanding of prospective areas and the prospects for discovery of new mines through support for and promotion of exploration in Ireland and Northern Ireland.

Outlined below are the key priorities:

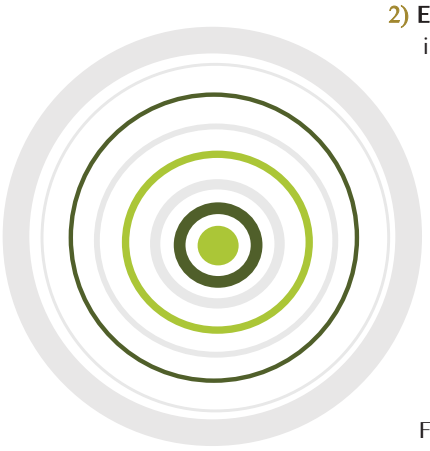
1) Modelling and visualising 3D Ireland and Northern Ireland: new discoveries are likely to be found at depth, a 3D understanding of our geological framework is essential. Integration of a range of Geoscience data can contribute to this.
2) 3D models need new data and interpretation (which can be derived from geophysics, including innovative techniques, deep drilling and cores).
3) Upgrading and extracting maximum value from existing databases: the third dimension requires leveraging of existing data, improving databases, and facilitating access to cores, samples, etc.
4) Supporting new hypotheses and discoveries: improved understanding of origins of, and controls on, our base and precious metal deposits; specific relevant expertise on metallogenesis including regional fluid flow, fracture patterns and mineralization systems.



# NATURAL HAZARDS

Globally, this area is attracting young scientists. Although our island has a relatively safe environment, it is affected by significant natural hazards where Geoscience has a role in understanding, forecasting and remediating. Natural hazard research is crucial in developing transferable Geoscience skills which play an important role in international development and bilateral aid. Geohazard research is a geoscientific priority and the following activities can facilitate and support its development:

1) **Large scale datasets** such as TELLUS and Irish National Seabed Survey (INSS) support hazard research in Northern Ireland (influence of environmental radioactivity on cancer incidence) and Ireland (submarine mass slides) respectively.



2) **Earthquake research** in recent years has had some dramatic results, including that based in Northern Ireland on the Sumatran tsunamigenic quake of 2004. Our landscape is relatively stable and does not experience devastating earthquakes, but the lack of long-term observations means that statistically rare medium-magnitude events are possible with unknown probability. World-class seismological research can now be undertaken at Irish universities based on accessible international datasets. It also provides opportunities to interact with the public at large.

3) **Volcanic hazards** research at Vesuvius, Krakatoa and in New Zealand has an impact not only for the millions of people within the footprint of individual volcanoes, but also in a global sense. For example, the fractal distribution of associated fractures could have implications for ore deposits research, while research results on the seismic signals associated with fluid ascent may be applied to carbon capture and storage. These are good examples of research cross-overs.

# WATER SUPPLIES

Groundwater is an important component of our water supplies. In Ireland, it represents 16.3% of the total volume of water supplied from Public and Group Water Supply Schemes, while in Northern Ireland some 5% of public water is supplied from groundwater. Private sector usage of groundwater is increasing.

The extreme weather events predicted by climate change studies will accelerate constraints on supplying water of suitable quality and quantity. Compliance with the EU Water Framework Directive (including impacts on sensitive groundwater-dependent ecosystems) is also important. Geoscience provides vital subsurface knowledge to groundwater supplies and contributes to managing all water supplies in an integrated manner. Groundwater research requires significant long-term investment at local and regional scales as well as an increased and sustained emphasis on field experience. Ongoing programmes at the Environmental Protection Agency (EPA) and GSI in Ireland and NIEA and GSNI in Northern Ireland are assisting in this.

The priorities are as follows:

1) Detailed knowledge of **bedrock geology** and the distribution of rock types at depth, including weathering (and karst weathering), fracturing and alteration (including dolomitisation) patterns which control the storage and movement of groundwater. This is particularly important in areas where bedrock is obscured by overburden.

2) Improved understanding of **fluid flow** in aquifers (which is typically along fractures in impermeable rocks), including the incidence of saline incursions. Modelling of groundwater resources based on a monitoring network of observation and recharge patterns, and made available on GIS databases.

3) High resolution information on **overburden** (including weathered bedrock and Tertiary deposits) which overlies aquifers and provides essential protection for groundwater. Geophysical data can provide high resolution information.

4) **3D/4D visualisation** of groundwater systems to provide support to decision makers, scientists and students on issues such as pollution and recharge.

5) Impact of groundwater on **habitats**, including the habitat that groundwater itself provides for microbial fauna and flora. The biosphere and biochemical processes in the rock fabric are significant in relation to water chemistry and microbiology.

# PRIORITIES TO 2013

The Geoscience priorities to 2013 are summarised as follows:

- Energy and the economy: Improve the understanding of our 3D subsurface to support natural resources exploration, carbon storage and new sources of renewable energy.
- Climate Change and Environment: Develop Geoscience databases to model climate change and its impacts on groundwater, carbon storage and natural processes, including hazards.
- Marine: Characterise, map and monitor the offshore marine environment, natural resources and economic potential of the seabed.
- Water Supplies: Build high resolution 3D knowledge of groundwater flow, quality and impact on habitats.
- Mineral Resources: Develop 3D models, populated by all available data sets, of our subsurface in order to support exploration.
- Natural Hazards: Promote Ireland- and Northern Ireland-based Geoscience research into natural hazards including flooding, extreme weather, tsunami, earthquakes and volcanoes.
- Training and education: Re-affirm the commitment to establish Ireland and Northern Ireland as a world-leading location for holistic training and education in the Geosciences through the establishment of the Irish Geoscience Graduate Programme.

Geoscience in both Ireland and Northern Ireland must be developed to world-class standards to deliver effectively on these priorities. Additional private sector investment is essential and will be based on proportionate support from public sector Geoscience services and research.

# MAKING OUR GEOSCIENCE WORLD-CLASS

Aspects of our Geoscience research are world-leading. However, it is essential that more areas of Geoscience in Ireland and Northern Ireland become world-class to contribute effectively to objectives such as climate change, environment, infrastructure and natural resources development. Geoscience must also contribute to economic recovery through employment and wealth creation, including the provision of knowledge excellence to support informed decision making at every level. Certain conditions are necessary to make this happen:

1) Ireland and Northern Ireland have small Geoscience communities. We must build critical mass in key areas of Geoscience to ensure our practice is world-class and double the numbers of geology graduates. Funding must be sustained on a multi-annual basis and structured to address both 'Big Science' themes (e.g. through the Griffith Geoscience Research Awards) and excellent 'Blue Skies' researchers (currently funded under PRTLI and SFI's Research Frontiers Programme). Comprehensive, interoperable and continuously updated databases are necessary to underpin world-class research and services. A significant start has been made with datasets such as those of INFOMAR in Ireland and TELLUS in Northern Ireland, but they need to be extended and their use maximised. The existing Cross-Border cooperation between GSI, GSNI and the British Geological Survey is a potential model for more extensive international cooperation. Increased processing and interpretation can be achieved by linking datasets with international research programmes.

2) It is expected that 50% of existing practitioners in Ireland and Northern Ireland will retire by 2020, raising serious concerns of a shortfall of geoscientists to respond to the future needs of society. Internationally there have been more vacancies recently than qualified applicants. Third level Geoscience training will need to be more holistic and integrated with other sciences. The Irish Geoscience Graduate Programme, starting in 2010, will pool educational resources at fourth level between institutes in Ireland and Northern Ireland, thus facilitating the training of researchers with flexible and transferrable skills. Continuous professional development, nurtured by the Institute of Geologists of Ireland over the past decade, is critical to ensure practitioners retain relevant skills.

3) In the 21st century, Geoscience and its associated diverse disciplines have much to contribute towards our understanding of planet Earth on local, regional and international scales. Increased knowledge is best achieved through sharing the international research effort, by focusing on important global themes and interacting with the best geoscientists. Geoscience issues are increasingly international and must be addressed in this context to ensure best practice, economies of scale and common standards.

In so doing, opportunities will arise for our geoscientists to contribute to bilateral aid programmes. International themes, which are relevant to the economy and which currently attract critical mass at the best research centres, include security of resources; mitigation of climate change (including CCS); optimisation of land and seabed use; and natural hazards.

4) Interdisciplinary working (as in INFOMAR and TELLUS) increases the potential for effective partnership, better research outcomes and attracting significant funding. Research must be relevant to policy-making and regulation at local, regional and international levels. Geoscience research must be collaborative and encourage interaction between industry, government and academia.

5) We must establish conditions to stimulate industry to go beyond simple endowment and consider the establishment of private sector research centres. This involves extending beyond site specific research for the natural resources industries, to embrace sustainable research centres specialising in key areas such as mining and hydrocarbons, service company research (drilling technology, geophysics, remote sensing) and major consultancies. Geoscience can perform in a way that other sciences have shown to be possible.

This will require the support of:

- Excellent Geoscience university centres;
- Strong Government support for knowledge enterprise in Geoscience, in line with the support IDA Ireland recently provided to life sciences;
- Promotion of Ireland and Northern Ireland as preferred destinations for Geoscience research with the coordinated backing of all stakeholders.

Geoscience research and services provide solutions to important societal issues and every effort should be made to ensure Geoscience captures the public imagination. Initiatives aimed at school students such as "Seismology in Schools" need to be augmented with parallel programmes. Increased engagement with geography and science teachers can be achieved through customised educational programmes delivered through Geoparks as part of their public outreach activities. Geoscience, in cooperation with related disciplines, is providing high-resolution, cost-effective solutions that can inspire aspiring students to choose Geoscience as a worthwhile career. A more insightful approach to communicating our message should take account of:

- Communicating Geoscience in concise, familiar and understandable language;
- Building public trust by focusing on audience interests and creating emotional links;
- Sharing our results from an early stage, recognising that inherent uncertainty and risk will be part of the message;
- Developing appropriate strategies for communicating with policy makers, opinion-makers and the interested public.

In order to develop world-class research and services, Geoscience must attract intelligent students in sufficient numbers, whether home grown or from overseas. This requires enduring government commitment to developing competitive career structures and to investing significantly in science programmes and infrastructure.

We need to position Geoscience to take advantage of opportunities when economic recovery comes. Geoscience has been important for both the Irish and Northern Irish economies. In Ireland in 2006 its enterprise was responsible for 3% of GNP and 1.4% of national employment. However, its importance is much greater than these figures, because it creates attractive employment in rurally-based locations thereby promoting balanced regional development. In the future, Ireland's and Northern Ireland's small scale and collaborative research landscape will provide unique advantages that could assist in creating a dynamic environment with a strong growth strategy.

## WHAT WILL GEOSCIENCE CONTRIBUTE IN 2020?

The Geoscience sector in Ireland and Northern Ireland has the ability to respond to the changing needs of society (both here and abroad) in a responsive and efficient manner. For example, seabed images from Ireland's INFOMAR and landward images of Northern Ireland's subsurface from TELLUS are now internationally recognised examples of our acknowledged success in Geoscience services.

In recent years, developments in methodology, equipment, data processing and interpretation have combined to support an explosion of Geoscience applications– in construction, environment, infrastructure, water supplies, waste disposal, tourism and climate change, as well as in more traditional offshore petroleum and onshore mineral resources. We have the potential to develop more of our research centres to world class, to increase the export of Geoscience services, to develop our teaching resources and to attract more knowledge-based enterprises and investments based on Geoscience. Increased access to Geoscience databases facilitates both local and international business opportunities.

Although it is important to grow existing Geoscience services and research, we need to envisage extending the range of Geoscience capabilities. We need to build a global profile of the current anticipated market for Geoscience education, research and services up to 2020. Emphasis should be placed on initiatives by the private sector and international organisations.

This would make the country more attractive for foreign direct investment in new industries such as equipment manufacture and technology development. Given our recent economic climate, we must be prepared to compete on quality grounds and the strength of our innovative environment (rather than on cost). We must stabilise investments by having the appropriate skills and research base to support them. This requires accelerating the output of researchers as well as building excellent research and data centres.

A vision of a successful Geoscience sector in 2020 would include the following:

- Research centres with critical mass and world-class expertise in key research themes playing a prominent role in international research.
- First-rate Geoscience services delivered through an interactive network of government, academia and private sector in both local and international markets.
- Ireland and Northern Ireland are the preferred location for multinational research, services and consultancy facilities, with increasing direct foreign investment in extractive sectors.
- Geoscience education is internationally regarded as first class and graduate throughput exceeds twice the 2008 numbers (with a significant proportion being non-EU).
- Public awareness is heightened to ensure an increased throughput of talented students backed by satisfactory resources. Active, vibrant and informed connectivities are developed with the media via the internet and consultation.

# APPENDIX 1: CASE STUDIES

The development of the following cases demonstrate the practical benefits of effective Geoscience research and techniques that target key focus areas such as hydrocarbon exploration and climate change effects. They demonstrate how collaborative working between industry and academia on focussed, objective research provide a compelling case for targeted funding that builds momentum, scale and results.

The following case studies also demonstrate recent success stories where we applied our knowledge and operational expertise to deliver results of the highest quality for our sponsors.

## Ocean Drilling

The Integrated Ocean Drilling Programme (IODP) is the latest in a series of ocean drilling programmes which have been enormously influential in Geoscience over the past 40 years, including validating the concept of plate tectonics. Subsequently, ocean drilling has underpinned advances in our understanding of climate change, biodiversity, ocean floor resources and oceanography. Geoscientists at Irish universities have had opportunities to participate in specific projects and sail on various drilling legs since GSI established national affiliation in 2002. A high point of our participation was the drilling of cold-water coral mounds in the Porcupine Basin in 2006.

## TOPO-EUROPE

TOPO-EUROPE, the largest geoscience project ever initiated in Europe, aims to understand the dynamic surface we live on. The topography of the continents and their margins is at the interface of deep Earth, surface and atmospheric processes. Topography influences society, not only as a result of slow landscape changes, but also in terms of how it impacts on geohazards and the environment. When sea, lake or groundwater levels rise or land subsides the risk of flooding increases, directly affecting the sustainability of local ecosystems and human habitats. On the other hand, declining water levels and uplifting land may lead to higher risks of erosion and desertification. Ireland participates in TOPO-EUROPE through the European Science Foundation EUROCORES mechanism, but additional funding would assist in maximising the value we get from this project.

## Industry Support

The Petroleum Infrastructure Programme (PIP) is an integrated alliance in Ireland of Government, industry and academic partners. Industry funds this initiative because it regards it as addressing its key needs for accessible databases, international collaboration and targeted research. This could represent a model for integrated research into base and precious metal mineralization.

## Isotope Research

The National Centre for Isotope Geochemistry, a key component of the UCD School of Geological Sciences, is a world-class analytical facility comprising state-of-the-art thermal ionisation and laser-ablation high-resolution multiple collector inductively-coupled plasma mass spectrometers. The National Centre underpins the School's programme of research and graduate training, but uniquely on the island of Ireland, it facilitates new opportunities for interdisciplinary research both within UCD and with other research focused institutions. The latter include University College Cork and Trinity College Dublin, who provided seed funding, as well as others (many overseas) with whom collaborative research is being undertaken. The Centre enables the School to compete more effectively for EU funding and, in the longer term, to seek funding for new interdisciplinary research.

Hosted by Mr Mark Durkan MLA, Mr Jim Wells MLA and Mr Brian Wilson MLA, this seminar was held at Parliament Buildings, Stormont, in June 2008.

## APPENDIX 2. GEOSCIENCE: THE FOUNDATION OF OUR FUTURE

Its programme was as follows:-

**Welcome**
• Professor Peter Mitchell, Science Secretary, Royal Irish Academy
• Arlene Foster MLA, Minister for Enterprise, Trade and Investment

**The Value of Geoscience in Ireland**
• Dr Peadar McArdle, Director, Geological Survey of Ireland

**Key Areas of Irish Geoscience Research**
• Professor Pat Shannon and Dr Julian Menuge, University College Dublin

**Geoscience – the Public Perspective**
• Mr Conall McDevitt, Weber Shandwick

**Research and Applied Geoscience in Scotland**
• Dr Martin Smith, Chief Geologist of Scotland, British Geological Survey

**Geoscience in EU Policy Making**
• Dr Patrice Christmann, Secretary General, Eurogeosurveys

**Geology at the Service of the Citizens of Europe**
• Professor Manuel Regueiro y González-Barros, President, European Federation of Geologists

**Discussion**
• EurGeol Garth Earls, Director, Geological Survey of Northern Ireland

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## APPENDIX 3. GEOSCIENCE: BUILDING THE FUTURE

The programme for this seminar at the Royal Irish Academy in Dublin in December 2008 was as follows:

### Opening

1. Professor Nicholas Canny, President, Royal Irish Academy
2. Representative on behalf of Mr Sean Power TD, Minister of State at the Department of Communications, Energy and Natural Resources.

### Sectoral Priorities

1. Energy: Dr Peadar McArdle, Geological Survey of Ireland
2. Climate Change: Dr Stephen McCarron, NUI Maynooth
3. Marine: Mr John Evans, The Marine Institute
4. Mineral Resources: Dr John Ashton, Boliden Tara
5. Hazards: Professor John McCloskey, University of Ulster
6. Water Supplies: Mr David Ball, Hydrogeologist

### Implementation

1. Linking to international "Big Science": Dr Mike Petterson, British Geological Survey
2. Involving the natural resources private sector: Mr Nick O'Neill, Petroleum Infrastructure Programme
3. Building capacity, the example of archaeology: Mr Raghnall O'Floinn, MRIA, National Museum of Ireland
4. Engaging with policy/regulations: Mr Billy McCabe, Planning Service (NI)
5. Education/skills gap: Professor Alan Jones, Dublin Institute of Advanced Studies
6. Interdisciplinary working: Dr Jenny McKinley, Queen's University Belfast
7. Future priorities: Professor John Gamble, University College Cork