



Department for the  
**Economy**  
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**GSNI** Geological  
Survey of  
Northern  
Ireland  
Celebrating 70 years: 1947-2017

**70th Symposium** | Programme and abstracts  
W5 Science Centre | 30 November 2017



*2017*

## 70th anniversary commissioned artwork



Hugh Crilly

After leaving Belfast College of Art and Design, I worked as a technical illustrator in DeLorean for nearly three years; a first in-last out sort of thing. Following the unfortunate demise of that enterprise, I retrained in cartography with the Ordnance Survey before eventually joining the Geological Survey of Northern Ireland in 1991 until early retirement in 2016.

Evolving technology and shifting priorities necessitated a programme of career tweaks which morphed into interesting, if varied, responsibilities in the office and even, in the latter years, many happy days spent in glorious sunshine in the field inspecting abandoned mines. I have a boat, you know.



Anna Crilly

Anna Crilly: celebrates fragmentation and sampling in her work. Her collagist approach achieves something familiar, but twists it to stage something odd; a somewhat figure, an alien landscape, a sort of room.

Crilly is an artist, milliner and costume maker. She graduated from Glasgow School of Art with a First Class BA(Hons) in Fine Art, Painting and Printmaking. She is currently finishing her HND in Fashion Design and Manufacture and was the Co-Director of Glasgow Open House Arts Festival 2017.



Jane Hunter

In 2013, after eleven years working in local government, Jane took a leap into the unknown to re-discover her love of making art. Later that year, following a chance encounter with a keen-eyed, gallery owner in Highland Perthshire, Jane was thrust into the spotlight with her first solo exhibition - "The Cloth, The Land, The Earth".

Since then Jane has continued to seek a deeper understanding of the forces which shape our landscapes. She credits such geologists, cartographers and artists as William Smith, Ben Peach and John Horne for unlocking the mysteries of the earth beneath our feet.

*"Like all maps, Jane's are interpretative accounts of a landscape, not mere objective representations of it. I find her work deeply evocative and suggestive. While her pieces often reference places I know well from experiencing them on foot, her cross sections or aerial perspectives, as well as her tactile medium, prompt me to look at them very differently.*

*Through her work, Jane consistently responds to Scotland's geology and topography in a uniquely thoughtful way."* Kate Davies



9:00	Registration	
9:30	Opening session	<i>Chair: Dr Marie Cowan</i>
9:30	Welcome and Geological Survey of Northern Ireland overview Koen Verbruggen, Director, Geological Survey Ireland Professor John Ludden CBE, Executive Director, British Geological Survey Dr Andrew McCormick, Permanent Secretary, Department for the Economy	
9:50	Geological Surveys: Meeting the challenge	Sir Keith O'Nions
10:10	Geological Survey: baseline information for sustainable societies and economies	Professor Mark Cooper & Dr Katie Whitbread
10:30	NextGen STEM session	<i>Chair: Dr Kirstin Lemon</i>
	Judith Harvey, Group Head of Education and Public Affairs for the Odyssey Trust School video competition	
11:00	Morning coffee, networking and interactive displays	
11:30	Infrastructure and landscape session	<i>Chair: Dr Sherry Palmer</i>
11:30	Research and innovation in geohazard management	Kieran Parker & Dr David Hughes
11:50	Geological information for planning and development	Alex Donald & Dr Diarmad Campbell
12:10	Using geoscience to enhance tourism and support education in Northern Ireland	Dr Kirstin Lemon & Professor Patrick McKeever
12:30	Question and answers panel	
13:00	Lunch, networking and interactive displays	
14:00	Natural resources in the national interest	<i>Chair: Lorraine Fleming</i>
14:00	Groundwater in Northern Ireland: past, present and future	Dr Paul Wilson & Dr Silke Hartmann
14:20	Investing in mineral exploration	Mark Patton & Sean Finlay
14:40	Aggregates: the foundation to Northern Ireland's construction sector	Dr Marie Cowan & Gordon Best
14:55	Clean energy: the role of Northern Ireland's geology	Derek Reay & Sam Knox
15:15	UK geoenery observatories (UKGEOS): changing the way Geological Surveys work	Professor John Ludden
15:30	Question and answers panel	
15:50	Closing session - Awards and acknowledgements	<i>Chair: Professor Mark Cooper</i>
	1. Early career award 2. Special publication award 3. STEMinist award	
16:00	Drinks reception, networking and interactive displays	
16:30	Commissioned GSNI 70th artworks launch	



## Welcome

We are absolutely delighted you have joined us to celebrate 70 years of public service since the Geological Survey of Northern Ireland (GSNI) first opened its offices in 1947; this symposium celebrates this milestone by showcasing how GSNI scientists provide this service and its progressive impact for Northern Ireland's economy, infrastructure, environment, tourism, education and health.

GSNI is an office of the Department for the Economy (DfE) staffed by scientists of the British Geological Survey (BGS) who provide information, data, research and expertise on natural resources and planning issues to support the economy and protect the environment.

GSNI scientists are unique within BGS as they are also government officials; the legislative functions of GSNI are covered by the Minerals (Miscellaneous Provisions Act) Act 1959. GSNI also works to support the responsibilities and priorities of the Departments for Infrastructure and Environment, Agriculture and Rural Affairs, NIEA, local councils and Invest NI. It works in partnership with the Department of Finance on the Northern Ireland Mapping Agreement, Opendata NI and Spatial NI.

*Operating as a key player in Northern Ireland's knowledge economy, the work of the Geological Survey of Northern Ireland is a critical factor in attracting foreign direct investment, development of indigenous natural resources balanced with a fundamental environmental protection ethos.*

GSNI is based on the Stormont Estate, Belfast and is staffed by 13 scientists from BGS and is one of five BGS regional sites across the UK; where it handles an enquiry service, runs a shop and manages a core store. GSNI has a memorandum of understanding with both the British Geological Survey and Geological Survey Ireland (GSI) for shared best-practice, peer-learning, co-operation and research.

GSNI also collaborates on research with over 35 universities globally. As we go to print, GSNI's Chief Geologist Professor Mark Cooper is in China for two weeks, together with research partners from Queen's University Belfast, building a new Chinese research partnership to work together on clean, advanced and sustainable energy research. GSNI, together with GSI and the Royal Irish Academy was central to influencing the strategic research priorities of Science Foundation Ireland to include geoscience which enabled the Irish Centre for Research in Applied Geosciences to unlock €26M centre bid funding.

GSNI is entirely outward-facing and actively engages all sectors of society including community organisations, NGOs e.g. landscape partnerships, schools, special interest groups and the public.

The key to GSNI's success has been the continued development of its scientists' expertise, data holdings and its work in direct partnership with all facets of society. I look forward to seeing GSNI's continued development and enabling role in particular sectors e.g. sustainable energy and water in response to an increasing population and changing climate. In addition to a growing volume of open data, innovatively fused with other data sources and continued valuable and valued contribution to Northern Ireland in years to come.

Marie Therese Cowan BSc, PhD, PGeo, MIOd, Director GSNi



Koen Verbruggen is a geology graduate and has an MSc in Petroleum Geology, both from UCD. He spent 15 years in the resource industry, briefly in Oil & Gas exploration and the majority of the time working in mineral exploration, mostly for Irish junior exploration companies. He worked and lived for several years, in Canada, Australia, Mexico, Cuba and various parts of Africa. In 2000 Koen joined the Geological Survey of Ireland (GSI), working first in Minerals, thereafter in Information Management, and then in the Marine Geology programme, where he co-managed the flagship INFOMAR Project. More recently Koen has been involved in all aspects of GSI management, working closely with the GSI's parent Department – the Department of Communications, Climate Action and Environment – and in the role of Acting Director since April 2012. Koen was appointed Director of GSI in January 2013.



Executive Director at the BGS since 2006, John Ludden has held numerous science direction and management posts. He was Director of the Earth Sciences Division at the French National Centre for Scientific Research (CNRS) and also served as Director of Research for the CNRS in Nancy, France, where he also taught at the French National School of Geology (ENSG-Nancy). Prior to this, Professor Ludden worked at the University of Montreal, Columbia University and with Woods Hole Oceanographic Institution in the USA. He holds a doctorate in Igneous Petrology from the University of Manchester, UK. Professor Ludden is a visiting professor at Oxford and Leicester universities and a Foreign member of the Russian Academy of Sciences. He is a past president of the European Geosciences Union and also EuroGeosurveys.



The early stages Andrew McCormick's career in the Northern Ireland Civil Service were mainly in the Department of Finance & Personnel. He was Finance Director (Senior Civil Service) in the NI Department of Education from 1993 to 1998, and then Director of the Central Finance Group of Department of Finance & Personnel from 1998 to 2002. He became Second Permanent Secretary, Department of Finance and Personnel in May 2002 and was Permanent Secretary of Department of Health, Social Services and Public Safety, and Chief Executive of Health and Social Care, for nine years from 2005 to 2014. He moved to Department of Enterprise, Trade and Investment (DETI) as Permanent Secretary from 1 July 2014, and was appointed to his present role when Department for the Economy was formed by the merger of DETI and the former Department for Employment and Learning in May 2016.

Andrew read Geology at University College, Oxford, graduating in 1978 and went on to achieve a PhD in Geochemistry from Queen's University Belfast.



Sir Robert Keith O'Nions FRS Hon.FREng is the first Chair of the new BGS Board and current Chair of Cambridge Enterprise at the University of Cambridge since 2014; before that he was President and Rector of Imperial College until 1 September 2014.

Sir Keith has previously held the positions of Professor of Geology at Columbia University, Royal Society Research Professor at University of Cambridge and Head of Earth Sciences at University of Oxford. He was Chief Scientific Advisor to the Ministry of Defence from January 2000 until 2004 after which he moved to the (then) Department of Trade and Industry to become Director General, Science and Innovation, and Chief Scientific Advisor – a position he held until 2008.

He is a Fellow of the American Geophysical Union, Member of the Norwegian Academy of Science and Letters, Fellow of the Royal Society, Honorary Fellow of the Indian Academy of Sciences, Fellow of the Indian National Science Academy and Honorary Fellow Royal Academy of Engineering. He was knighted in 1999 for his services to earth sciences.

## Geological Survey: baseline information for sustainable societies and economies

Mark Cooper, Chief Geologist, Geological Survey of Northern Ireland ([mark.cooper@economy-ni.gov.uk](mailto:mark.cooper@economy-ni.gov.uk))

Katie Whitbread, Project Manager, National Geological Model, British Geological Survey ([kwhi@bgs.ac.uk](mailto:kwhi@bgs.ac.uk))

Geology is the unifying global foundation on which all natural and human processes and activities operate. Information and knowledge, that underpin geological understanding, have been collected in Northern Ireland by GSNI for 70 years. In broad terms the drivers of survey have shifted, for example in the 1970s to oil and gas exploration, and in the 1980s to the search for gold. However, what remains clear is that geological information is required to make informed decisions on for example, resource exploration, environmental assessment, urban and infrastructure development.

Conceived in the 1990s and completed between 2004 and 2011, the Northern Ireland Tellus Project entailed regional-scale, high-resolution geophysical and geochemical mapping. The project provided an injection of geoscience data that allowed geological survey to advance in a more informed way. The data also served as a catalyst to survey, industry and academia led research and exploration, directed towards minerals and energy, agriculture and ecology, and environmental mapping and management, which are the main sections of the RIA published book 'Unearthed' which showcases these outputs and their impacts.

Geology is multi-dimensional, so how can we readily visualise the third or even fourth dimensions? Northern Ireland was the first part of the UK to build a countrywide 3D model of its bedrock geology. This 'crustal-scale' model was completed in 2012 with GSI and the BGS, and encompasses the entire north of Ireland to a depth of 15km. Since 2010 the BGS has been developing a National Geological Model to a depth of 2-3km. The model known as UK3D, brings together information from geological maps, boreholes and geophysical/geochemical surveys which in Northern Ireland includes the Tellus Project. UK3D provides national-scale visualisation of the subsurface which helps people to understand what might be entailed in a particular scheme, and make decisions on how to proceed.



Professor Mark Cooper CGeol joined GSNI in 1996 on completion of his research doctorate at University of Liverpool. He is currently the GSNI Chief Geologist for Northern Ireland and has a broad understanding of Northern Ireland geology in its all-Ireland, UK and international context. Mark is chartered through the Geological Society of London and holds a visiting research professorship with Queen's University Belfast. Mark's publications include close to 40 peer-reviewed, high impact papers and book chapters, and 20 geological maps and models covering a wide range of geological subject areas.



Katie first joined the BGS as a survey geologist in 2005. Between 2008 and 2012, she completed a PhD in fluvial geomorphology at the University of Glasgow. Since returning to BGS, Katie has delivered a range of projects for both public national good science and commercial clients, covering diverse areas including Quaternary mapping, Devonian stratigraphy of the Moray Firth, structural assessment and geodiversity auditing. Alongside this work, she has established a new BGS research programme to assess the geological controls on sediment connectivity in catchments. In 2017 Katie became project manager for the BGS's National Geological Model project leading the development of 3D geological modelling and analytical geoscience to underpin the national geological knowledge base of the future.

## Research and innovation in geohazard management

Kieran Parker, Geological Survey of Northern Ireland ([kieran.parker@economy-ni.gov.uk](mailto:kieran.parker@economy-ni.gov.uk))

David Hughes, Queen's University Belfast ([d.hughes@qub.ac.uk](mailto:d.hughes@qub.ac.uk))

Mining in Northern Ireland dates back to the Neolithic but was at its peak during the 19th Century before declining in the 20th. The extraction of resources such as salt, iron ore, lead and coal, has had a positive socio-economic impact upon the country, but has left a legacy of instability in the form of disused mines. The GSNI Abandoned Mine Database contains information on over 2,400 shafts and adits which pose a significant hazard to development. To mitigate this, GSNI conducts a Mine Monitoring Programme to determine risk to the public, infrastructure and environment. A range of techniques have and continue to be used to assess and understand abandoned mines and this has resulted in detection of ground movements and early warning prior to surface collapses.

Landslides are frequent but are generally of small scale in Northern Ireland. The majority of events occur naturally but can be triggered by human activity. Areas susceptible to landslides are indicated on geological survey maps and this is complemented by a recently established landslide occurrence database. Knowledge of where and how landslides take place is essential to avoid damage to property and infrastructure.

The GSNI and the BGS, along with collaborating partners, continue to develop initiatives to monitor ground instability with greater efficiency and cost effectiveness. Most recent work has been partnered with QUB and has used the Interferometric Synthetic Aperture Radar (InSAR) technique to assess ground motion. The application of satellite technology allows rapid regional assessment at millimetre scale, enabling a greater understanding of ground deformation which will prove crucial in the future as abandoned mines continue to deteriorate and increased periods of extreme rainfall trigger landslides at greater frequency.



Kieran joined GSNI in 2014 as Environmental Geologist. His work focuses on hazards associated with mining and landslides where he leads the Mine Monitoring Programme, providing risk analysis assessment. Kieran is currently part of a collaborative research team assessing Northern Ireland ground motion using satellite technology. He formally worked in the mineral exploration sector with Lonmin and a previous role within GSNI. He is a member of the Northern Ireland Mines Oversight Committee and council member of the Irish Association of Economic Geology.



David Hughes is Head of Civil Engineering and senior lecturer in Geotechnical Engineering in the School of Natural and Built Environment (SNBE) at QUB. He was Co-Investigator on a £1.67m EPSRC project – 'Infrastructure slopes Sustainable Management And Resilience Assessment' (iSMART). Other recent research includes 'Climate Change Biological and engineering impacts of climate on slopes / learning from full-scale' EPSRC, and an EPSRC CASE award with Golder Associates on 'Predictive modelling of climate impact on slope stability'.

## Geological information for planning and development

Alex Donald, Geological Survey of Northern Ireland ([alex.donald@economy-ni.gov.uk](mailto:alex.donald@economy-ni.gov.uk))

Diarmad Campbell, Chief Geologist, Scotland, British Geological Survey ([sdgc@bgs.ac.uk](mailto:sdgc@bgs.ac.uk))

Geological and geotechnical data underpin decision making across a range of infrastructure applications. GSNI holds an archive of over 100,000 geotechnical boreholes and 10,000 site investigation reports. These archives are accessed daily through the online GeoIndex and the enquiry service, by a range of stakeholders. Through the Tellus project, the survey has collected geochemical and geophysical data across the entire country. Publication of the Tellus data on [opendatani.gov.uk](http://opendatani.gov.uk) shows the survey's commitment to the Northern Ireland Open Data Strategy. The geochemical samples from Tellus are archived alongside 20km of borehole core and 30,000 rock specimens in the GSNI Core Store. Looking ahead, GSNI will be expanding its archive of data by collecting, storing and delivering digital geotechnical information.

In Glasgow, the BGS Clyde-Urban Super-Project (CUSP) has developed 3D and 4D subsurface models and other geoscience datasets including geochemistry, groundwater and engineering geology. These are intended to support city planning and delivery of construction and regeneration projects, and address other urban subsurface issues in the Glasgow area such as flooding and contamination. The models and datasets, based on data from tens of thousands of boreholes and other sources, provide new insights into Glasgow's complex geology, impacts of its industrial legacy and opportunities for harnessing heat from abandoned mine workings. To make the CUSP models and data more accessible, BGS and Glasgow City Council have established ASK (Accessing Subsurface Knowledge), a data and knowledge exchange network involving public and private sector partners. ASK promotes digital free flow of subsurface data and knowledge between its partners. Lessons learnt in Glasgow are also being shared across the UK, 30 European countries through a COST Action (Sub-Urban) focussed on sustainable use of the urban subsurface, and in Asia (e.g. India, Vietnam and Malaysia, etc.), through BGS's Official Development Assistance programme focussed on the resilience of Asian cities.



Alex Donald is a geology graduate from Queen's University Belfast and has been working for the GSNI for 15 years. He was a member of the Tellus Project team and now works in Information and Infrastructure dealing with data delivery, data management and information products. He has compiled GSNI publications including *A Guide to the Tellus Data* and *Unearthed*. He has a particular interest in urban geology and has been involved in the European Co-operation on Science and Technology (COST) Action "Sub-Urban".



Dr Diarmad Campbell is the BGS Chief Geologist, Scotland, and currently lead BGS's Resilience of Asian Cities research platform, under the Official Development Assistance project Geoscience for Sustainable Futures. He has also been leading the European Co-operation on Science and Technology (COST) Action, "Sub-Urban", dealing with sustainable use of the subsurface of major European cities in 30 countries. Before that, he led BGS's multi-disciplinary Clyde-Urban Super-Project (CUSP) in partnership with Glasgow City Council (GCC) with whom he initiated the ASK (Accessing Subsurface Knowledge) knowledge exchange network.

## Using geoscience to enhance tourism and support education in Northern Ireland

Kirstin Lemon, Geological Survey of Northern Ireland ([kirstin.lemon@economy-ni.gov.uk](mailto:kirstin.lemon@economy-ni.gov.uk))

Patrick McKeever, UNESCO, Chief of Section for Earth Science and Geohazard Risk Reduction ([pj.mckeever@unesco.org](mailto:pj.mckeever@unesco.org))

One of Northern Ireland's finest natural assets is the aesthetic appeal of its landscape. It has attracted visitors for hundreds of years, many of whom were first enticed by the evocative watercolours of the Giant's Causeway by Susannah Drury in 18th century. The medium of engagement may have changed but imagery used in big budget film and television productions such as Game of Thrones is doing the same job today and attracting tourists in their droves.

Understanding the geology that forms these special landscapes plays a key role in enhancing the visitor experience. By telling the stories of the Earth, and linking those with history, culture, archaeology and biodiversity, it provides for a fully immersive tourism product that is attractive to not only domestic but international visitors. However, the number of visitors to Northern Ireland has been steadily growing, adding to increasing pressures on sensitive environments, so sustainable tourism and targeted education is a key priority.

GSNI has worked closely with UNESCO for nearly two decades which ultimately helped lead to the creation of UNESCO's first site designation since the signing of the World Heritage convention in 1972: the UNESCO Global Geopark. UNESCO Global Geoparks will not only enhance sustainable tourism in Northern Ireland but will also provide a mechanism for promoting science and education. By drawing on examples of good practice from around the world, UNESCO advises and assists GSNI in maintaining and developing UNESCO Global Geoparks that are holistically managed for protection, education and sustainable development.

By engaging, enticing and inspiring members of the local community, together with both domestic and international visitors, GSNI is able to deliver sustainable tourism that has a tangible economic benefit for the local area. At the same time, through a program of education and understanding, it is contributing to the protection of one of Northern Ireland's greatest resources, its natural landscape.



Dr Kirstin Lemon joined GSNI in 2004 as Geopark Geologist for the Marble Arch Caves UNESCO Global Geopark. Kirstin is now Team Leader for Information and Infrastructure and has responsibility for developing tourism and education products across Northern Ireland. Kirstin works across the UK and Ireland and internationally through her work with UNESCO. Kirstin is Chairperson of the Irish UNESCO Global Geoparks Committee and Vice-Chair of the UK Committee for UNESCO Global Geoparks and a member of the European Geoparks Network Coordination Committee. Most recently Kirstin was elected to the UNESCO Global Geoparks Council and plays a key role in the governance and assessment of UNESCO Global Geoparks around the world.



Prof Patrick McKeever is Chief of Section for Earth Sciences and Geohazard Risk Reduction and Secretary of the IGCP at UNESCO. Among his jobs since joining UNESCO, Prof McKeever directed the formalising of the relationship between the Global Geoparks Network and UNESCO. This has happened through the creation of the new International Geoscience and Geoparks Programme and the creation of the UNESCO's first new site designation since the creation of the World Heritage Site label in 1972 by establishing of the designation "UNESCO Global Geopark" which happened in November 2015. Today there are 127 UNESCO Global Geoparks in 35 countries.

## Groundwater in Northern Ireland: past, present and future

Paul Wilson, Geological Survey of Northern Ireland ([paul.wilson@economy-ni.gov.uk](mailto:paul.wilson@economy-ni.gov.uk))

Silke Hartmann, Northern Ireland Environment Agency ([silke.hartmann@daera-ni.gov.uk](mailto:silke.hartmann@daera-ni.gov.uk))

Groundwater is pivotal to a whole spectrum of natural environments. Historically its reliable occurrence from springs and wells has determined where people have settled and developed in social and economic communities. More recently, human technological advancement has enabled groundwater to be accessed more readily through the drilling of boreholes to power industry and increase living standards globally. However, such advancement presents a threat to groundwater from contamination and overuse requiring hydrogeologically informed management of one of our most valuable natural resources.

Nowadays groundwater plays a vital but hidden role in sustaining our way of life from health care to leisure services, but only a fraction of Northern Ireland's high quality, sustainable groundwater resource is currently used. Globally, access to secure water supplies is a growing problem not only for people and businesses, but for the natural world. Within the next ten years, Northern Ireland will be an increasingly attractive place for businesses that depend on secure water supplies. Is Northern Ireland ready to welcome such interest whilst at the same time managing groundwater sustainably? The Geological Survey of Northern Ireland has played and continues to play a central role in meeting the challenge of achieving this balance. Through strong links and partnerships across government and industry, the GSNI gathers and disseminates hydrogeological information and expertise on groundwater in support of its sustainable use. As demand for water increases, the GSNI must be equipped to use new hydrogeological technology and practices to observe and monitor groundwater more effectively so that informed decisions can be made regarding groundwater management.



Paul Wilson has been a hydrogeologist at the Geological Survey of Northern Ireland (GSNI) since 2008. Paul trained as an engineer at The Queen's University of Belfast (QUB) and worked in consultancy before completing a PhD in engineering hydraulics. Paul has worked on a wide range of hydrogeology projects both locally and abroad from implementation of the Water Framework Directive to supervising drilling monitoring wells in Iceland. He is presently championing the sustainable use of Northern Ireland's groundwater resources through the building of a central groundwater data repository that will lead to advancements in hydrogeological understanding.



Dr Silke Hartmann has led the Groundwater Resources section in NIEA since 2007. Silke holds a Masters degree in Geophysics from Leipzig University and a PhD in hydrogeology from the University of Leeds. Her team covers a wide area ranging from planning and abstraction licensing consultations; regional assessment of groundwater quality; to the Programme of Measures under WFD for groundwater improvements in catchments. She is responsible for the NIEA's regional groundwater monitoring network, which is utilized for national and international assessments and reporting. Silke is a STEM ambassador and has a strong interest in raising the awareness of groundwater.

## Investing in mineral exploration

Mark Patton, Geological Survey of Northern Ireland ([mark.patton@economy-ni.gov.uk](mailto:mark.patton@economy-ni.gov.uk))

Sean Finlay, Geoscience Ireland ([sean.finlay@gsi.ie](mailto:sean.finlay@gsi.ie))

Subsurface mining in Northern Ireland dates back at least to the 1700's. Historically coal, iron ore, bauxite and base metals have been extracted. Modern exploration began in earnest in the 1970s and as result Northern Ireland is now the most prospective region in the UK and Ireland for gold.

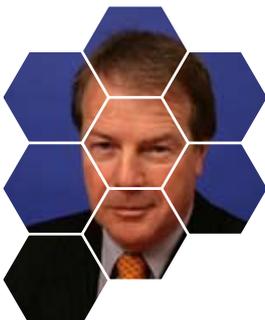
The development of our precious metals represents a tremendous opportunity for Northern Ireland in terms of future jobs and investment. Since 2005 almost £90 million has been invested in searching for and developing our high value metallic minerals. The mine planned for the Curraghinalt gold deposit is projected to bring over 300 jobs to the area for a 13 year mine life. The potential for base metals, platinum and most recently diamonds is evidenced by exploration companies remaining invested in Northern Ireland. The Republic of Ireland ranks as an important producer of zinc and lead concentrates having enjoyed a revival of the mining industry since the 1960's.

GSNI and GSI have been at the forefront of promoting mineral exploration in Ireland, collaborating in regional surveys and, along with Exploration and Mining Division and the Department for the Economy, attracting investors through, for example, attendance at the PDAC in Canada. In the annual Canadian Fraser Institute survey of mining companies the island of Ireland has repeatedly placed 1st in the policy perception category. In 2016, the first year of inclusion as a separate jurisdiction, Northern Ireland was placed 10th globally.

Enterprise Ireland and Invest NI support the efforts of Irelands companies to sell services and products in international markets. Enterprise Ireland along with GSI supports Geoscience Ireland, a network of 33 companies winning business in international markets. Invest NI supports manufacturers of mining and quarrying equipment; Northern Ireland produces c 40% of the world's screening equipment. Many geoscientists who have worked in Ireland have gone on to provide expertise to international companies, to Governments and to International Financial Institutions.



Mark Patton is the Minerals Geologist at GSNI. He joined the survey in 2004 as Data Manager for the Tellus Project. After graduating from his undergraduate degree in geology at Liverpool University he completed an MSc in Geophysics at Birmingham University before starting his career in oil field services and data management. In 2007 he took on the minerals role and is currently in his final year studying for a Professional Masters degree in Mining Engineering at the Camborne School of Mines.



Sean Finlay is a Professional Geologist and Chartered Engineer. Sean has over 40 years' experience in Project Management, leading multidisciplinary teams implementing mining and infrastructural projects. He was appointed Director-Business Development of Geoscience Ireland in September 2012. Prior to that he was Director of TOBIN Consulting Engineers, Managing Director of Celtic Resources Holding Plc, Managing Director of Celtic Gold Plc and served as Chief Exploration Geologist at Tara Mines. Sean is also a former President of the Irish Mining and Quarrying Society and a Fellow of the Academy of Irish Engineering.

## Aggregates: the foundation to Northern Ireland's construction sector

Marie Cowan, Director, Geological Survey of Northern Ireland ([marie.cowan@economy-ni.gov.uk](mailto:marie.cowan@economy-ni.gov.uk))

Gordon Best, Quarry Products Association ([gbest@qpani.org](mailto:gbest@qpani.org))

Minerals and other natural resources are essential to support sustainable economic growth and quality of life. It is vital there is a sufficient supply of raw and recycled materials from our natural resources for manufacturing, construction, power generation, transportation and agriculture. In the UK, trade in minerals and mineral-based products makes up over 20% of total, with exports of £66bn and imports of £85bn in 2014 (UK Minerals Yearbook 2015).

The Quarry Products Industry is worth £650m per year to the Northern Ireland (NI) economy and 5000 jobs (QPANI 2017). Off the back of this enabling industry, NI is a recognised global centre of excellence in the production of materials handling equipment; 40% of the world's mobile crushing and screening equipment is made here. Applications include iron ore mining in India, road construction in Peru, diamond exploration in South Africa and sand washing in the Arabian Gulf (Invest NI).

The construction sector is worth £2.5bn to the NI economy, has 12k firms and provides 60k jobs (CITB). 60 tons of aggregates are required for an average house. 10k tons aggregate, 3k tons asphalt and 2000m<sup>3</sup> concrete are required for 1km of a 6m-wide single carriageway. Such demand for aggregates creates issues for society including security of supply, as minerals are finite and can only be worked where they are found, sterilisation, safeguarding, sustainability and the clean growth agenda.

Since the transfer of planning powers in 2015 from central to local government in NI; each of the 11 local councils are now responsible for their respective local development plans and planning decisions. DfE/GSNI have actively engaged with planners, councillors, industry and DfI and have contributed data and advised throughout the consultation process. This has resulted in the development of a new GIS-based decision-making tool to help understand how much of these resources are actually accessible when all surface infrastructure is removed, and will inform minerals planning for a generation.



GSNI Director since 2014, beforehand Marie co-project-managed the award-winning £6m Tellus and £4.5m Tellus Border soil geochemistry and geophysical mapping projects in NI and Ireland. Marie is a member of the Institute of Directors and a professional geologist with the Institute of Geologists of Ireland. Marie holds a PhD and 1st Class BSc Hons. from Queen's University Belfast. Described as 'one of the most influential geoscientists on the island of Ireland', Marie is a member of the North-east Atlantic Group of Geological Survey Directors, the Royal Irish Academy's Geosciences and Geographical Sciences Committee and its Brexit taskforce, the NI Assembly All Party Group for Science and Technology and the NI Learned Societies and Professional Bodies Forum. She is a Governance Board member for the Irish Centre for Research in Applied Geosciences, past Chairperson of Earth Science Ireland and past elected non-executive board member of the Institute of Geologists of Ireland. She is also currently Chair of a Social Enterprise in her local community.



Gordon has been Regional Director of the Quarry Products Association NI since 2001. The Association represents 95 % of the supply of construction materials to the NI Construction Industry and is an important employer particularly in rural areas. The Mission of the Association is "To be the voice of the aggregates and quarry products industry in Northern Ireland, representing and promoting the industry so that its economic, environmental and social contributions are recognised and valued" Gordon is a Board Member of the NI Construction Group, a member of the Construction Industry Forum, member of the Institute of Quarrying, the Chartered Institute of Highways and Transportation and the Institute of Asphalt Technology. Gordon also sits on the Consultative Committee of the Geological Survey of Northern Ireland.

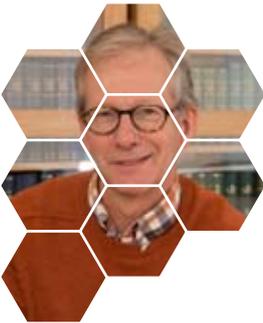
## Clean energy: the role of Northern Ireland's geology

Derek Reay, Geological Survey of Northern Ireland ([derek.reay@economy-ni.gov.uk](mailto:derek.reay@economy-ni.gov.uk))

Sam Knox, Invest NI ([sam.knox@investni.com](mailto:sam.knox@investni.com))

Natural resources are the original resources of the earth used by people to support life and drive economic activity. These include industrial raw materials, energy resources and other environmental resources such as clean water that are used in or to support such economic activity. We must therefore examine the various natural resources available in Northern Ireland that can be exploited for the development of business opportunities now and the need for continued research to develop the technologies to build the economy of the future.

Energy plays an essential role in modern living. For centuries natural resources – wood, wind and water – were harnessed for use as fuel and mechanical power, before coal was mined to power the industrial revolution in the nineteenth century. In the twentieth century natural hydrocarbons - oil and gas - were used to produce electricity and as raw material for the petrochemical industry. In the current century society faces a great challenge – the need to limit the concentration of greenhouse gases in the atmosphere to ameliorate the effects of climate change, whilst meeting the needs of a growing global population. Wind and solar energy are intermittent sources of renewable energy that will produce an increasing proportion of Northern Ireland's electricity but developments in geothermal energy and geological storage of energy in Northern Ireland have the potential to deliver consistent low carbon heat and to help maximise the efficiency of the energy network, respectively.



Derek Reay is a Chartered Geologist with over 35 years' experience in the British Geological Survey. He joined GSNI in 1989 and worked on geological mapping projects before taking on responsibility for Energy & Minerals. In this role he has helped to write new petroleum legislation, provided scientific support to Ministers, senior civil servants, and the DfE Minerals & Petroleum Branch. He initiated two research projects assessing the potential for underground gas storage and deep geothermal energy in Northern Ireland. Derek was recently a member of the IRETherm deep geothermal energy research group and the steering committee for the Joint Research Project into the potential environmental impacts of unconventional gas exploration and extraction in Ireland.



Sam Knox is a Business Development Executive in the Strategy Team at Invest Northern Ireland. He is an Energy Engineer with over 30 years' experience in the sector and has delivered new business opportunities in the technology areas of energy efficiency, bio-energy, offshore wind, water and waste water and energy storage.

## UK geoenery observatories (UKGEOS): changing the way geological surveys work

John Ludden, Executive Director, British Geological Survey (BGS) ([jludden@bgs.ac.uk](mailto:jludden@bgs.ac.uk))

Scientists, policymakers, industry leaders and the public urgently need to understand how the Earth responds to new and emerging subsurface energy technologies. These energy technologies will make a major contribution to the economy, to jobs, and to energy security, but are largely untried, unproven, and untested, within the UK's complex geological conditions. Without understanding this better, nascent energy industries are likely to be arrested in their development, investments at best delayed and potentially unrealised, and economic dividends lost in the face of uncertainties related to technical feasibility and environmental impact, and as a result public scepticism and opposition.

In the UK we will develop the UK geoenery observatories (UGEOS) through a £31m capital investment from government and a BGS resource co-investment of £7.5m - UKGEOS will be a national facility, open to global science projects which will:

- facilitate real-time, open access observations of the effects of subsurface energy applications (such as shale gas extraction, CCS and geothermal power generation) on groundwater, seismic activity and surface atmospheric emissions;
- enable world-class understanding of subsurface energy applications leading to better management, regulations and environmental security assurance;
- provide a platform for the development and commercialisation of a range of new low-carbon technologies; and
- develop innovative, exportable UK-created technology and expertise in energy technologies using the subsurface.



Executive Director at the BGS since 2006, John Ludden has held numerous science direction and management posts. He was Director of the Earth Sciences Division at the French National Centre for Scientific Research (CNRS) and also served as Director of Research for the CNRS in Nancy, France, where he also taught at the French National School of Geology (ENSG-Nancy). Prior to this, Professor Ludden worked at the University of Montreal, Columbia University and with Woods Hole Oceanographic Institution in the USA. He holds a doctorate in Igneous Petrology from the University of Manchester, UK. Professor Ludden is a visiting professor at Oxford and Leicester universities and a Foreign member of the Russian Academy of Sciences. He is a past president of the European Geosciences Union and also EuroGeosurveys.

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