

## GEOSCIENCE : BUILDING THE FUTURE

### A SUMMARY

This seminar was held in Academy House, Dublin, on 3 December 2008 and organised by the Royal Irish Academy (RIA), Geological Survey of Ireland (GSI) and Geological Survey of Northern Ireland (GSNI). The seminar sought to identify and establish support for the key geoscience objectives and priorities for the next five years. It built on extensive consultation with stakeholders at the Stormont Seminar in June 2008 and subsequently via the websites of the organising bodies.

This is a draft summary of the seminar's proceedings. The programme for the seminar is contained in Appendix 1 and individual presentations (where available) have been placed on [www.ria.ie](http://www.ria.ie). This draft reflects the subsequent discussion at the Geosciences Committee of the RIA on 12 December 2008, as well as feedback received since the seminar.

It has been suggested that a small workshop of industry/academic/government players be convened to identify and refine key objectives in metallic mineral resources. Such a workshop could be held in early 2009. In view of the prominence accorded by Government to renewable energy in its December 2008 strategy (Building Ireland's Smart Economy), a workshop on this theme may also be appropriate to determine how best geoscience can contribute.

The intention is to publish a strategic document on future geoscience priorities with the aim of promoting their funding over the next five years. The date of publication of this document will largely depend on events over which we have no control so it is important to complete it as soon as possible. This publication will be based on the outcomes of the Stormont Seminar, this summary of the Dublin Seminar and any workshops that are convened, as well as the feedback received over the course of the process.

**Views on this document (as well as more generally on the overall process) are welcome and as soon as possible. Please email them to [v.carswell@ria.ie](mailto:v.carswell@ria.ie), [gearls@bgs.ac.uk](mailto:gearls@bgs.ac.uk) or [peadar.mcardle@gsi.ie](mailto:peadar.mcardle@gsi.ie).**

The organisers wish to thank all the speakers and participants for their contributions to this process and for making the seminars a success.

### GEOSCIENCE PRIORITIES – ENERGY

- 1. Hydrocarbons** will continue to supply a substantial proportion of Ireland's energy demand for many decades, yet Ireland's offshore remains lightly explored and poorly understood. This leaves Ireland vulnerable to international events that could negatively impact on energy imports. The following objectives will remain important in addressing this situation.
  - Improved 3D architecture of offshore basins to maximise resource recovery, identify new targets and stimulate new exploration. The Petroleum Infrastructure Programme (PIP) has been an important contribution in recent years;
  - Enhanced understanding of petroleum potential in frontier basins off Western Ireland through regional syntheses, basin analysis and deep seismics. The North Atlantic Petroleum Systems Analysis (NAPSA) Group, managed by a Canadian-Irish consortium, is currently underway, while the Northeast Atlantic Geoscience

(NAG), a northwestern Europe consortium of geological surveys, is getting underway.

- Strategic environmental assessment, including seabed surveys, are an essential basis for eco-friendly and secure petroleum exploration and exploitation. INFOMAR, jointly managed by the Marine Institute and GSI, is undertaking near-coastal surveys as a follow up to the deeper-water Irish National Seabed Survey.

**2. Carbon-Capture-and-Storage (CCS):** Fossil fuels, including coal, will remain a significant component of feedstock for electricity generation for much of this century. CCS will be an essential feature of this scenario in order to meet national climate commitments on greenhouse gas emissions. The following are essential in order to successfully develop CCS:

- Regional offshore assessment of CCS potential as a basis for evaluating options, developing a national strategy on CCS, and generating contextual information to inform national decision-making on commercial proposals; The 2008 CSA assessment of island-wide possibilities is an important start, but it is no more than that;
- Assessment of specific options such as depleted gasfields, saline aquifers, un-mined coal seams, mineral carbonation and methane hydrates. The EU proposal to undertake demonstration projects might include one in the UK-Ireland region whose results could have important implications for Ireland. The Clare Basin study, a joint EPA-GSI study, aims to test the potential for saline aquifers in the vicinity of Moneypoint coal-fired power station.
- Research on the flow characteristics of fluids in offshore geological formations is a necessary precursor to successful CCS and work has already begun under Griffith Geoscience Research Awards.

**3. Renewables:** An increased level of geoscience research and services is essential to support the challenging new national objective of increasing the renewable proportion of the energy mix to 40% by 2020. The key geoscience tasks are:

- Geothermal energy takes two forms. Deep hot sources, based on both dry rocks and aquifers, could provide warm water for domestic, industrial and agricultural uses, provided suitable regulation and incentives are in place. Small scale deep sources have been locally implemented already but larger scale exploration has mainly taken place in Northern Ireland where GSNI has been a key player. Drilling on a potential source in west County Dublin has recently taken place. The second form of geothermal energy, ground source heat pumps (GSHP), is being implemented in Ireland and Northern Ireland, with subsoils databases providing valuable geoscience information to identify suitable sites.

- Geoscience can provide valuable datasets to assist the location 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 to prevent hazards such as flooding and landslides. The Marine Institute is leading international research on ocean energy while GSI supports both onshore and offshore wind projects. This area needs to be re-examined in view of the Government's new (December 2008) strategy for economic recovery, including the raising from 20% to 40% the percentage of energy needs provided by renewables.

**4. General:**

- Geoscience must develop the essential knowledge to contribute effectively to national strategic consideration of short-to-long-term energy supplies. Such considerations may include the development of scenario modelling that could

involve the future roles of CCS and nuclear energy (the latter is currently ruled out by Government policy).

- Geoscience must contribute to public discussion of energy issues, ensuring there is adequate understanding of public attitudes and concerns.
- This text on energy priorities by Dr P. Mc Ardle is based on the National Geoscience Programme (2007-2013), published jointly by the Royal Irish Academy and GSI; the submission to Government following the RIA Energy Conference (2007); and additional feedback at and since the Stormont Geoscience Seminar (June 2008).

## **GEOSCIENCE PRIORITIES – CLIMATE CHANGE**

Climate change and shifting demographic patterns are increasing the pressures on the environment across Ireland. It is important that geoscience contributes to a greater understanding of the potential impact of these pressures as well as to effective mitigation strategies where appropriate. This contribution was summarised by Dr S. Mc Carron and is likely to be in the following areas:

1. **Groundwater resources:** Climate change in Ireland is likely to lead to more extreme weather events and geoscience must develop models to simulate impacts on the quality and quantity of groundwater resources. Current initiatives include groundwater protection schemes (GSI), groundwater monitoring (EPA) and third level research (including under Griffith Awards). Groundwater issues are discussed more fully below (Water Supplies).
2. Records of **past climate change** are very extensive in the landscape and earth materials of Ireland. These provide useful proxies and indicators which allow comparison with results elsewhere and will inform the development of models of future climate change. The links between climate and North Atlantic circulation suggest that change may be relatively sudden and can take place within as little as a few years.
3. **Carbon capture and storage (CCS)**, discussed under Energy Priorities, can be an important ameliorating technology to manage greenhouse gas emissions while continuing to utilise fossil fuels.
4. There is a need to develop high resolution assessments and monitoring networks for **natural hazards** arising from climate change. These require prioritised surveys, both onshore and offshore, which allow the development of systematic databases as baselines for future modelling. Examples of existing datasets would be those arising from TELLUS (GSNI) and INFOMAR (MI, GSI). See additional discussion below on Hazards.

## **GEOSCIENCE PRIORITIES – MARINE**

Ireland is fortunate in having an extensive marine area, with associated opportunities to develop leadership in knowledge management, effectively managed databases and to support policy and regulation at national and international levels. The Marine Institute (MI) in its Seachange (2007-2013) foresight document sets out a comprehensive vision for how this can be achieved. Additional guidance is available in the Strategy for Science, Technology and Innovation (2006) and the National Geoscience Programme (2007). There are significant cross-links between geoscience and marine science which enrich the application of both and the key geoscience elements, as presented by Mr J. Evans, are set out below:

1. The integrated work programme of **INFOMAR** ([www.infomar.ie](http://www.infomar.ie)), jointly managed by the MI and GSI, is focused on the nearshore environment to provide support for an improved marine environment, navigational safety, energy and infrastructure projects, coastal flooding, fisheries, heritage (including shipwrecks) and business development.
2. **Monitoring the seabed** as a basis for modelling future 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 (DIAS), have key roles.
3. There are additional objectives related to **energy and climate change** which have an important relevance for the marine and they are described above.

## GEOSCIENCE PRIORITIES – MINERAL RESOURCES

Ireland's zinc mining industry is significant, accounting for 60% of West European zinc ore production. The turnover at its three operations amounted to €316.5 million in 2006, with an R&D spend (exploration) of 3.2% of turnover. However mines are based on finite ore reserves and in order to sustain itself the industry (with direct employment of 1250 in 2006) must identify additional reserves urgently: at least one mine is already planning closure, while any new discovery may have a 6-10 year lead time to production. The National Geoscience Programme in addressing mineral resources emphasised objectives relating to aggregates that are still valid but there is now a need, as outlined by Dr J. Ashton, to prioritise the following objectives in support of metal mining:

1. An enhanced knowledge of Ireland's **subsurface geology**, based on deep drilling and systematic datasets (such as those of TELLUS in Northern Ireland). Rock and core archives also essential.
2. Improved understanding of the controls on and origin of the types of **metal deposits** most likely to occur in Ireland. A weakness in research expertise is identified here which must be addressed and may require the recruitment of overseas talent. Links to world centres of excellence would help.
3. **Analysis of available information** and datasets in forms that will encourage increased investment by the various stakeholders. The use of 3D and 4D visualisation techniques is considered important.
4. Need for major **regional multidisciplinary study** of Central Ireland orefield, involving deep geophysics, regional fluid flow, 3D/4D models and ore-forming systems. Need for GSI leadership and advocacy in developing such a proposal. TELLUS in Northern Ireland was regarded as model for what was wanted, although it was noted that improved access to earlier commercial survey results in Ireland could advance this proposal significantly. There is a need to consider new techniques (for example, airborne gravity) as well as deep drilling and data analysis. Also European Technology Platform for Sustainable Mineral Resources was praised.
5. Metallic mineral resources are set to remain a crucial area to support economic development especially in rural areas. A small **workshop** of industry/academic/government players could develop the outlines of a strategic proposal in this area.

## GEOSCIENCE PRIORITIES – HAZARDS

While Ireland has a relatively safe environment, it can be affected by significant hazards where geoscience has a role in understanding and remediating them.. This is an area that attracts young scientists. It also receives widespread publicity and has application in the developing world. Geohazard research accordingly is a high priority for geoscience and Prof. J. Mc Closkey argued that the following 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 radioactivity on cancer incidence) and Ireland (submarine mass slides) respectively.
2. Research on **volcanic hazards** associated with Vesuvius has an impact not only for the 1.5 million population within its footprint, but more widely in Europe. For example, the fractal distribution of associated fractures could have implications for ore deposits research in

Ireland while research results on the seismic signal associated with fluid ascent may be applied to carbon capture and storage. These are good examples of research cross-overs.

3. **Earthquake research** in recent years has had some dramatic results, including that based in Northern Ireland on the Sumatran tsunamigenic quake. It provides a remarkable opportunity to interact with the public, provided we are prepared to communicate with less than perfect evidence.
4. Natural hazard research can play an important role in the national economy. It develops geoscience skills which are applicable in other areas of national life and it can play an important role in international development and bilateral aid.

## **GEOSCIENCE PRIORITIES – WATER SUPPLIES**

The Geosciences are the essential foundation for the understanding, protection and development of our water supplies. In the past, awareness and development of water supplies focussed on rain, rivers and springs; the water that could be easily seen or measured. In the last twenty years, there has been a complete change. Now, it is realised that there is a flow system from rain, through the ground, to the rivers and sea. The Geosciences from the atmosphere to the bedrock control this system. All parts are equally important and interdependent. Now, through the Water Framework Directive, there is an holistic approach. It is recognised that rivers depend on groundwater for their perennial flow. Rivers are groundwater drains. To understand river quality, it is essential to understand groundwater quality. Water is an opportunistic mobile fluid, that, under gravity, will take the easiest path to reach the lowest point. Therefore, to understand the movement and storage of our water, and subsequently develop or protect this water, we need to understand the relatively static framework of landforms, soils and rocks over which, and through which, the water passes. To develop sustainable, high quality water supplies for both urban and rural populations, industry and agriculture, we must understand the existing flow system. It is difficult to achieve this understanding because the subsurface part is hidden and some components change rapidly and others very slowly. The understanding is also essential in order to predict and prevent impacts from the development of water supplies on sensitive groundwater dependent terrestrial ecosystems. It is no longer possible just to ‘engineer’ a water supply. Applied geoscientists now are to the fore in the development of high quality sustainable water supplies in Ireland.

Though there have been many advances, a large long-term effort is still required to obtain adequate information on the flow system. A water supply depends upon site specific characteristics and designs, therefore regional information or broad classifications of the subsurface are not adequate, as they might have been in the past for other purposes, particularly as all our fresh, unweathered bedrocks are impermeable. Water does not move through the rock matrix. Instead it moves through open breaks in the rock, or zones and conduits, that have been altered by weathering. Heterogeneity is the key characteristic of our ‘aquifers’.

The priorities for the future are many, and will require a short and long term commitment of resources by the State, and a change in attitude and approach by educators and geoscience professionals.

The following are amongst the many priorities, as presented by Mr. D.Ball:-

1. Much better information on the basic bedrock three dimensional stratigraphy, in areas where the bedrock is obscured by overburden.
2. Much better information on structural geology; large features such as faults and small features such as jointing patterns. We need to understand the neotectonic stress in order to determine which fractures are open and which are closed.

3. Much better information on weathering (Quaternary and Tertiary weathering). Much of the water is probably moving through zones of paleo-weathering.
4. Much better information on present and past solution weathering of limestones and sandstones, and the characteristics of shallow and deep karst systems in all limestones, particularly in the lowlands where the rock is obscured by overburden
5. Much better information on the palaeo-geomorphology of the landscape buried below the Quaternary - Holocene deposits.
6. Much better information on dolomitisation and post depositional alteration of the bedrock.
7. Much better information on the stratigraphy of the overburden at depth (eg gravels within and at the base of the overburden). The overburden can be 20 to 30 metres thick.
8. Fundamental research into the ecosystems and biochemistry of the flora and fauna in our rocks and aquifers. The biosphere and the biochemical processes in the rock fabric are significant in relation to water chemistry and microbiology.
9. Greater prominence of the applied geosciences in undergraduate courses, so that students can appreciate the value and application of the core knowledge they acquire in the rest of the course.
10. Greater emphasis in universities and professional institutions, on the value of 'getting your hands dirty', to encourage real experience and learning, and counterbalance a modern perception that a professional geoscientist is someone in an office processing and interpreting existing information from other sources.
11. A change in the modern perception that field work is for technicians or junior grades, and that their work can be prescribed by adherence to templates, protocols and guidelines. The geology of Ireland is complex, and our knowledge is incomplete. The development of good water supplies cannot be carried out according to a 'One-size-fits-all' template. Each borehole is a 'voyage of discovery'; full of surprises. Instructions to follow rigidly a standard methodology reduces the scope, and job satisfaction of the geoscientist. There is now, almost a generation, of applied geoscientists whose inquisitiveness appears to have been constrained by a standard methodology, formulaic approach.

Finally, standard methodologies are often country specific. The location and development of better water supplies is a world-wide demand. Geoscientists, with a wide perspective of their applied science are in demand throughout the world, whereas geoscientists, with a narrow, standard method approach and experience, can be ill-equipped to do useful work at short notice elsewhere in the world.

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## **IMPLEMENTATION**

In order for geoscience in Ireland and Northern Ireland to become world-class it is essential to embrace **international** themes, according to Dr. M. Petterson. Such themes attract critical mass at the best research centres and it is important to engage with those centres in various ways.

1. It is also essential to join **international initiatives** (e.g. Aurora Borealis, IODP, EPOS) where young researchers from Irish institutes are exposed to the brightest minds and facilities. It is vital that researchers express clearly their priorities among competing (and expensive) international initiatives.
2. It is in **global challenges** such as security of resources supply (energy, minerals, water, soil), land use optimisation, mitigation of climate change and natural hazards that geoscience has a crucial international role to play.
3. The value of geoscience is maximised when it is integrated with other sciences and social sciences to address **complex global issues**. However geoscience must start to set the agendas on key issues rather than simply following current trends.
4. **Large scale collaborative and interdisciplinary research** has the best potential to successfully address key global issues and will be more effective than the combined results of individual research projects.
5. It is important that **synergies between blue skies and applied science** constantly refresh one another, maintaining their relevance and sense of curiosity. The application of geoscience in the developing world can play an important role and generates public interest.
6. Geoscience needs to **capture public imagination** again. Good communications and stakeholder dialogue remain vital. Perhaps a new paradigm is required (plate tectonics is now out-dated) to ignite the scientific community and set a geoscience-focused agenda.

It has become clear that the **private sector** involvement in geoscience research and services needs to be increased in order for such research to be effective. The potential involvement of the minerals sector is discussed elsewhere. The petroleum sector has been regarded as a more effective partner through the Petroleum Infrastructure Programme ([www.pip.ie](http://www.pip.ie)) and the following issues were seen by Mr. N. O'Neill as key to its success:-

1. An **integrated alliance** of government, industry and academic partners is regarded as the most effective. Industry will become engaged only if it is convinced that its key needs for geoscience will be directly addressed.
2. Integrated research programmes involving industry may be best managed by a **managing board** chaired by government and with industry representation, and supported by a dedicated secretariat. Thematic technical committees can provide important support.
3. Research programmes should focus on institutes in Ireland and Northern Ireland, should involve a strong element of international cooperation (see NAPSA, elsewhere) and should build accessible databases (including interpretive reports). In the case of petroleum, common industry problems were addressed through regional studies, data gathering, special research projects, baseline environmental surveys and by sponsoring research cruises (either by chartering ships or participating in planned cruises).

There is a recognised need to build a critical mass in geoscience in Ireland. For example, there has been no significant increase in the number of professional geologists over the past 20 years although their role has shifted away from natural resource exploration and extraction, and has diversified into several new areas. The meeting looked to **the archaeology profession** for guidance,

based on its significant growth in numbers over the same period and the increased public interest in its results. A review by Mr. R. O’Floinn indicated there were no easy solutions and addressed the following issues:

1. An essential context for the practice of archaeology is its **tradition of close regulation**, established in the 1930s in line with the situation elsewhere in Europe, and with standards established by a recognised professional body.
2. The growth in archaeology was driven by the considerable increase in **excavation licences** (from 55 in 1985 to about 2000 in 2003) as a result of the enormous investments in motorways and construction over that period.
3. While the profession was largely employed in the **public sector** in earlier decades, by the years 2000-2004 77% of archaeologists worked in the **private sector**. Up to €30 million per annum was spent on pre-development excavations and only €2 million on research.
4. This led to a crisis in archaeology for which the profession was not prepared, because the **rate of publication** slipped significantly and the public was no longer convinced that the work constituted value for money. However there was a positive response to the outcome of a Heritage Council review of excavation needs and additionally the National Museum of Ireland was resourced to manage effective archives.

The future success of geoscience relies to a considerable degree on its relevance to **policy and regulation** at international, national and local levels. It is recognised that the public perceives the impact of geoscience especially through planning decisions that affect local communities. Accordingly the meeting heard feedback from the viewpoint of a professional planner in Northern Ireland, Mr. W.Mc Cabe, who has had experience of the extractive industry. His feedback included:

1. There is an **inherent tension** between unfettered development and absolute protection of the environment. The public interest is somewhere in between and is best served by a process informed by geoscience.
2. **Regional development strategies** are important processes to facilitate public involvement. Their preparation involves public consultation where results can significantly influence the shape of the emerging strategy.
3. Each phase of policy formulation and the planning process requires the identification of appropriate environment controls which should be informed through geoscience knowledge. This provides additional exposure for geoscience in planning processes of interest to the public.

**Geoscience education** on the island of Ireland lacks critical mass. Its aggregate geoscience faculty amounts to less than 70, while that of Edinburgh alone is over twice that number. With 60 geology graduates per annum currently, the aim is to double that number by 2012. In this context a review of educational needs and skills gaps by Prof. A. Jones emphasised:

1. The key future needs for geoscience lie in training more students with broader **more holistic and integrated training**, against a background of restoring the public’s sense of wonder in what geoscientists do.
2. Geoscience education **must start at Primary School level** with initiatives such as “Seismology in Schools”. At Secondary School level there is a need to involve not only

physical geography teachers but also science teachers. At third level a broader teaching base is needed, demonstrating a wide range of applications. This is particularly urgent at a time when the average age of practitioners is increasing.

3. The **Irish Geoscience Graduate Programme** at fourth level is due to be launched in September 2009. A list of short courses is being developed at present but there is a need to fund its implementation, incentivise staff and convince university management on credit transfers.
4. Following the establishment of the “plate tectonics” paradigm by 1970, politicians believed that we had fully understood how the earth functions and students now consider **there is no longer a challenge** in geoscience. However the truth is that there is much we need to learn about Earth and we must apply all the diverse aspects of geoscience to do so successfully.

The need for more **interdisciplinary working** is constantly acknowledged as a critical need in ensuring future success for geoscience and Dr. J. Mc Kinley emphasised the following:

1. There is the potential for **better research outcomes** by working in interdisciplinary partnerships. Such partnerships in turn improve the chances of attracting significant funding. There is a shift away from independent disciplinary research towards broader relationships that are interdependent.
2. By working in **interdisciplinary partnerships** we challenge traditional boundaries between disciplines, emphasis the value of integration, develop effective relationships and promote a collaborative style of working.
3. The **TELLUS Project** provided data free of charge for research and teaching purposes and, in interdisciplinary relationships, has provided new insight from diverse sources. Its trace element geochemistry is being used to test geoscience influences on cancer incidence while geophysical data has supported geoforensics in seeking “the disappeared” of the Troubles.
4. The meeting was urged to make the most of opportunities to **promote geoscience**, using the widest possible context and adopting a leading role in tackling important issues.

In identifying **future priorities** the following points were made by Prof. J. Gamble:

1. The need for a new **geoscience paradigm** was questioned. Since plate tectonics, there have been major developments in, for example, geochronology, digital seismometry and remote sensing, and all had been achieved in cooperation with other sciences. We should emphasise these achievements.
2. Priorities in **natural resources** relate to hydrocarbons, base metals, natural materials and water.
3. **Natural hazards** research should address volcanoes, earthquakes, extreme weather, tsunami and climate change.
4. There is a need to **build connections** both nationally and internationally, perhaps taking the GSI/GSNI/BGS relationship as a role model.

5. Increased **interdisciplinarity** in teaching and research will be facilitated by building stronger links between industry and third level.
6. There is a need to encourage support for national **initiatives** (TELLUS, IGGP, National Isotope Facility in UCD), international initiatives (IODP, Aurora Borealis) and web based conduits (eg., EPOS, EUROCORES).
7. **Our greatest asset** lies in our students and practitioners, whose training ideally suits them to cooperate across boundaries. We must nurture this well-trained talent pool, whether for export or not, and thereby build the future.

The following **generic issues** were emphasised during discussion at various points:

1. Ireland and Northern Ireland each has a small geoscientific community, lacking critical mass in many key areas. In order to develop world class research and meet Government objectives, it is essential that we attract the best talent from overseas. This requires an enduring commitment by Government to developing competitive career structures for scientists and to invest significantly in science programmes and infrastructure.
2. We must promote our research and services as providing solutions to important societal issues, rather than to expose the technical details of the science we practice.
3. In increasing industry involvement in research, note that its interest tends to be short term and focused on its own location/theme. Its contribution will tend to be data-rich but analysis-poor. Bigger and collaborative research involving Government, industry and academe is favoured, rather than individual projects of best value to participants themselves.
4. The contrast in approach between petroleum and mining industries was emphasised. Government promotes mining actively and makes data freely available. But there is little analysis of large scale datasets (such as TELLUS) and little funding of ore deposit research. The essential role of Government in minerals research was emphasised and the development of a parallel programme to PIP in Ireland was suggested. Minerals research is more difficult to fund because its results are not usually transferable and therefore is not funded on a significant scale by industry. Professorships in mineral resources tend to be endowed only in countries with a long history of mining on a significant scale (e.g., Canada).
5. International initiatives (e.g., ESFRI, IODP, EPOS) are expensive and Ireland must prioritise which programmes it affiliates to. Accordingly it is important that researchers express their enthusiasm for specific programmes.
6. There is a need to review our participation in natural hazard research with a view to increasing it. There are significant examples of research cross-overs, for example, work on volcanic hazards may have application in ore deposits and CCS research. Such research also has the capacity to increase our role in developing countries. However as geoscientists we seek too much certainty before communicating with the public: we just need at times to tell society the imperfect facts.
7. The extensive range of recent outreach initiatives was summarised including events and competitions forming part of the programme for the International Year of Planet Earth (2008). Landscape tourism initiatives and initiatives at first and second level schools were

described. The importance of effective communication was emphasised, with no room for complacency. We need to regain the public's sense of wonder!

## APPENDIX 1

The programme for the seminar 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 Ragnall 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