The Geological Survey of Ireland
GSI News
Issue No. 2, Winter 2005

Contents

Reaching Out

Following the successful launch of GSI News in the Autumn of 2004 we are pleased to present this second issue. Many of you wrote complimenting the variety of articles and the relative lack of jargon. We hope to continue in this vein and in this issue we present some topical articles, some on the work of the Geological Survey and some short accounts of events that have taken place since the last issue. In this issue we feature four short articles on tsunami. One of these is by our Assistant Director, Dr. Ralph Horne, who was in Sri Lanka at the time of the Indian Ocean tsunami. The other tsunami articles are by Brian McConnell (Bedrock Section) who explains how tsunami form and Eibhlín Doyle who describes a sub-marine slide in the Rockall Basin which is being investigated as part of the Irish National Seabed Survey (INSS). As explained in Brian's article sub-marine slides are one of the mechanisms which can trigger tsunami and Eibhlín's article describes one such slide, which measures some 160km by 100km.

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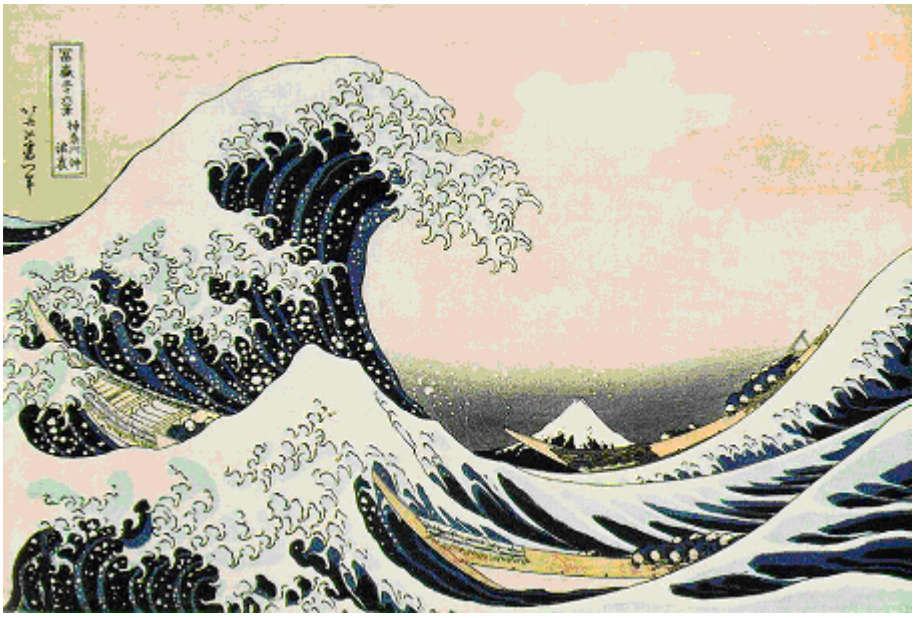
And mentioning the **INSS**, this is our feature article on the work of the GSI in this issue. Ireland's offshore area is some ten times that of the land area and relatively little is known about what lies under the sea. All that is changing with the government's funding of the INSS and our feature article describes some of the exciting discoveries and uses to which the results of this important work is being put.

In addition to our regular articles (**Director's Discourse** and **Agenda**) there are items on some of the **research that is taking place in Irish Institutions using data provided by the GSI**; an update on the **Breifne** project; a **review** article on **Understanding Earth Processes, Rocks and the Geological History of Ireland** - the recently published book (by GSI) for geology covering the geological aspects of the new geography curriculum; a follow up article on **gold in Ireland**; and more.

Thank you for your feedback from the first issue and we would encourage you continue providing us with your views. **Enjoy the read**.

Tsunami

Dr. Ralph Horne (Assistant Director, GSI)



"The Great Wave off Kanagawa" by Katsushika Hokusai (1760-1849)

Above my fireplace at home hangs a wood-block print by the famous Japanese artist, Katsushika Hokusai called "The Great Wave off Kanagawa". This great wave is, of course, a tsunami, a phenomenon well known to the Japanese and other Pacific rim nations because they are generated by earthquakes related to the seismically active subduction zones of the Pacific margin. Once a tsunami is generated anywhere in the ocean it spreads outwards to affect all coastal regions of the ocean. Because of this well-known vulnerability of the Pacific to such tsunamis, an early warning system monitoring seismic activity and ocean water movements is being developed for the Pacific basin in order to try to give early warning of tsunami generation.

When our family decided to spend Christmas this year in Sri Lanka we did not anticipate that the Indian Ocean waters driven by the submarine earthquake and seabed movement off the Indonesian coast would impact in such a disastrous way on the coastal regions of Sri Lanka. We had spent our first week on the island in an hotel right on the beachfront just north of Colombo, but had left on 23rd (December) for a tour of the island and we were at about 2,000m up in the tea-growing area of the central mountains near Kandy and Nuwara Eliya when the tsunami struck on the 26th. Such tends to be the randomness of luck - good or bad - in the face of such natural disasters.

Afterwards our tour had to be somewhat modified and we returned to the same hotel near Colombo which, being on the mid-western side of the island, was on the most sheltered side and not damaged.

Tsunamis can have, of course, a variety of causes - earthquakes, landslides, volcanic eruptions and collapses - and so every ocean basin is vulnerable to these events. The massive scale of the loss of life and the damage to coastal zones in the Indian Ocean has certainly focussed world attention on the possibilities of developing warning systems for tsunami-generating events in oceans other than the Pacific. Ireland and Irish agencies like the Geological Survey will have an active role in this in relation to the Atlantic.

Clearly Sri Lanka and the other affected countries are in massive need of short-term aid for survival and re-construction and the international effort to deliver this is both impressive and encouraging. However, as many of the Sri Lankan friends we made said to us, there is a real worry in the medium term for their vital tourist industry. The taxi driver who took us to the airport on New Year's Day said that we were his first fare of 2005 - and he hoped we wouldn't be his last. Their tourist industry was just enjoying its first real strong recovery this season as a result of their peace process - which is something we in Ireland should identify with.

Sri Lanka is a marvellous country whatever your interests - beaches, antiquities, natural history etc. Geologists will be interested in the ancient gneissic rocks of the island and their tropical weathering which releases the gem and semi-precious stones into gravels, which are worked in many pits on a very low-tech basis. Stones such as sapphires, moonstones and garnets are widely on offer, although it is wise to buy from established dealers who will give certificates of authenticity. It also does no harm to mention that you are a geologist!

So do think of Sri Lanka as a possible holiday destination over the next year or two. The living costs, once there, are very low and the people most welcoming and cheerful. I would be happy to give people information.

Tsunami - How and Why?

Dr. Brian McConnell (Bedrock Section)

The devastation caused by the December 26th earthquake and tsunami in the Indian Ocean has once again emphasised the awesome forces of the Earth's plate tectonic activity. A tsunami is a wave train generated by a sudden vertical displacement, or movement, of a body of water. This could be caused by

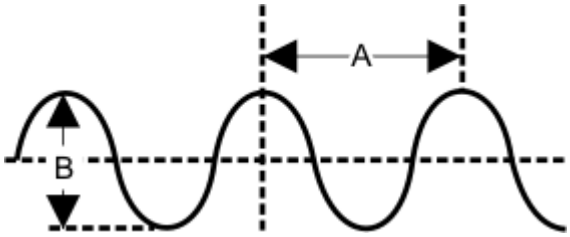
- An earthquake, or
- A landslide, or
- A volcanic eruption, or
- The impact of a cosmic body such as a meteorite.

Waves are formed as the displaced water mass, which acts under the influence of gravity, attempts to regain its equilibrium position. Tsunamis are often wrongly called "tidal waves" but they have nothing to do with tides.

Tsunamis have much longer periods and wavelengths (see Text Box on Wave Properties) than the normal wind-generated waves observed on a coastal beach. A tsunami can have a wavelength in excess of 100km and period on the order of one hour. In the open ocean they travel at about 200m/s, or over 700km/hr, and can travel across oceans with little loss of energy.

WAVE PROPERTIES

· **Wavelength**: horizontal distance between the crests or troughs of two consecutive waves **A** in the diagram.
· **Wave height:** vertical distance between a wave's crest (high point) and trough (low point) **B** in the diagram.
· **Wave period**: time it takes for two consecutive crests or troughs to pass a fixed point.



As a tsunami leaves the deep water of the open ocean and travels into the shallower water near the coast, it slows down and its height increases. A tsunami, imperceptible at sea, may grow to be several meters or more in height near the coast. When it reaches the coast, a tsunami may appear as a rapidly rising or falling tide, a series of breaking waves, or **a tidal bore** (see text Box below). Video footage seen on television of the Indian Ocean tsunami showed coastlines rapidly engulfed in rising water level, rather than the huge wall of water envisaged in the popular conception of tsunamis.

Tidal Bore

A tidal bore is a wall of water that moves up certain low-lying rivers due to an incoming tide. Tidal bores form when an incoming tide rushes up a river or inlet, developing a steep forward slope due to resistance to the tide's advance by the river, which is flowing in the opposite direction. The height of the tidal bore increases with the range of the tide and may very in height from just a ripple to several metres

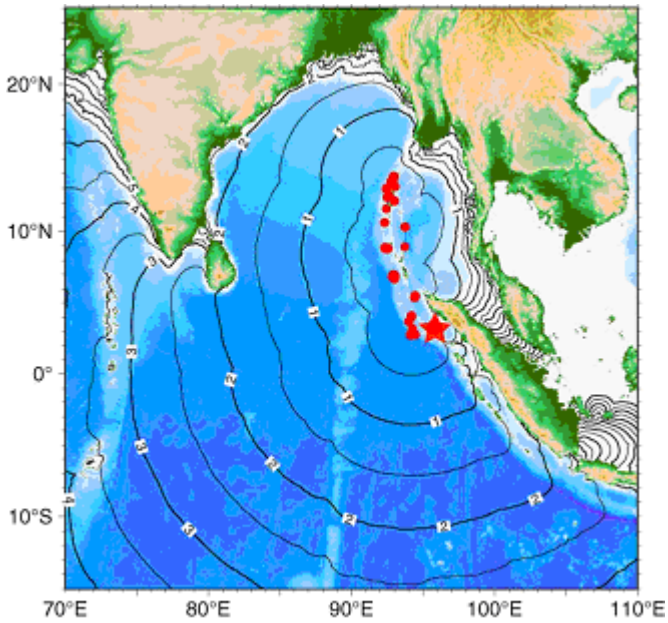
The tsunami in the Indian Ocean was caused by an earthquake occurring under the ocean. Earthquakes commonly occur along what geologists call plate boundaries. The Earth's crust is made up of a relatively small number of these plates. A plate boundary is the name given to where the plates meet. Movement along these boundaries is possible and when movement occurs this is an earthquake. One type of plate boundary is called a subduction zone. This is where plates meet and try to move together resulting in one plate attempting to ride up over the other and the other trying to descend beneath the other. The topographic expression of this is a deep trench beneath the ocean. Large vertical movements of the Earth's crust can occur at plate boundaries and earthquakes at subduction zones are particularly effective at generating tsunamis. The Magnitude 9.0 December 26th Sumatra earthquake caused 6m of vertical uplift of the Burma plate as it was pushed up over the descending Indian plate along 1000km of the Sunda Trench.

The Pacific Ocean, being encircled by subduction zones, has the most frequent occurrence of tsunamis. A Tsunami Warning System is operated by the U. S. National Oceanic and Atmospheric Administration (NOAA), with a centre in Hawaii serving as the international warning centre for tsunamis that pose a Pacific-wide threat. If the location and magnitude of an earthquake meet the known criteria for generation of a tsunami, a tsunami warning is issued predicting arrival times at coastal communities. If a significant tsunami is then detected by sea-level monitoring instrumentation, the tsunami warning is extended to the entire Pacific Basin.
Unfortunately there is no equivalent organisation in place for the Indian Ocean. While the Sumatra earthquake and its tsunami risk were detected by the NOAA and others, the simple lack of a proper communications network with the authorities in Sri Lanka and adjacent countries has been given as the reason that the two hour travel time of the tsunami across the ocean was inadequate to allow prevention of the tragic loss of life.

Tsunamis are rare on the Irish coast and in the Atlantic in general because the continents around the ocean have passive margins, apart from small subduction zones in the Caribbean and the South Sandwich microplate (off the coast of Argentina). One notable example in the North Atlantic was caused by a sub-marine landslide triggered by an earthquake off the coast of Grand Banks, Newfoundland in 1929. The tsunami caused damage and deaths on the Burin Peninsula, Newfoundland, and was registered as far away as South Carolina and Portugal.

Recently, geological modelling of a catastrophic collapse of part of La Palma on the Canary Islands, into the ocean causing large tsunamis over the North Atlantic has received media attention. This would be caused by volcanic activity on the island, inducing instability resulting in a large part of the island sliding westwards into the ocean. Tsunamis would be generated by this large land mass sliding into the sea with the waves generated being greatest travelling to the west towards the United States, the Caribbean and South America. Smaller waves would travel to the north and north-north-east possibly affecting Ireland especially around the south coast. However, there is considerable uncertainty as to the likelihood and timing of such an eventuality.

For more information see the following websites:
http://temp.water.usgs.gov/tsunami/
http://iri.columbia.edu/~lareef/tsunami/
http://www.ess.washington.edu/tsunami/toc.html
http://pubs.usgs.gov/circ/c1187/

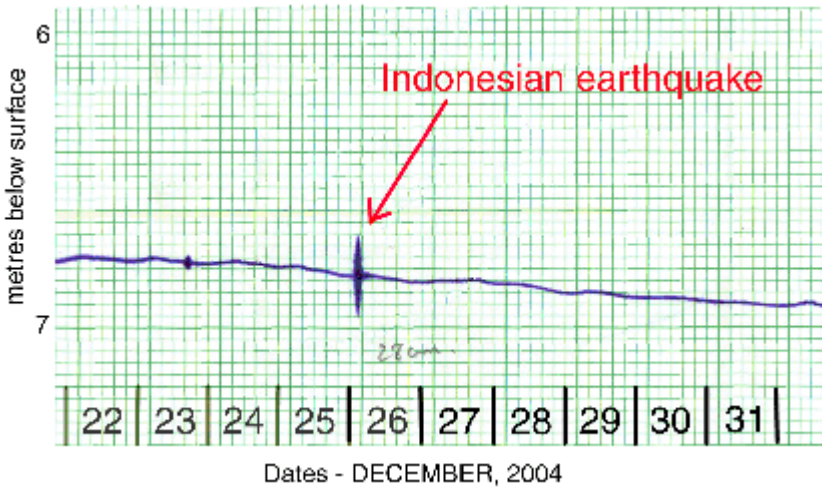


Earthquake epicentre (star), aftershocks (red dots) and computed tsunami travel time in 30min contours (National Institute of Advanced Industrial Science and Technology, Japan). The labels are in hours.

The SE Asian Earthquake registered in Ireland

Geoff Wright PGeo (Groundwater Section)

Groundwater level monitoring charts recently received from OPW showed significant fluctuations of water levels in three boreholes in Co. Kilkenny. The three wells (KNY 18/92, KNY 27/58 and KNY 31/72) were drilled for GSI and have been monitored since the early 1980s (August 1980, August 1981, August 1980 respectively). They penetrate different aquifers (18/92: 20m deep in Quaternary gravel; 27/58: 62 m deep in Dolomitic Limestone; 31/72: 40m deep in Kiltorcan Sandstone). Each well is equipped with a recorder - the fluctuations in water level are transmitted, via a float suspended on a wire, to a pen writing on a chart on a clockwork-driven rotating drum.



All three wells simultaneously registered abrupt water level changes in the early hours of 26 December 2004 (the chart does not allow the precise time to be registered). The maximum fluctuations ranged from about 50 mm in 18/92, to 240 mm in 25/78, to 280 mm in 31/72. The differences are probably related to the differing storage coefficients in the three aquifers - the gravel aquifer will have the largest storage coefficient, giving the lowest response to a given pressure.

Interestingly, both 27/58 and 31/72 also registered a much smaller sudden fluctuation in the afternoon of 23 December, which seems to correspond to an earthquake of magnitude 8.1 on Macquarie Island, southeast of New Zealand. (No record was seen in 18/92, probably because the effect was too small.)

Similar effects have been seen in wells monitored by GSNI/EHS in Northern Ireland. Prompted by a message from GSNI's Peter McConvey, we examined our charts for a record of the major Turkish earthquake of 17 August 1999, and found that this had also registered on the charts for the same three wells, with maximum fluctuations of approximately 30 mm (18/92), 120 mm (27/58) and 220 mm (31/72). The Turkish event also registered in a borehole monitored by GSI/OPW in Co. Roscommon (Ros 14/91), with a fluctuation of about 230 mm. (Charts from our Roscommon wells for December 2004 have not yet been received.)

It is well known that major earthquakes can give rise to observable changes in groundwater levels in confined aquifers. The fact that such changes can be observed at a distance of some 10,000km reflects the magnitude of this particular event. However, our monitoring wells register only a few of the many earthquakes which occur around the world each year.

Submarine Slides in the Atlantic

Dr. Eibhlín Doyle PGeo (Marine Geology and Geophysics Section)

Large submarine slides have been described from the Atlantic. One of the largest identified occurred off the western Norway coast. This submarine slide, known as the Storegga Slide, extends for some 800km into the Norwegian Basin and took place approximately 8,200 years ago (Bryn et al 2002). Sedimentological evidence indicates that a tsunami reached the Scottish shoreline and extended inland for several hundred meters. The tsunami deposited debris in its wake. These sediments typically comprised marine sands along with debris from costal marshes. This mixed layer is interbedded with estuarine clays and peat (Long and Holms 2001).

In Irish waters submarine slides have been described by Flood et al (1979). A large submarine slide in the Rockall Trough (Figure 1) is clearly recognized from data collected by the Geological Survey of Ireland (GSI) for the Irish National Seabed Survey. This slide measures 100km wide and extends into the basin for 160km (Figure 2) and lies in water depths in excess of 2000m. It is smaller than the Storegga Slide but it is still significant in size. Figure 3 shows a projection of the slide on Ireland to give some idea of its scale, as can be seen it would cover a large portion of Munster.

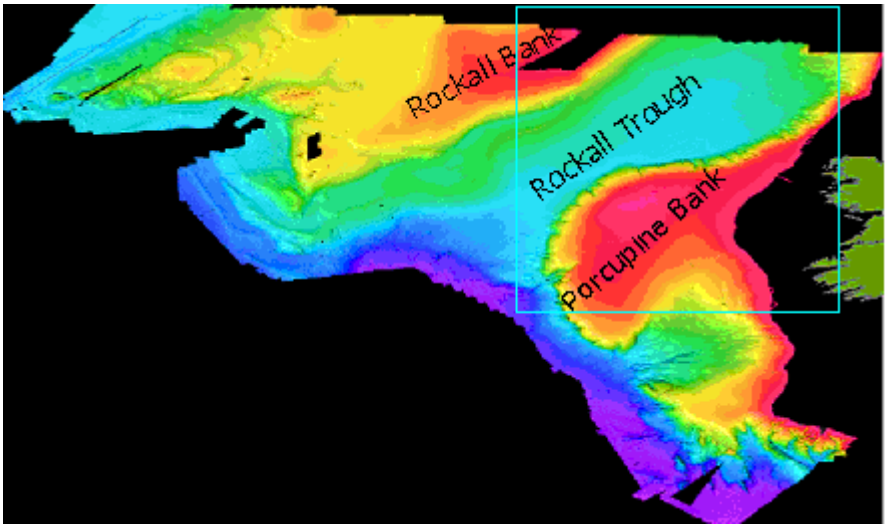


Figure 1. Bathymetric map for Irelands deeper offshore waters. Blue box represents area shown in Figure 2

Examination of shallow seismic profiles indicates that the margins of the submarine slide are still sharp in many places and have been little affected by the Atlantic currents (Figure 2). Flood et al determined an age of 15,000-16,000 years before present (BP) for the slide (young in geological terms). Similar slides further north off the coast of Scotland and Norway range in age from 4,000 years to 16,000 years BP.

The slide stands as a positive feature, which decreases as it extended into the Rockall Basin. In many places the slide stands 25m high lying on the contourite sediments of the Rockall basin (Figure 2).

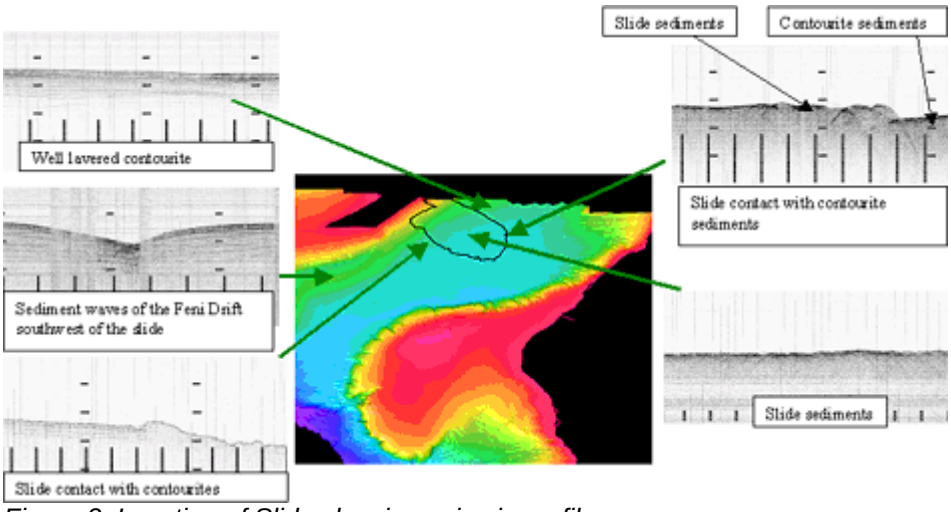


Figure 2. Location of Slide showing seismic profiles

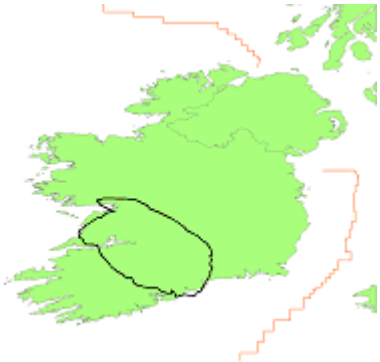


Figure 3. Projection of Rockall Slide on Munster

The exact mechanism that triggered the slide is unknown. However it is likely to be the result of a number of factors such as:

· Rapid deposition of glacial sediments during glacial times followed by post glacial sea level rises.

· The sudden load from the glacial sediments on thin interglacial sediments may have resulted in increased pore pressures in the underlying interglacial sediments, this is likely to have resulted in instability.

· In addition earthquakes caused by glacio-isostatic rebound following glacial retreat may have triggered the slide. Other possible triggers include gas hydrate melting and gas charging of shallow sediments, which result in increased pore pressure in the sediments.

It is likely that a submarine slide of this size would have triggered a tsunami, which would in all probability have reached the coast of Ireland. The slide occurs on the eastern margins of the Rockall Bank some 350km away and the toe of the slide is only 200km away. Tsunami sediments may well be preserved on the west coast, which would add to the story of this large slide in Irish waters.

References:

Bryn, P., Berg, K., Lien, R., Solheim, A., Ottesen, D., and Rise, L. 2002. The Storegga Geomodel and its use in slide risk evaluation: Geological and Geotechnical site investigations in the Storegga slide area. Published in Offshore Site investigations and Geotechnics. P.219-233.

Flood, R.D., Hollister C.C., and Lonsdale P. 1979. Disruption of the Feni Sediment drift by debris flows from the Rockall bank Marine Geology 32. p.311-334.

Long, D. and Holmes, R. 2002. Submarine landslides and tsunami threat to Scotland. ITS Proceedings Session 1, Number 1-12, p.355-366.

Agenda

Cabinet reshuffle
As you all know, by now, An Taoiseach Mr. Bertie Ahern T.D. announced his Cabinet reshuffle in September 2004 - after the publication of Issue 1 of GSI News. The reshuffle affected our parent Department - the Department of Communications Marine and Natural Resources. The new Minister at the Department is Mr. Noel Dempsey T.D. while the new Minister of State at the Department is Mr. Pat 'The Cope' Gallagher T.D. We wish them well in their new portfolios as well as wishing the outgoing Minister Mr. Dermot Ahern T.D. and Minister of State Mr. John Browne T.D. well in their new Departments.

Recruitment
As you know the staffing situation in the GSI is becoming critical with many staff no having been replaced, in recent time. This is about to change with the recruitment of five permanent staff from amongst our temporary staff. The staff to be recruited will fill much-needed gaps in our Groundwater (3 posts), Marine Geology and Geophysics (1 post) and Quaternary and Geotechnical Sections (1 post). In addition there are a further five vacancies and we are hopeful that these too will be filled in the not too distant future.

The new posts in the Groundwater Section will assist Ireland's compliance with various EU Directives on water and groundwater; completing additional groundwater protection schemes and in improving the delivery of services overall. The post in our Marine Geology and Geophysics Section will be assigned to the Irish National Seabed Survey (INSS) - currently our largest single project. The successful candidate will contribute to the INSS in the areas of hydrographic, marine geological, and geophysical surveying. The successful candidate for the Quaternary Geology and Geotechnical will provide much needed support in mapping Quaternary glacial geology and geomorphology.

In addition, a long-standing vacancy in our Central Technical Services (CTS) will also be filled. The technician will primarily be responsible for providing thin sections to GSI staff and assisting CTS generally.

We look forward to updating you on our new staff members in the next GSI News.

Decentralization
As mentioned in the last issue government policy is to relocate the Headquarters of our parent Department (Communications, Marine and Natural Resources) along with the Geological Survey to Cavan. The latest Decentralization Implementation Group (3rd Flynn Report) made recommendations, which were accepted by government, dividing the Departments and Agencies due to move into three - the immediate movers, the early movers and the remainder. The Department and GSI were allocated to the third category. This third category would be the subject of a further report in Spring 2005.

Book Review

Understanding Earth Processes, Rocks and the Geological History of Ireland -
ISBN 1 89970250-4
A companion to the 1:1,000,000 scale Bedrock geological Map of Ireland
by
Andrew Sleeman, Brian McConnell and Sarah Gatley

If we go back to the Greek origins of the word and the discipline of Geography we can immediately see the rationale for this impressive publication. Geo - meaning 'earth (or Earth)' and Grapho - meaning 'I write' tell us much about the Geographer's perspective on the world. To write the Earth is not a low-level ambition but it certainly one that would be significantly more problematic without resources such as this book.

The preface to the book suggests that Geography is a 'descriptive science that relates the distribution and interaction of the physical, biological and cultural aspects of the World we live, past and present'. The Geography of centuries, perhaps even decades ago, was largely descriptive. Today's Geography is descriptive but it is also analytical. The wealth of information contained in this pack - for it is more than a book - will aid Geographers at all levels, be they teachers, students, academics, in fact anyone who has a questioning mind about the Earth we live on - to understand the Geology and aspects of the Geography of Ireland at many scales and levels. The Island of Ireland is posted both in its global evolutionary history and its current geographical position. Those who use the bedrock map judiciously to look at their own localities in broad sweeping terms may examine the local environment.

This is a book that articulates its purpose in its preface. The new syllabus for Geography in the Republic of Ireland's Leaving Certificate places greater emphasis on Geology and the geological processes that have shaped the landscape. It is also anticipated that it will provide a useful resource for students taking GCSE Geology at A/AS levels in Northern Ireland. It serves those stated purposes very well. In reality, however, it also has another potential purpose that may be equally significant. It should enjoy a wide readership among members of the public - especially now that events and concerns of an environmental nature - geological, climatic and human-environment relationships - are so topical and challenging.

This is a book that welcomes its readers in as the design and layout are very user-friendly. The photographs are particularly appropriate in their content, location within the book and in their standard. The graphics - both in the form of diagrams and especially enjoyable from a Geographer's point of view - the maps are, quite simply superb.

The bedrock map itself, which is provided as an A2 insert in the book also provides a geological timescale that is clearly Ireland-driven. In addition there are seven landscape photographs that are chosen to illustrate the geological-landscape connection. A very useful county boundary framework is superimposed on the bedrock map and the majority of the thirty two county units that result have at least one important city or town shown within them. I would have liked to have all such county units displaying at least one such settlement - they would undoubtedly help students (and indeed other readers as well!) to position themselves in their counties within the broader island context.

All of the images from the book are also provided on the CD that is part of the book/pack. These will offer teachers the ability to either use the individual images for projection in the classroom or, perhaps, as part of Powerpoint presentations they may themselves devise.

The text reads easily. The authors are conscious of the book being written primarily as a resource for teachers but in keeping technical terms to a minimum they will encourage students to read, inform themselves and, I hope, enjoy their exploration of the Island of Ireland. The book also provides excellent study boxes that highlight key processes and modern exemplars that take students through each phase of Ireland's geological history. The net result is that the student readers will be enabled to identify both process and rocks in their own localities.

The authors have explored the human-geological interconnections where appropriate. They look, for example, at environmental geology and engineering, at quarrying and mining and at

hydrocarbon settings and petroleum exploration in Ireland. A bibliography of useful books, maps and pamphlets as well as a series of recommended websites further add to the educational usefulness of this book/pack.

Marathon Ireland Ltd. who led the cluster of hydrocarbon companies in providing sponsorship to make copies of the book and map available to all secondary schools in Ireland is to be congratulated for their public service. Ultimately, however, it is to the Geological Survey of Ireland that my final words are written: Congratulations on having produced such an excellent resource that will be widely used for many years by teachers and students, and, I sincerely hope, by a very wide public readership.

Jim Hourihane,
Head of the Geography Department,
St. Patrick's College of Education,
Dublin 9.

Director's Discourse

Dr Peadar McArdle PGeo (Director)

The Geological Survey in seeking to serve our customers and the general public in a more effective manner have recently updated our Vision Statement as well as developing documentation which describes the benefits that GSI brings to the nation as a whole.

Geosolutions is the title of our recently developed Vision Statement to the year 2015. The underlying message is that **Understanding our physical environment improves our quality of life** and the document provides succinct and cogent reasons why this is the case.
The Vision statement reads:
The Geological Survey of Ireland will be the recognized national provider of quality geological services, information and advice to support policy and decision-making at EU, national and local levels, as well as to inform all relevant sectors.

The Mission Statement reads:
The Geological Survey of Ireland seeks to support the sustainable management of Ireland's natural resources through underpinning high-quality decision-making at EU, national and local levels with appropriate geological services, information and advice. In this role it responds to customer / stakeholder needs as an impartial multi-disciplinary organization within the State sector founded on integrity and innovation.

Many of the challenges facing society today have their roots in geology - after all we do live on Planet Earth. Issues such as flooding, groundwater contamination, siting of urban development, infrastructure development, locating mineral and rock resources, landslides, and disused mine sites all have geology as their fundamental foundation.

The qualities GSI brings to bear on these issues are addressed under the headings: Creating good solutions; Ensuring success; and Getting the message out. In the final section 'Outlook for 2015' an ambitious programme is provided in which an indicative list of products and deliverables is summarized.

Supporting the Vision Statement document is a paper entitled **Cherishing Our Earth**. This latter document provides many examples where geology is invaluable to society. Ten individual areas are detailed including:

- Adequate clean water
- Safe communities
- Minerals support our lifestyles
- Ocean management and competing seabed uses
- Sustaining our landscapes and seascapes
- Secure transport routes

The document provides details on 'GSI services', the 'Cost of not providing services' and a section on 'Who benefits?' for each example.
The documents are available on the GSI website.

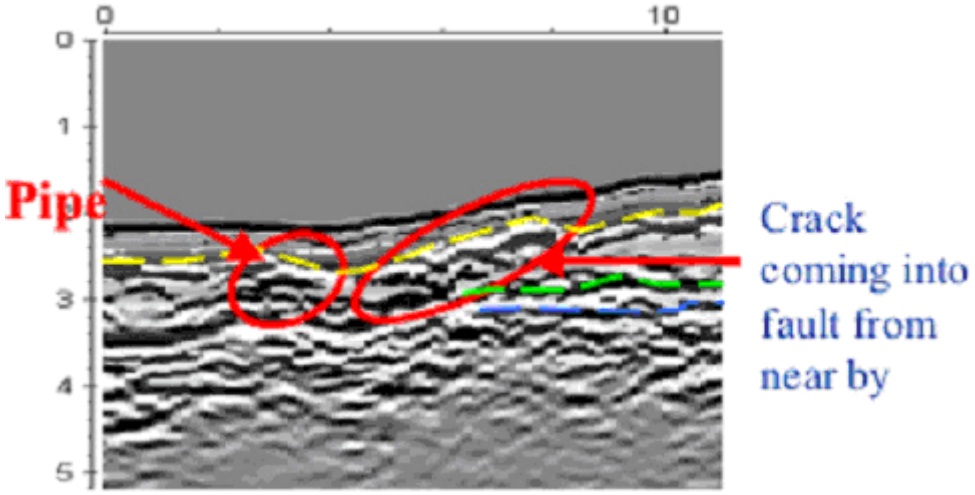
Geological Survey of Ireland involvement in Research

Koenraad Verbruggen PGeo (Information Management Programme)

While GSI staff is limited in the amount of research they themselves carry out, the datasets held by GSI are commonly used in postgraduate research, often in close collaboration with in-house experts in various fields. We hope to feature some of this ongoing research in each edition of GSI News and our Annual Report and we welcome submissions from researchers on how they have utilised our data.

In the area of Geohazards, a number of research projects were undertaken recently in response to the Landslides in Mayo and Galway in 2003. The projects were either facilitated or supported by GSI through its establishment of the Landslide Working Group. **Shane Murphy**, a Dublin based UCD graduate, completed an MSc in Exploration Geophysics in 2004 at the University of Leeds, titled **"A geophysical study of a large peat slide on Dooncarton Mountain, Co. Mayo"**. From the two geophysical methods used to investigate stability features in peat, Seismic Refraction and Ground Penetrating Radar (GPR), GPR proved to be the superior method for mapping the slide. The seismic refraction survey was found to be inappropriate for use in peat land areas due to high wave attenuation. GPR, however, imaged internal structures (e.g. internal layers, pipes and sub terrain pipes) in both the peat and the weathered layer, with an accuracy of 13±11cm in pre-migrated sections. From an engineering point of view, laboratory testing confirmed that the peat was buoyant in water and had a low hydraulic conductivity. While slope stability modelling, which was constrained with index strength tests, proved the peat had a cohesion of 8kPa and an internal angle of friction of between 30º and 40º. The MSc, supported by GSI, received a Leeds Alumni award for the project work.

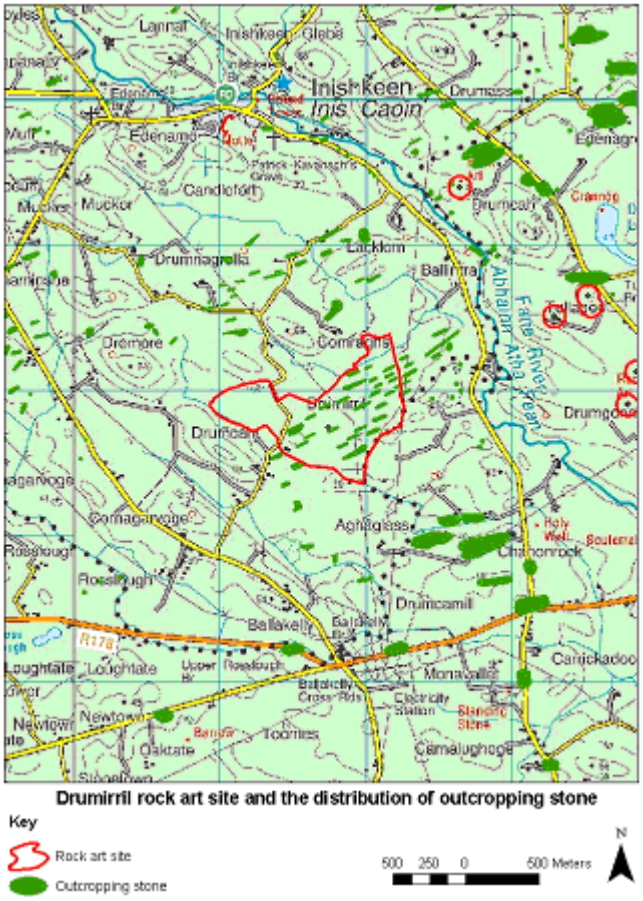
Landslide Feature at Dooncarton, Co. Mayo
studied by Shane Murphy



Ground Penetrating Radar image from Shane Murphy's work, showing interpreted "pipe" and "crack" features which may be important in initiation and localisation of peat failures

Much of the research being carried on in areas of applied geology and outside geology departments, relies on utilizing the GSI's digital and GIS datasets, an interesting example of this is in the field of Archaeology.

Blaze Valeska O'Connor, a Post Doctoral researcher from New Zealand, is working in the Archaeology Department of UCD, on Irish petroglyphs or "rock art" and its location. She is using GIS and the extensive archive of historic GSI 6 inch to 1-mile field sheets to try to establish the reasons for the location of known rock art sites. In addition to showing the rocktype at a given location, and level of exposure of outcrop over 100 years ago, the maps are drawn on the earliest Ordnance Survey field sheets and contain valuable early settlement information, not always present on revised later editions.



Map of a key rock art site in Monaghan whose location corresponds to a major area of outcropping sandstone

Photo of a rock art panel in Aghacarrible, Dingle Peninsula

In summary, GSI's large resources of geological data (much of it digital), and in-house expertise, represent an opportunity for Irish geology and geological related researchers and we welcome approaches to see it put to work.

Europe's Major Base Metal Deposits

Gerry Stanley PGeo (Minerals Programme)

The Irish Association for Economic Geology, the body representing the scientific interests of geologists working in the minerals sector in Ireland, organised a very successful meeting on Europe's Major Base Metal Deposits in 2000. This year (January to be precise) saw the publication of the papers from this important event. The task of editing and producing the volume fell to John Kelly, Colin Andrew, John Ashton, Mike Boland, Garth Earls, Leo Fusciardi and Gerry Stanley. All gave freely of their time to produce what is a very fine production. I know their fellow editors will not be upset if I give a special mention to John Kelly and John Ashton who put a huge amount of work into completing the task of producing the book. Their efforts were recognised by the Association by being awarded Honorary Membership of the Association.

The book amounts to 551 pages, contains many diagrams and photographs in colour, has 28 papers divided into eight sections:

- Overview and Status (2 papers)
- Scandinavia (4 papers)
- Central Europe (5 papers)
- Southern and Southeastern Europe (3 papers)
- Eastern Europe (3 papers)
- Iberia (4 papers)
- Ireland (6 papers)
- Economics (1 paper)

The two overview papers provide a summary of Europe's diverse recent mining history and provide a background for the remaining papers in the book.

The book is accompanied by an A1 sized wall map (scale 1:7,000,000) of the principal base metal deposits and base metal smelters and refineries in Europe. There are detailed insets for Ireland, the Iberian Pyrite belt and Southeast Europe where there are mining districts with too many deposits to show at the smaller scale main map. The background is a simplified geological map of Europe. The map together with a poster explaining the map and providing some information on Europe's mining industry has been distributed to all secondary schools in the country.

To obtain a copy of the book and map please contact:
Dr. Vincent Gallagher
C/o Geological Survey of Ireland
Beggars Bush
Haddington Road
Dublin 4
Fax: (01) 678 2589

The cost of the book is €60 to Members of the IAEG and €80 for non-members. Post and packing is additional and costs €12 within Ireland (for other destinations please enquire from the above). The map is available separately at a cost of €20 plus €5 postage and packing (within Ireland).

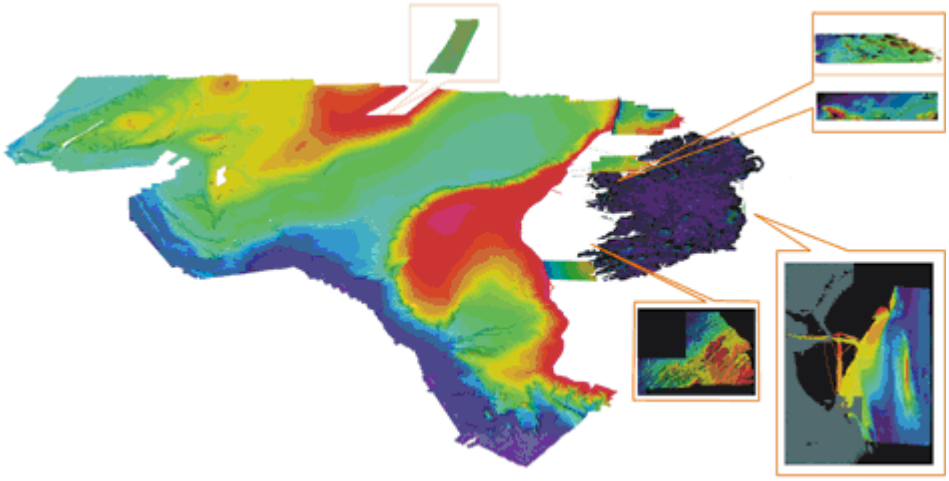
In this issue of GSI we feature GSI's largest current project. Enda Gallagher of the marine Geology and Geophysics Section takes time to explain what the survey is about and to present some of its initial findings.

The Irish National Seabed Survey

Enda Gallagher, Marine Geology and Geophysics Section

The Geological Survey's largest ongoing project is undoubtedly the Irish national Seabed Survey (INSS). Ireland's land area is small compared to that part of the country that lies offshore. At approximately 90 million hectares or 220 million acres it is an area that is 10 times the size of the on-land country itself. The INSS is a study of the part of Ireland that lies under the sea. The first survey ships took to the water in the year 2000 and commenced surveying at the outer western margin of Ireland's territorial waters at distances from the coast of more than 1,100km or 700 nautical miles, stretching more than half way to Iceland. In some of the more remote areas the depth to the seafloor reaches almost five kilometres. The Irish seabed is being thoroughly investigated as never before to reveal massive valleys, canyons and substantial rocky outcrops on an impressive scale.

Why survey the seafloor?
In the same way that it's important to map and understand our landscape, it's also imperative that we begin to understand the vast resource that is our seabed. As an island nation our knowledge of our seabed and oceans is distressingly low. Mapping the seabed begins to enable us to identify what ocean habitats exist and which ones might need protection. It helps us to better understand where there might be natural resources of value to the nation, such as oil or gas. It helps us identify better routes for trans-Atlantic telecommunication cables and so on. Literally there is no limit to the usefulness of acquiring knowledge about our seabed. Just some of the wide range of parties who are benefiting from the findings of the INSS include those involved in fisheries, offshore navigation, aquaculture, heritage, natural resources exploration and development, renewable energy development, environment protection and telecommunications.



What is the INSS?
Managed by the Geological Survey of Ireland (GSI) in co-operation with the Marine Institute (MI), the INSS is the world's largest marine survey. The graphic shows the impressive area of coverage that has been achieved to date - 450,000kms^2, an area the size of Germany and Austria combined. A remarkable blend of national and international competencies has seen 11 survey ships sail the seas together with some airborne surveys along the Western coastline. The INSS is now regularly reaching almost to the shoreline at intervals along the western coast and around Dublin Bay on the east. The MI vessel, the Celtic Explorer, currently the main survey vessel for the INSS, can survey safely into about 10 metres water depth near the shoreline.

How is the seabed surveyed?
The vessels travel in parallel lines to gather the seafloor information using state-of-the-art geophysical and hydrographic equipment. Located on the underside of each ship are multi-beam echo sounder transducers, which emit fans of acoustic signals. As the signals reach the seabed or other hard surfaces, pulses are bounced back to the transducers. The travel times of the signals are then analysed to determine the depth to the seabed, as well as its reflectivity, which can indicate its composition. As well as this technique a variety of other underwater measurements is recorded whilst the vessel is both surveying and in transit; generating a large, integrated and multifaceted dataset. These include sub bottom profiler, gravity and magnetometer measurements, useful in determining rock structure and composition. Sediment and rock samples are retrieved from the seafloor and then sent for biological, chemical and geotechnical analysis.

What are we looking for?
Surveying the Irish seabed has led to several interesting discoveries and improvements in our knowledge of our sea territory. For instance, the INSS is working with Bord Iascaigh Mhara and others in the fishing industry to help create efficiencies in the industry. Data from the INSS are being used in on-board systems to help provide a 3D view of the seafloor, identifying fish habitats and hazards, which will assist fishermen, avoid loosing their nets.

As a result of INSS surveying we now know that the Irish seabed is home to vast systems of previously unidentified coral reefs, some stretching for over 100km. Such coral, living at depths of up to 2,000 metres, are known as lophelia - deep-sea, cold-water coral.

Surveying of an area marked as "unsurveyed" on one of the United Kingdom Hydrographic (Admiralty) navigation charts for the area in the approaches to the Shannon Estuary has been undertaken. The Marine Safety Directorate of the Department of Communications, Marine and Natural Resources had specifically requested GSI to survey this potentially dangerous area to fill in the gaps on the navigation chart and perform a service of value to the state. The area is a busy shipping area, but would probably be much busier if charted. Under international law if accidents occur in unsurveyed waters it is the state that is held responsible. So, for instance, if an oil tanker capsized in "unsurveyed" Irish waters then Ireland would have to clean up any pollution from taxpayer funds.

The INSS is working with Bord Iascaigh Mhara and others in the fishing industry to help create efficiencies in the industry. Data from the INSS are being used in on-board systems to help provide a 3D view of the seafloor and such initiatives will ultimately assist fishermen avoid loosing their nets.

The INSS has identified the decaying remains of more than 100 shipwrecks around the Donegal coast, alone. Further work on their identification and history will be undertaken in 2005 by the National Parks & Wildlife Service using the precision location data provided by the INSS.

The INSS carried out seismic refraction surveys in 2002 and 2004 in a remote frontier area known as the Hatton Basin. The 2002 survey utilised equipment that enabled useful information to be obtained from 35kms below the seafloor. These surveys are contributing to the oil and gas exploration effort in this remote area. A second objective of the surveys is to help identify areas of gas hydrates. These are essentially areas of frozen hydrocarbon that may someday be possible to use as a fuel.

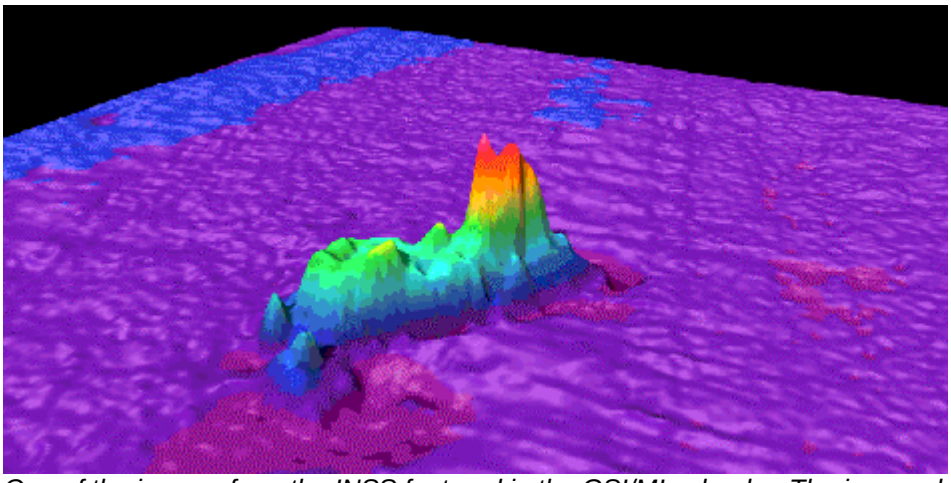
The Irish seabed is a whale sanctuary and so the INSS has provided a platform for research for the Irish Whale and Dolphin Group and the Coastal and Marine Resources Centre, UCC. Both organisations have sent "spotters" out to sea on various vessels to observe and report on sightings of cetaceans (whales, dolphins and porpoises). The INSS has always been respectful of our marine mammals. So, when we were surveying the approaches to the Shannon Estuary we had consultations with the National Parks & Wildlife Service and decided that no surveying should took place in the Special Area of Conservation designated here, as the survey leg was taking place during the main calving season.

Data and Outputs
In the offices of GSI all the various datasets are checked, catalogued and archived. GSI carries out some post survey quality control work on the data and then they're available for further and more formal processing and use by interested parties. To date more than 50 university research projects have been initiated utilising data obtained from the INSS. Some of these will lead to further research projects whilst others will undoubtedly have industry applications and commercial possibilities. The numbers of applicants for the data are increasing and GSI sees 2005 as being very busy in this area. Some commercial projects are also in place but to date most effort has been placed on the initiation of academic research projects.

One of the objectives of the INSS is to develop and expand Irish marine science expertise. During the time that the INSS has been operating over 1,000 persons have contributed and been employed at different times. This provides an opportunity for young aspiring Irish scientists to learn their trade at home. And right now there is no better place in the world in which to learn that trade than Ireland, the country that now leads the way in the global use of marine technologies.

Conclusion
Operating INSS, the world's leading marine survey, GSI and Ireland are now at the leading edge marine science - something that was unimaginable just a few years ago. Investment in the matters marine has mushroomed, from the commissioning of the Celtic Explorer, to the recent opening of two dedicated marine research facilities in Cork and Coleraine, and expanded departments in most other universities. Underpinning such a catalogue of activity and achievement is the INSS. We expect that to complete the job - the survey of Ireland's entire seabed area - we will need to continue surveying until 2010. We expect that the GSI will receive the funding to complete this mammoth effort, and in so doing, cement Ireland's place at the forefront of marine science.

Calendar
A calendar showing images of Ireland's 90 million hectares underwater territory is now available from GSI. The calendar shows full colour imagery ranging from deep-water coral reefs, to shipwrecks, to sea mounds and sand-banks. It also contains imagery capturing just some of the day-to-day work involved in the mapping of Ireland's offshore. Copies can be ordered free of charge from Enda Gallagher, Tel 01 678 2834 or enda.gallagher@gsi.ie



One of the images from the INSS featured in the GSI/MI calendar. The image shows a sunken wreck at the bottom of the sea off the coast of Donegal

The Dublin Stone Show - 23/24 November 2004

Scott Engering (Heritage Section)

In keeping with their responsibilities as the state agency for Earth Science related matters, the GSI played a full role in the Dublin Stone Show, the inaugural trade exhibition for the dimension stone and allied industries in Ireland.

Set in a prominent position in the reception area, the GSI stand displayed attractively presented information on three key areas of the Survey's work that relate to these industries; Aggregate Potential Mapping (dimension stone); Petrographic Analysis - based on the pilot Irelithos Project for Castletown House; and the Irish Geological Heritage Programme. With stone becoming a less fashionable building material over the years and with the closure of original quarry sources making the repair of historic buildings with closely matching material more difficult, the potential value of the GSI's services were strongly emphasised.

Sharing exhibition space with Ireland's principal stone suppliers, consultants and restoration contractors, the GSI was well placed to attract architects, specifiers, private clients and public authorities, who are dependent on receiving good impartial advice, in addition to members of the public who have a more general interest in geology and the landscape. Visitors to the GSI stand were well represented from all of the above.

A wide selection of GSI publications were also available on the stand and throughout the two days, a steady stream of memoirs, Quarry Directories, maps, leaflets etc were purchased by visitors that ranged from architects, landscape gardeners to students and a group of American tourists. In addition, the staff members attending the stand answered a wide variety of questions that covered the entire spectrum of geology, emphasising the fact that the GSI possesses an unrivalled wealth of practical expertise and information resources that is readily available for public and private use.

The large number of visitors to the show in general and the GSI stand in particular demonstrated that in spite of the relatively remote venue, CityWest, there is a strong demand for products and information that relate to geology and stone. In this respect, the GSI can consider their attendance at the show to be an unqualified success.

Bréifne Project - An Update

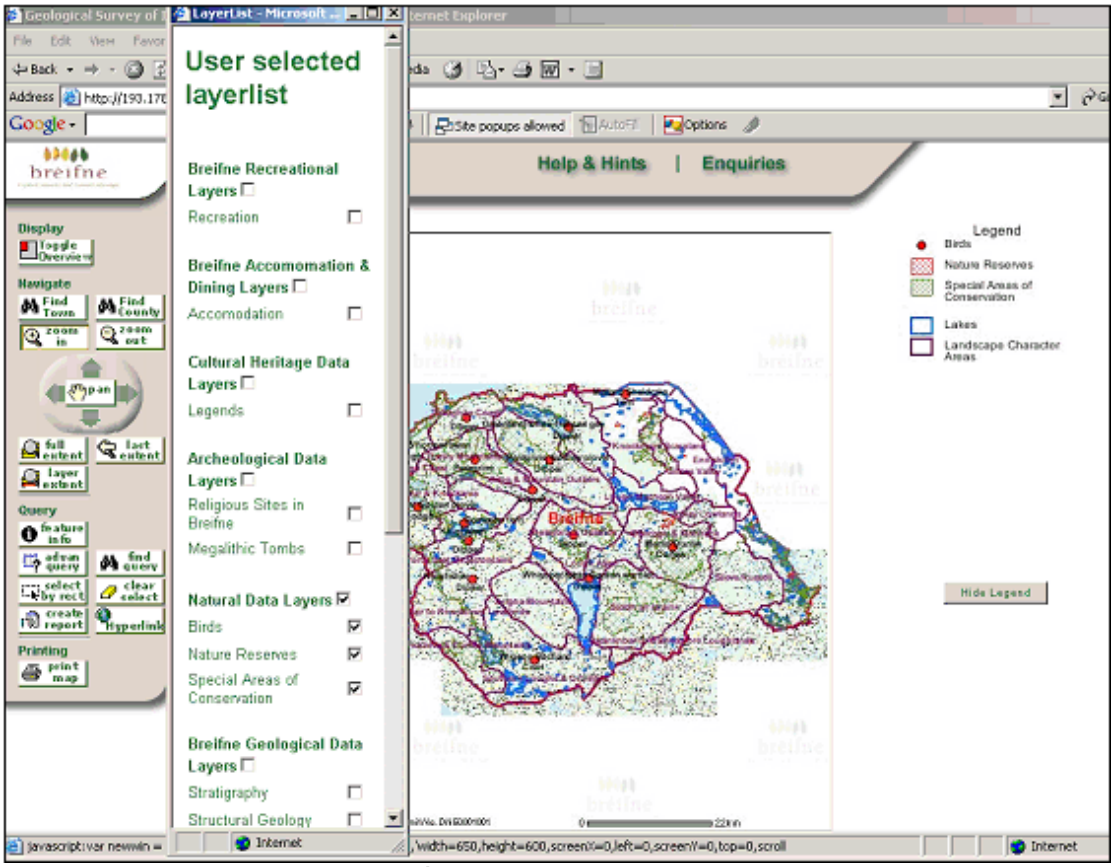
Koenraad Verbruggen PGeo (Information Management Programme)

Bréifne is a collaborative initiative between the Geological Surveys of Ireland (GSI) and Northern Ireland (GSNI), the Academy of Irish Cultural Heritages at the University of Ulster (Magee), and the local authorities of five counties: Sligo, Leitrim, Roscommon, Cavan and Fermanagh. The Special EU Programmes Body (SEUPB) funds the project, under the Programme for Peace and Reconciliation 2000-2004, with an overall aim to promote sustainable economic development within the region, particularly within the tourism sector.

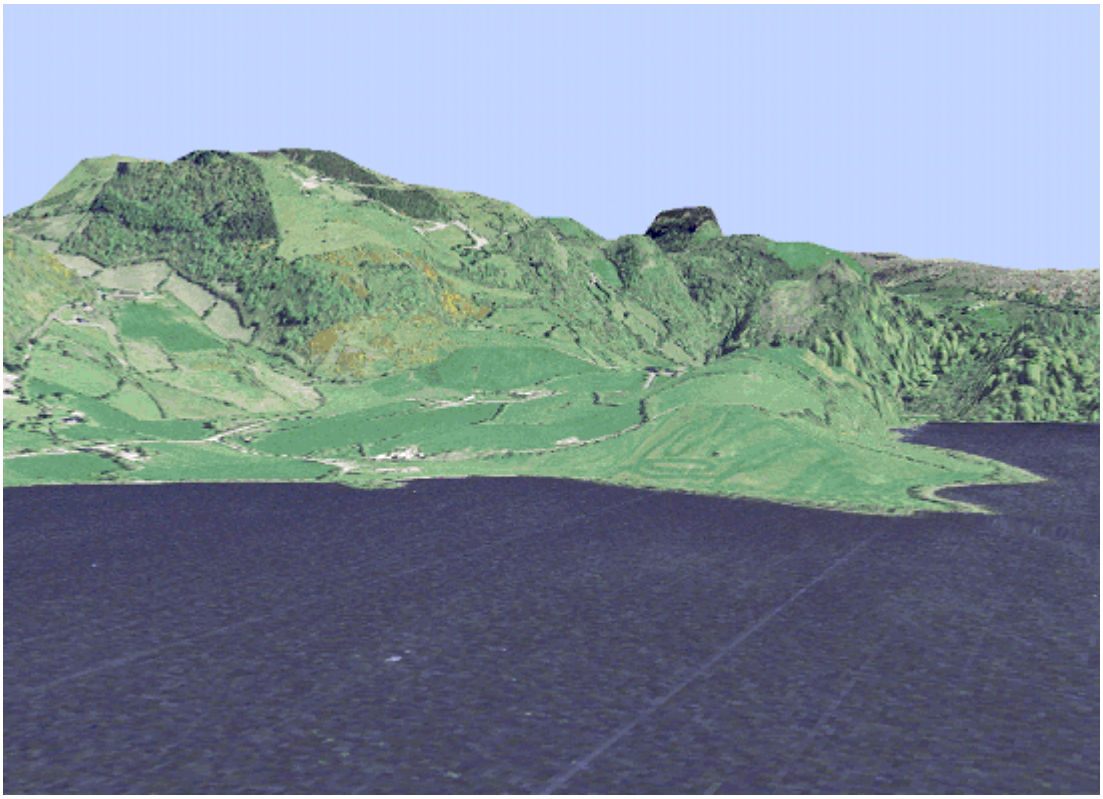
The project area covers approximately 3,000km2, delineated by the Sligo Coast to the west, Lough Key to the south and Lough Erne to the north and east, with the principal focus on an "upland core" encompassing the Dartry, Arigna, Sliabh an Iarainn, Cuilcagh and Bricklieve Mountains.

A key task of the Bréifne initiative is to collate existing natural and cultural heritage information (ecology, geology, archaeology and ethnology or folklore) into a web-based GIS database that will form the basis for an information/educational resource for project stakeholders, tourists and local interests. The first product, already produced, is a Landscape Characterisation of the area, as a report and GIS. To date the team based at GSI have also carried out development work on a customised web-mapping interface and 3D visualisation, as methods of delivering and explaining the heritage of the region. Outputs from the project will also include a Bréifne region DVD pack and booklet on the region, as well as a suite of road and tourist information signage

Further information is available at the project website, www.breifne.ie



Draft Web Mapping Interface for Bréifne Project



3D Visualisation of Topography in the Lough Gill area

Update to Gold in Ireland

Following on from the article on Gold in Ireland in Issue 1, the following has been provided by ***Conroy Diamonds and Gold Plc****. We welcome comment and observations on any of the articles in GSI News.*

Conroy Diamonds and Gold Plc (Conroy) has been exploring for gold in the Longford-Down Massif of the northeast of Ireland since 1995 and was until recently one of the few companies actively involved in gold exploration in Ireland. Conroy, through its exploration programmes in 2004, has continued to demonstrate the overall gold potential of the Longford-Down Massif.

The Longford-Down Massif is a major geological feature, which as its name suggests runs from Northern Ireland into the Republic of Ireland across the northeast of Ireland. It is intersected by a major fault known as the Orlock Bridge Fault and the massif is comprised of Ordovician and Silurian rocks.

The Company has already intersected high gold grades at the Tullybuck-Lisglassan gold deposit in Co. Monaghan, and discovered another gold deposit at Cargalisgorran in Co. Armagh. Both lie within a 65km² area, which it has termed the Armagh-Monaghan Gold Belt. In situ bedrock sampling at Glenish in Co. Monaghan in 2004 returned a 1m channel sample grading 9.40 g/t gold. Grab samples from the area have assayed up to 2.45g/t gold. The style of mineralisation seen here is similar to that seen at other locations in the Armagh-Monaghan Gold Belt, and like at other localities would appear to be fault controlled and hosted by intensely sheared argillite with quartz-carbonate veining and pyrite. Numerous other gold anomalies have been demonstrated in the Gold Belt. Conroy has also discovered gold near Slieve Glah in Co. Cavan.

A recent report by international consultants SRK reported that one small area drilled has the potential to contain over 100,000oz of gold and that other areas are considered to have better potential for mineralisation. The SRK report gives increasing encouragement to the Company's aim of establishing a new gold province in the Longford-Down Massif.

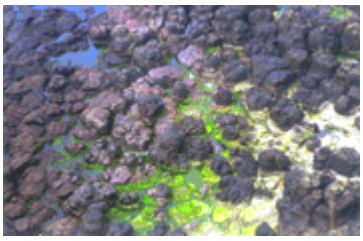
2004 John Jackson Memorial Lecture

This was delivered in the RDS by Donal Daly (GSI Groundwater Section) to an audience of over 100 people on 11th November. An abstract of the lecture is given below. The paper was published as Number Twenty Eight of the RDS Occasional Papers in Irish Science & Technology Series.

Groundwater at Risk in Ireland - Putting Geoscientific Information and Maps at the Core of Land Use and Environmental Decision-making
The interaction between human activities and the natural environment is a key element in the well-being of both the environment and humans as an integral component of the environment. We have much to lose if our relationship with the geological environment is not managed effectively. Potential pressures on the environment, arising from social and economic development, are growing in Ireland. Yet never in our history have environmental and health concerns and awareness been so great. In parallel, knowledge and mapping of the subsurface - bedrock, subsoil, soil and groundwater, - have made great progress in recent years. Decision-makers are now increasingly using geoscientific information and maps in land use and environmental planning as a means of achieving the optimum long-term benefit for all. The required information is now available, as are the means of communicating and utilising the information effectively. Current progress and future possibilities will be illustrated in the lecture.

Du Noyer Photography Competition

The Annual Du Noyer Photography Competition, run in association with the Irish Geological Association, seeks to encourage geological photography with a high technical and artistic content. The Awards for the Sixth Du Noyer Photography Competition were made in December. In the Open Category the first prize was awarded to Sadhbh Baxter (Galway) and the runners-up were Scott Engering and Sarah Gatley. In the newly-established Overseas Category, joint first prizes were awarded to Geoff Wright and Alain Murphy, and a runner-up prize went to Robert Moss (Dublin). Some samples of the handywork of the entrants are shown below.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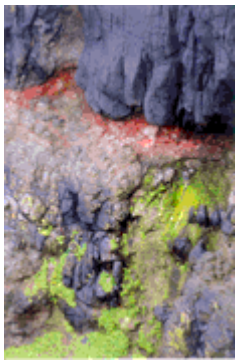
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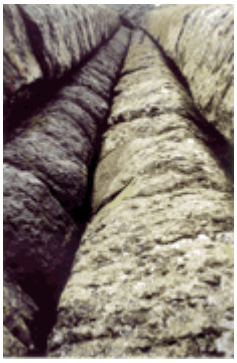
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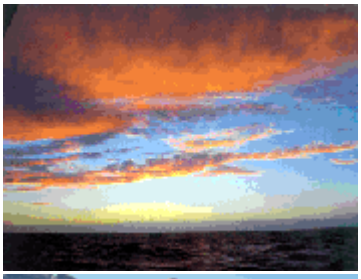
Alain Murphy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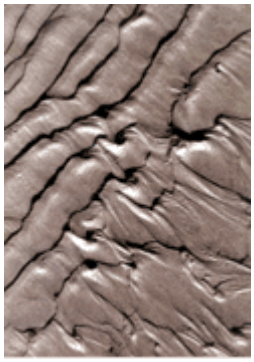
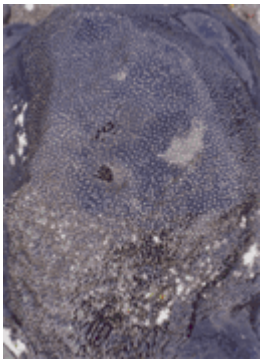

Scott Engering


Robert Moss


Sarah Gatley

Health and Safety Week 2004

Matthew Parkes (Staff Safety Representative)

As always in GSI, safety of staff is an important issue, and each year a wide range of events are organized for Health and Safety Week, which was held during the week of on 18th - 22nd October of last year. Together with colleagues in our parent Department, Joe Carey organized a programme, which included medical issues such as The Healthy Heart, Retirement Planning and Shiatsu for de-stressing. More traditional items such as Safety on the Water, First Aid and Fire Safety were supplemented this year by our Assistant Secretary Mr. Michael Guilfoyle presenting on Safety in the Field. Michael is a keen hill walker and climber and can often be seen out in the Dublin and Wicklow Mountains - as well as further afield. Given the increasing frequency with which building sites constitute the geological exposures which require assessment, a talk by Anthony Deevy on Building Site Safety was very topical. Many GSI geologists already possess the Safe Pass, which is now required for access to all building sites. Thanks are given here to all the speakers at events and to the staff who organized them.

Written in Stone relaunched

On the 27th July 2004 the then Minister of State at the Department of Communications, Marine and Natural Resources Mr John Browne, T.D. relaunched the 'Written in Stone' video at a function in the Burren Visitor Centre, Kilfenora, Co. Clare. The video traces through six programmes the 4,500 million years of geological history of this planet, and recounts those events with particular reference to Ireland. The video recalls volcanic eruptions, earthquakes, ice-ages and mans' impact on the landscape. During the year a DVD version became available as well. A book of the same title is available to accompany the video/DVD. A cluster of hydrocarbon companies, led by Marathon Oil Ltd, provided sponsorship to make copies available to every secondary school in the country. The Monaghan Education Centre kindly assisted with the distribution. The programme itself was also recently rebroadcast by RTE.

Additional information i.e. a questionnaire and notes on each of the six programmes is available on the GSI website - http://www.gsi.ie/ - as an aid for teachers and pupils.

The video (or DVD) and book are available through the GSI Customer Centre, Beggars Bush, Haddington Road, Dublin 4, (telephone number 678 2868) for €32 including postage.

Mars Rocks

GSI sponsored a very interesting TV programme broadcast during Science Week in November. It was produced by Leo Enright, Chairman of the Discover Science and Engineering Programme run by Forfás. The programme was co-funded by Forfás/Discover Science and Engineering and the Geological Survey of Ireland. The idea of the programme was to make links between the fantastic new information coming from the probes that had landed on Mars, and some fundamentals of Irish geology and geologists. For example, basalt from the Giant's Causeway is comparable to the basalt identified on Mars. Also, rare minerals like jarosite, are found in old mines at Muckross, Killarney and is also found on Mars. Sedimentary structures like cross bedding at Hook Head demonstrate the presence of water, as do the same features on Mars. These and a range of other linking locations and Irish geological faces were featured making the remote planetary geology somewhat more accessible to the interested viewer. If you missed it first time around, then perhaps RTE may screen it again, or it may be shown on BBC in Northern Ireland, giving a second opportunity to catch it.

Signing the way

Many readers will have known their way to GSI for as long as they can remember, but there are of course many new visitors to GSI each week in search of information or publications. A significant improvement took place in January with the erection of a new sign outside Beggars Bush on Haddington Road, pointing to GSI and our parent Department of Communications, Marine and Natural Resources offices. It has long been apparent to staff and visitors alike that a sign was required, but a surprising amount of obstacles had to be overcome to achieve this seemingly simple action. Thanks go to Petra Coffey, of the GSI Consultative Committee for her persistence in finally getting the sign in place.