Department for the Economy
www.economy-ni.gov.uk

GSNI Geological Survey of Northern Ireland
www.bgs.ac.uk/gsni

Annual Report 2018-2019

Front Cover. © Tourism NI Media Library

Contents

Introduction

The Geological Survey of Northern Ireland (GSNI) is an office of the Department for the Economy (DfE) in Northern Ireland (NI) staffed by scientists of the British Geological Survey (BGS) who provide research and technical services to help develop NI's economy and monitor its environment.

GSNI is based at Dundonald House on the Stormont Estate, Belfast where it runs an enquiry service and shop; it also manages a national core store and sample repository at Duncrue Industrial Estate.

GSNI scientists provide data, information and advice to support the legislative responsibilities and strategic priorities of DfE, other NI government departments, Invest NI and local Councils.

GSNI also collaborates on geoscience research with BGS, the Geological Survey Ireland and over 35 universities globally. GSNI's datasets are available on *Open Data NI* and *Spatial NI*. GSNI also hosts information on geology, engineering geology, minerals, borehole data and site records, mines, quarries and pits, airborne geophysics, soils and water geochemistry on *GeoIndex* and *GeoRecords*.

GSNI actively engages and works with all parts of society including central and local government, industry, academia, community organisations, NGOs, schools and the general public. Its key partners are DfE, Invest NI, Land and Property Services, Northern Ireland Environment Agency, Marble Arch Caves UNESCO Global Geopark, Quarry Products Association NI, Queen's University Belfast, University of Ulster, Royal Irish Academy, W5, Ulster Museum and UNESCO.

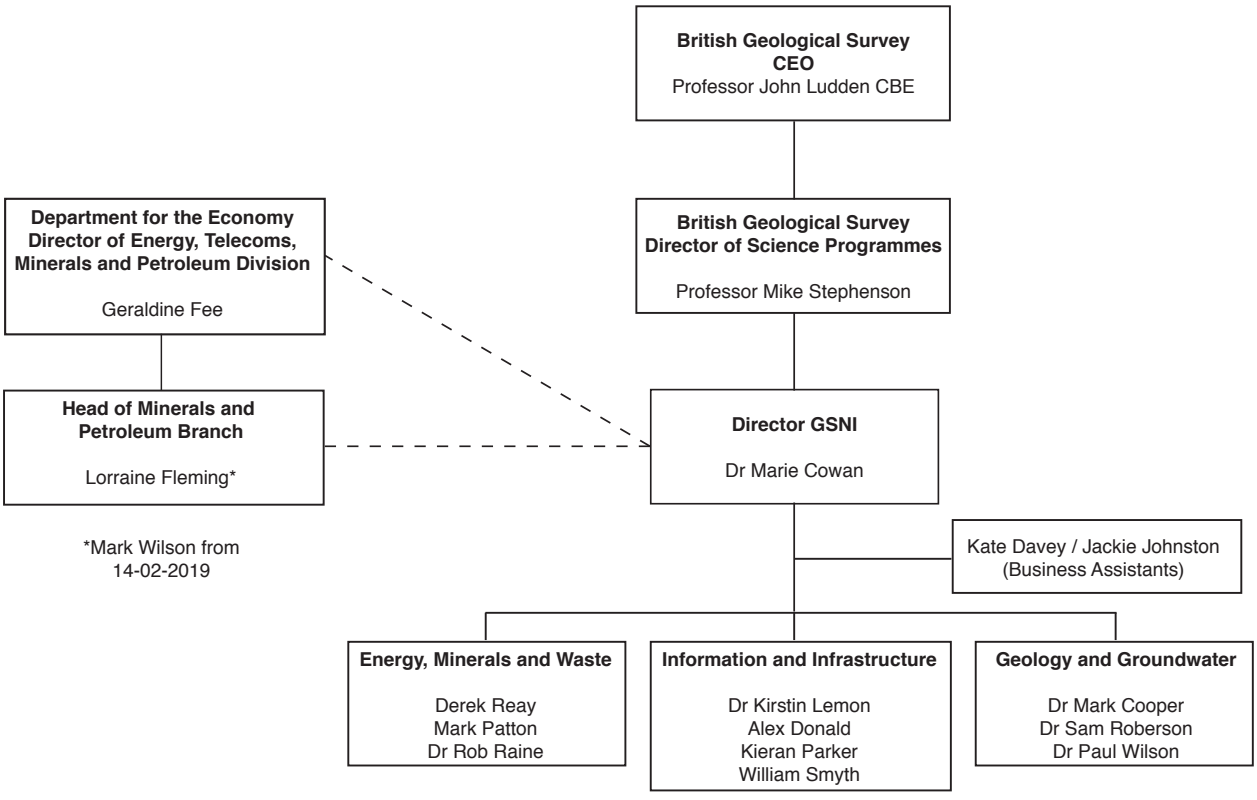
This annual report summarises how GSNI performed in the financial year (FY) 2018–2019 and the impact its science had on Northern Ireland's economy, infrastructure, environment, tourism, health and education sectors.

In the same year DfE commissioned the Ulster University Economic Policy Centre (UUEPC) "*to research the economic value and impact of the geosciences sector to the NI economy and consider the potential of that sector to further benefit the NI economy*".

For the purpose of the UUEPC report, Geoscience included a series of activities connected to the extraction and processing of natural resources (specifically minerals and metals) to meet the needs of energy supply, manufacturing, technology and construction.

The UUEPC report concluded that in 2018, the NI geoscience sector incorporated 6,150 businesses, some 8.6% of all NI businesses; 34k jobs accounting for 4.6% of total NI employment and generated a Gross Value Add of £2.1 billion to the local economy, some 5.8% of NI total GVA. In terms of NI equivalents, geoscience employment is similar to the agriculture sector and the knowledge economy and the GVA total is close to that produced by construction. This data underlines the impact of our sector, the importance of geoscience research, national geological survey data and geoscientists working in the public interest.

Dr Marie Therese Cowan PGeo, MIoD
Director, Geological Survey of Northern Ireland



Organisation and reporting structure.

Our structure

The Geological Survey of Northern Ireland (GSNI) is an office of the Department for the Economy (DfE), herein referred to as 'the Department'. GSNI is staffed by scientists of the British Geological Survey (BGS) under contract to DfE.

Governance and Administration
The GSNI Director, supported by two business assistants, is responsible for the governance and effective administration of the organisation, including setting the strategic aims, providing leadership to ensure that these are put into effect, and reporting on the delivery of the work programme. GSNI's research programme is delivered by three teams as described below.

Energy, Minerals and Waste
The Energy, Minerals and Waste (EMW) team provides advice and support to the Department on resources and energy-related issues including oil and gas exploration, geothermal energy, underground energy storage and carbon capture and storage. The EMW team also provides geoscientific advice and support on the economic development of natural resources and assists Minerals and Petroleum Branch of the Department with minerals licensing. The team contributes to policy development for minerals and energy.

Information and Infrastructure
The Information and Infrastructure (II) team provides geological information through the enquiries service to external customers and stakeholders, ensures that GSNI's data is collated, managed and distributed effectively, and responds to planning consultations through the local council and regional planning process. They are also responsible for the monitoring of Northern Ireland's abandoned mines many of which are vested in the Department, and contribute to the development of geological tourism and education resources.

Geology and Groundwater
The Geology and Groundwater (GG) team provides information on the extent, thickness and properties of geological materials, primarily in the form of bedrock and superficial geological mapping. The GG team also provides information and advice on groundwater resources in Northern Ireland and contributes to groundwater monitoring.

Developing the Economy

Porosity highlighted by blue resin in a Triassic sandstone reservoir from the GSNI Ballymacilroy No. 1 borehole.

Research Report of Geothermal Reservoirs

We have produced a report for the Department reviewing geothermal reservoir properties across Northern Ireland. The report covers aspects of the properties of deep geothermal aquifer systems, geothermal gradients and heat flow in buried sandstone reservoirs in Northern Ireland and reviews published and unpublished data held on Carboniferous, Permian and Triassic aged sandstone reservoirs. Specific properties covered include fluid flow, porosity and permeability, anisotropy of permeability, transmissivity, drill-stem tests and fractures. Variation in porosity with depth in deep borehole records and the respective depths of geothermal reservoirs is considered.

Sandstones of similar age and types are being used to produce heat in geothermal energy systems in the Netherlands, Denmark, Germany and Great Britain. There is potential to develop similar geothermal energy systems in Northern Ireland that can play a role in the decarbonisation of heat.

Geothermal resources are characterised by their high deliverability and availability approaching 24/7, 365 days a year. Deep geothermal energy systems involve relatively high initial capital expenditure associated with the drilling of deep boreholes so it is important to be able to predict accurately the nature and performance of the target geothermal aquifers. In particular, exploration requires knowledge of the thickness and depth of these sandstones and the temperature of the formation fluids they contain. Additionally, information on how much fluid is stored within them and how easily it can move through the rocks is required.

The report will be widely available and will inform further consideration of the geothermal potential of Northern Ireland.

A new Groundwater Data Repository now provides a central store for hydrogeological data.

Groundwater Resources and the Groundwater Data Repository

We recently launched the first ever Groundwater Data Repository (GDR) for Northern Ireland. This is a centrally managed database for all hydrogeology data in Northern Ireland and includes information on over 2000 boreholes, springs and shallow wells.

As the need to secure resources for both social and industrial demands increases, being able to confidently understand what groundwater resources are available is essential when providing advice to the public and interested parties. This data repository will empower more companies in Northern Ireland to make an informed decision on the availability and security of water supply and whether or not to prospect for their own private water supply.

Water scarcity is increasing globally with some businesses in the south of England restricted to reduced working weeks by limits on water abstraction licences. Being able to make reliable future investment, knowing that water supply will not be restricted, is an attractive prospect. The Groundwater Data Repository, as it grows, will enable prospectors to make informed and low risk decisions on where to base their businesses in to the future.

Local Councils and the Local Development Plan Process

The reform of local government in Northern Ireland in 2015 saw the replacement of the previous 26 districts with 11 new “super councils”, each responsible for developing concurrent Local Development Plans (LDP) running until 2030. The transfer of the majority of planning powers from central government to councils meant that these new entities immediately faced the challenge of developing individual planning frameworks.

Several areas under their responsibility are shared with GSNI and we have proactively engaged with all of the councils from the outset to inform decision making and local plan policies. What started with a series of presentations on topics of mutual interest such as minerals, geothermal energy, groundwater and abandoned mines developed into specific input to the councils Preferred Options Papers and Draft Plan Strategies; milestones in the iterative LDP process. These have led to ongoing meetings with individual councils and the formation of the Minerals Working Group as well as convergence with relevant parties on the subject of coastal change, leading to likely participation in the NI Coastal Forum.

A specific output of engagement with local councils as part of the LDP process was produced in response to initial proposals from Fermanagh and Omagh District Council (FODC). We produced a paper, accompanied by a GIS-based

tool, to assist with the council's evidence based decision-making. The tool demonstrated that the apparent extent of mineral resources across council area can be greatly reduced when surface infrastructure (buildings, roads and water bodies) is excised from the resources displayed on geological maps.

The tool has also been shared with the Principal Planners for all councils and the Northern Ireland Local Government Agency (NILGA). Due to this exposure, and at the request of officials, the tool was expanded to cover the resources for all councils and the information disseminated across them. Over the past 12 months, as more councils have progressed with their own LDPs it is clear from supporting evidence papers that the information provided by GSNI is being incorporated into the decision-making process across Northern Ireland.

The University of Ulster were commissioned to research the economic value and impact of the geosciences sector in NI.

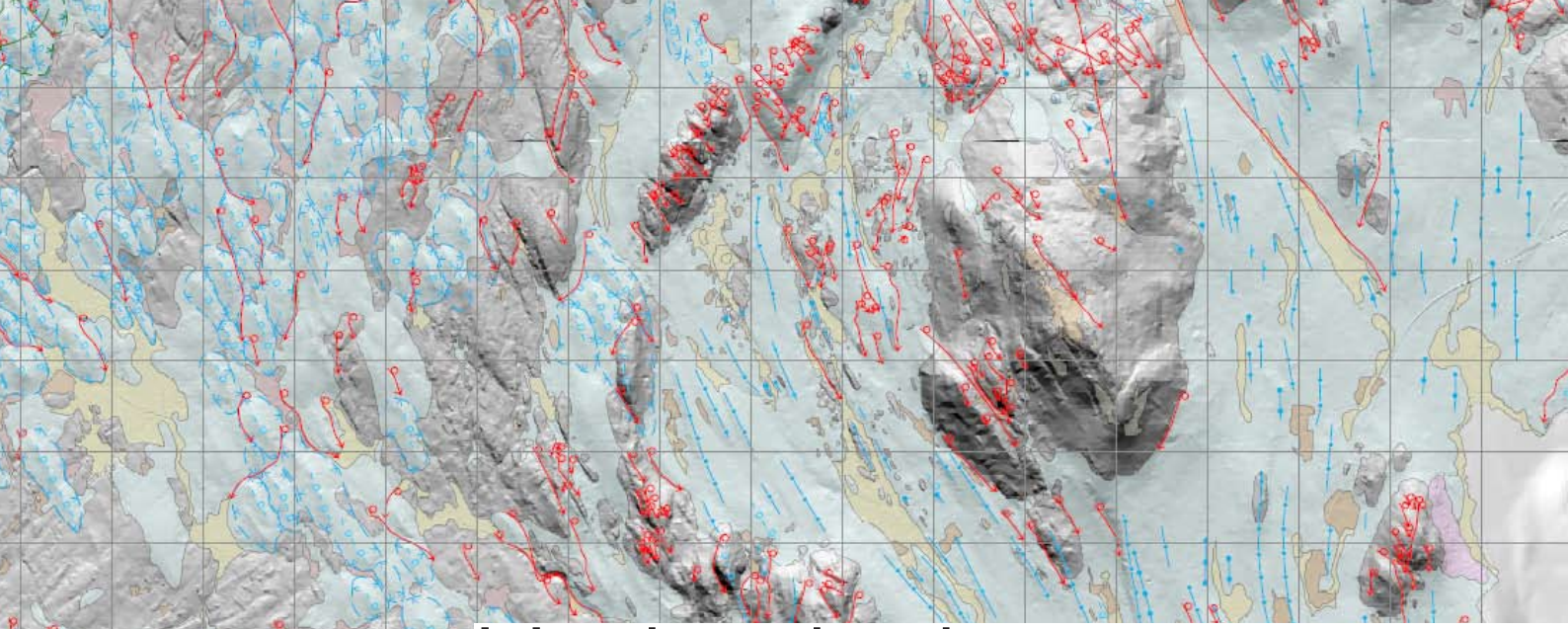
Economics of Geoscience Report

In 2018, the Ulster University Economic Policy Centre (UUEPC) was commissioned by the Department to research the economic value and impact of the geosciences sector to the NI economy and also to consider the potential of that sector to further benefit the NI economy.

The results of this research were published in March 2019 and highlighted that the NI geosciences sector led to the following;

- 34,000 jobs (4.6% share of NI total employment);
- a GVA of £2.1 billion (5.8% share of NI total GVA)
- 6,150 businesses (8.6% share of all NI businesses);
- productivity higher than NI average with a 21% premium;
- on average employees in sector earn 9% more than NI average wage;
- £84M R&D spend (15.5% of the total NI);
- geoscience firms more externally-focussed with 43% of sales (£2.9 billion) going outside NI e.g. construction material for the GB and Irish markets and materials handling equipment for export markets.

The results of this report are still being analysed but it undoubtedly highlights that the economic impact of the NI geoscience sector is significant and in terms of NI equivalents, geoscience employment is similar to the agriculture sector and the knowledge economy, and the GVA total is close to that produced by construction.



Underpinning Infrastructure

Extract from the 1:10k superficial mapping of the Keady area.

Completion of Keady Sheet

The new 1:10,000 scale dataset (DiGMapNI 10k) has been completed for the Keady region, south Armagh for superficial and artificial deposits. This baseline map of the area's geology has been collected from start to finish for the first time using an all-digital workflow. This workflow approach, combined with the very latest digital surface model supplied by Land and Property Services, has enabled a previously unmatched degree of mapping precision and efficiency to be realised.

These data provide information pertaining to the nature of geological deposits and landforms developed during and since the last Ice Age (~15,000 years ago), as well as man-made ground conditions. These deposits cover more than three-quarters of the Keady area and inform us not only about how they arrived there in the first place, but what the behaviour of their constituent materials is likely to be when they are interacted with, both by ground and surface water, and by farmers and civil engineers seeking to work with and enhance the landscape.

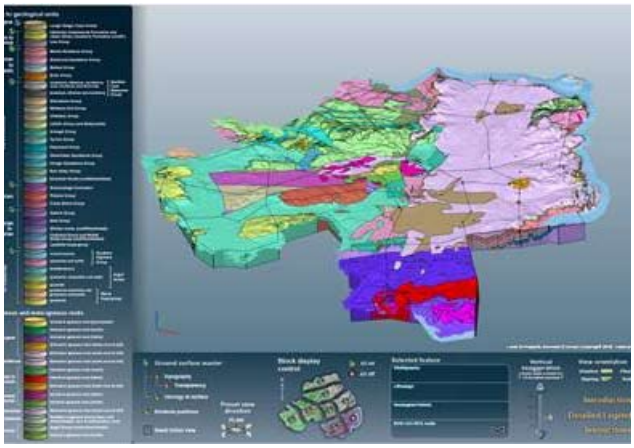
The ASK NI data portal was launched at a webinar hosted by the Institution of Civil Engineers NI.

Accessing Subsurface Knowledge (ASK) NI

Together with BGS, we are now collecting, validating and publishing Association of Geotechnical and Geoenvironmental Specialists (AGS) data format files to enable better re-use of ground investigation data within Northern Ireland. We want to encourage open access AGS data donation through public sector contract frameworks as well as on a voluntary basis through the Accessing Subsurface Knowledge (ASK) NI initiative which was launched in partnership with the Institution of Civil Engineers NI Year of Infrastructure in November 2018.

Working with Construction & Procurement Delivery (CPD) in the Department of Finance, data procured through the Pan Government Collaborative Framework Agreement for Ground Investigation Works are being made available for re-use under the Open Government Licence. This is an open data resource for users in government, councils, industry, academia and NGOs that will deliver savings in construction costs, enhance environmental protection and provide greater public safety from hazardous ground conditions e.g. subsidence, compressible ground.

These AGS data also allow us to refine existing 3D geological models of the subsurface, produce more detailed maps of the depth to bedrock, and enhance a physical rock properties database. Using digital data to refine these maps and models results in an efficient process to deliver new tools to aid our understanding of the subsurface and provide a valuable data asset for future infrastructure projects.



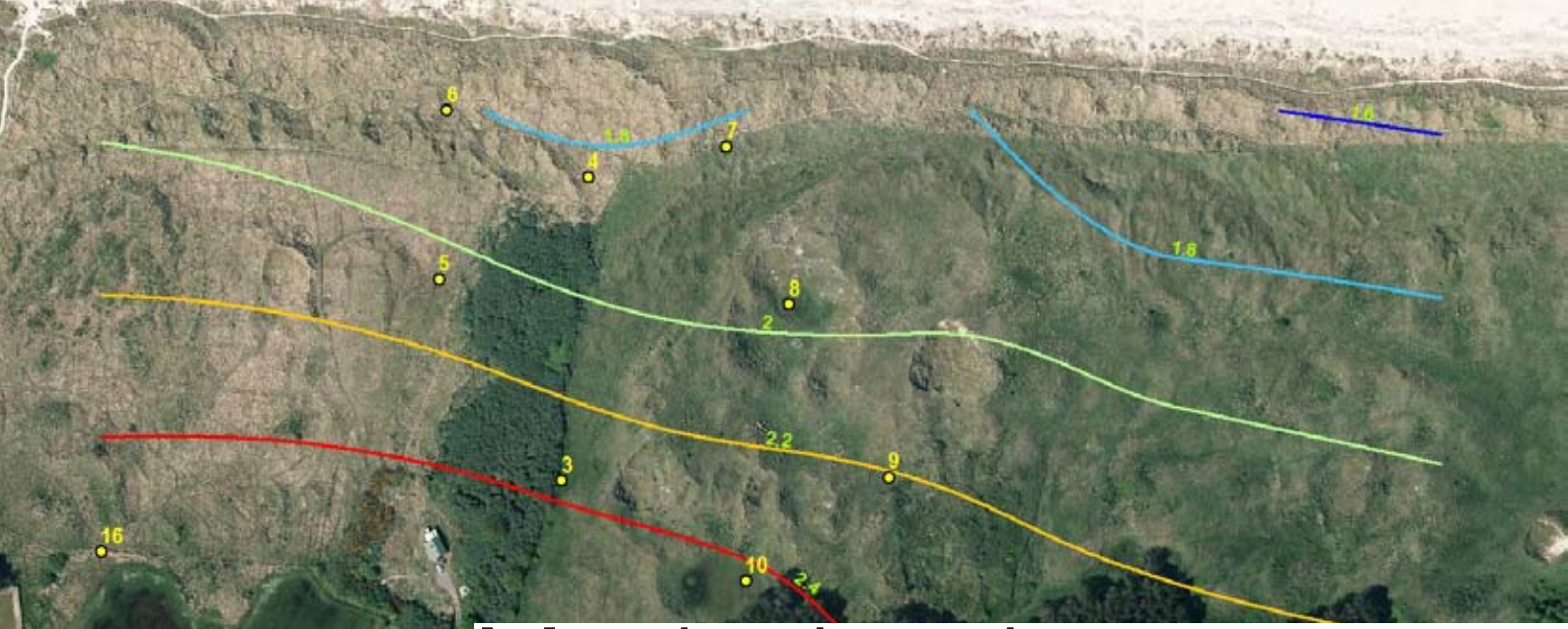
The UK3D Geological Visualisation model provides a user-friendly tool to explore geology in three dimensions.

Regional 3D Geological Visualisation Model

A new 3D bedrock geological model for Northern Ireland is one of 14 new Regional Geological Visualisation Models (GV Models), which have been produced by the BGS to provide interactive, user-friendly tools for exploring the UK's geology in 3D. The GV Models depict geology at regional to national-scale, and the interactive tools are designed to facilitate desktop visualisation of the subsurface environment and enhance conceptual understanding.

The GV Models are based on GSNI geologists' cross-sections which have made use of publically available data from, for example, deep boreholes, regional memoirs and reports and other open access publications. Cross-sections have been combined with a digital terrain to develop 3D 'block models' of the upper 1.5 km of the crust.

Users can explore Northern Ireland geology by switching on/off individual blocks, hiding or displaying groups of geological units, and by zooming and rotating to view the blocks from any angle. The model legend provides information about the geological units, and select functions link to additional sources of information including the BGS Lexicon and scanned records of key boreholes that have informed the model's development.



Monitoring the Environment

Orthophotograph with groundwater levels derived from monitoring at Magilligan Umbra.

Groundwater Monitoring at Magilligan Umbra

We continued to monitor the groundwater conditions beneath the Magilligan Umbra in the northwest of Northern Ireland under our SLA with the Northern Ireland Environment Agency (NIEA). In 2017, the NIEA removed 6000 Corsican pine trees, along with some stands of sea buckthorn from the site. This was carried out to increase the groundwater levels and chemistry, thereby improving the conditions for the sensitive and protected flora and fauna that are found only at Magilligan.

Groundwater Sampling at Magilligan Umbra.

Three rounds of groundwater sampling and retrieval of groundwater level data from 12 loggers in piezometers were carried out. The samples were analysed by the BGS laboratories and the water level data processed in GSNI. Analysis of both sets of data was carried out by our hydrogeologist and other BGS staff. The results show that improvements in groundwater conditions are slow to materialise, but the trends are already showing that groundwater levels have increased and that the way that groundwater is recharged at the site has also changed. The chemistry data is also showing a decline in nitrate as a result of the sea buckthorn removal but ongoing monitoring is required to fully appreciate the impact of the conservation measures.

This work was carried out through a Service Level Agreement between the UK Research and Innovation (UKRI) (BGS) and DAERA (NIEA).

An artesian borehole.

Drinking Water Reports

In 2017, the Private Water Supply Regulations (Northern Ireland) were amended. This introduced the provision of a risk assessment to be carried out on each registered private water supply. The GSNI submitted a consultation response to the regulations asking how such a risk assessment would be carried out given that 98% of all private water supplies are from groundwater. The Drinking Water Inspectorate then approached GSNI looking for support to define a risk assessment process and to provide geological reports for each of the registered private water supplies to support the officers that would be carrying out the risk assessments. A total of 134 reports were required. These needed to be generated, edited and reviewed by a team of GSNI staff. To supplement the reports, a guidance document was produced to explain how each of the different maps and datasets could be used to inform a risk assessment on a groundwater source.

This work was carried out through a Service Level Agreement between the UKRI (BGS) and DAERA (NIEA).

Enhancing Tourism

The Mourne Gullion Strangford aspiring UNESCO Global Geopark. Image © Ring of Gullion AONB.

Mourne Gullion Strangford Aspiring UNESCO Global Geopark
In 2017, Newry Mourne and Down District Council published its tourism strategy that identified the development of a UNESCO Global Geopark as one of its catalyst projects for the region. As a critical economic driver, tourism and the development of a UNESCO Global Geopark in particular will help to create jobs and diversify the rural economy, whilst still maintaining the integrity of the landscape and celebrating the local cultural heritage. Due to the high level of geotourism expertise in GSNI, we have been working with the council to submit an application for UNESCO Global Geopark status that will take in the three Areas of Outstanding Natural Beauty (AONB) within the district.

In 2018–2019 the main focus of this work was on communication, with the primary aim of raising awareness and understanding of the UNESCO Global Geopark concept and what the benefits of this status will bring to the region. An extensive communications plan was developed and delivered throughout the course of the year:

- 20 media briefings to local, national and specialist newspapers;
- the delivery of nine community drop-in sessions at locations throughout the proposed UNESCO Global Geopark;
- attendance at five farmers marts to highlight the impact that UNESCO Global Geopark status will have on the farming community;
- a community open day;
- attendance at five agricultural shows, both locally and regionally;
- several family fun events at locations with high tourism footfall;
- the production of a series of videos to highlight the various components of a UNESCO Global Geopark;
- various meetings with key stakeholders to communicate and discuss individual needs and requirements.

This work was carried out through a Service Level Agreement between the UKRI (BGS) and Newry Mourne and Down District Council.

Drifting apart supported the development of new and aspiring UNESCO Global Geoparks.

Completion of the Drifting Apart Project

June 2018 saw the completion of the Drifting Apart project funded through the Interreg VB Northern Periphery and Arctic Programme (NPA). The overall aim of the project was to unearth and strengthen the understanding, appreciation and enjoyment of the interconnected geological heritage of the Northern Periphery and Arctic region, and the many links to natural, built and cultural heritage.

The project was led by the Causeway Coast and Glens Heritage Trust (CCGHT) in Northern Ireland and included partners from Scotland, Norway, Russia, Iceland and Ireland. Drifting Apart supported the development of new and aspiring UNESCO Global Geoparks, the promotion of innovative products and services for social and economic prosperity and the building of a strong network of Geoheritage destinations.

GSNI was a sub-partner in the project and worked with both CCGHT and Fermanagh and Omagh District Council (as Marble Arch Caves UNESCO Global Geopark) to deliver a number of elements of the project.

- produce the Drifting Apart storyline that summarised the geological history of the entire project area. This was used as a basis for all elements of the project;
- delivery of five community engagement events for CCGHT;
- development of post-primary education resources for FODC and the review of all education material for other partners;
- contribution to several interpretative panels and development of Time Trail for FODC;
- development of GeoVR – innovative virtual reality tool to allow users to virtually visit geological sites and find out more detailed information;
- familiarisation events for tourism businesses and local champions for both CCGHT and FODC.

Protecting Human and Animal Health

Orthophotograph with shafts, adits, seams and areas of undermining compiled as part of the East Tyrone coalfield risk assessment.

East Tyrone Coalfield Risk Assessment

We have initiated a project to carry out an assessment of the east Tyrone coalfields to inform the Department of the risk posed by historic mines in the area. Coal and fireclay was mined around the towns of Dungannon and Coalisland for 300 years with many of the records incomplete or absent. The area contains a high number of mine workings over a small area due to the heavily faulted nature of the underlying strata.

Using GSNI databases, historic geological field slips, borehole records, mine plans, historical archives and literature a desktop study was carried out to ascertain the scale of mining and identify areas of high risk. 606 known mine shafts were identified and using locations of outcrop and shallow coal seams helped delineate areas of possible mining activity. The depths of workings, together with shaft location and proximity to overlying structures and infrastructure resulted in developing new mining risk maps.

These will be used to prioritise further investigative work, enable high risk areas to be monitored closely and plan for any necessary remedial works that may be required. As well as informing the Department of the risk, the new information is incorporated into the planning consultation process to assist regional and local council planners to minimise any risk to new development.

A multi agency mine rescue excercise was held at the Marble Arch Caves in September 2018.

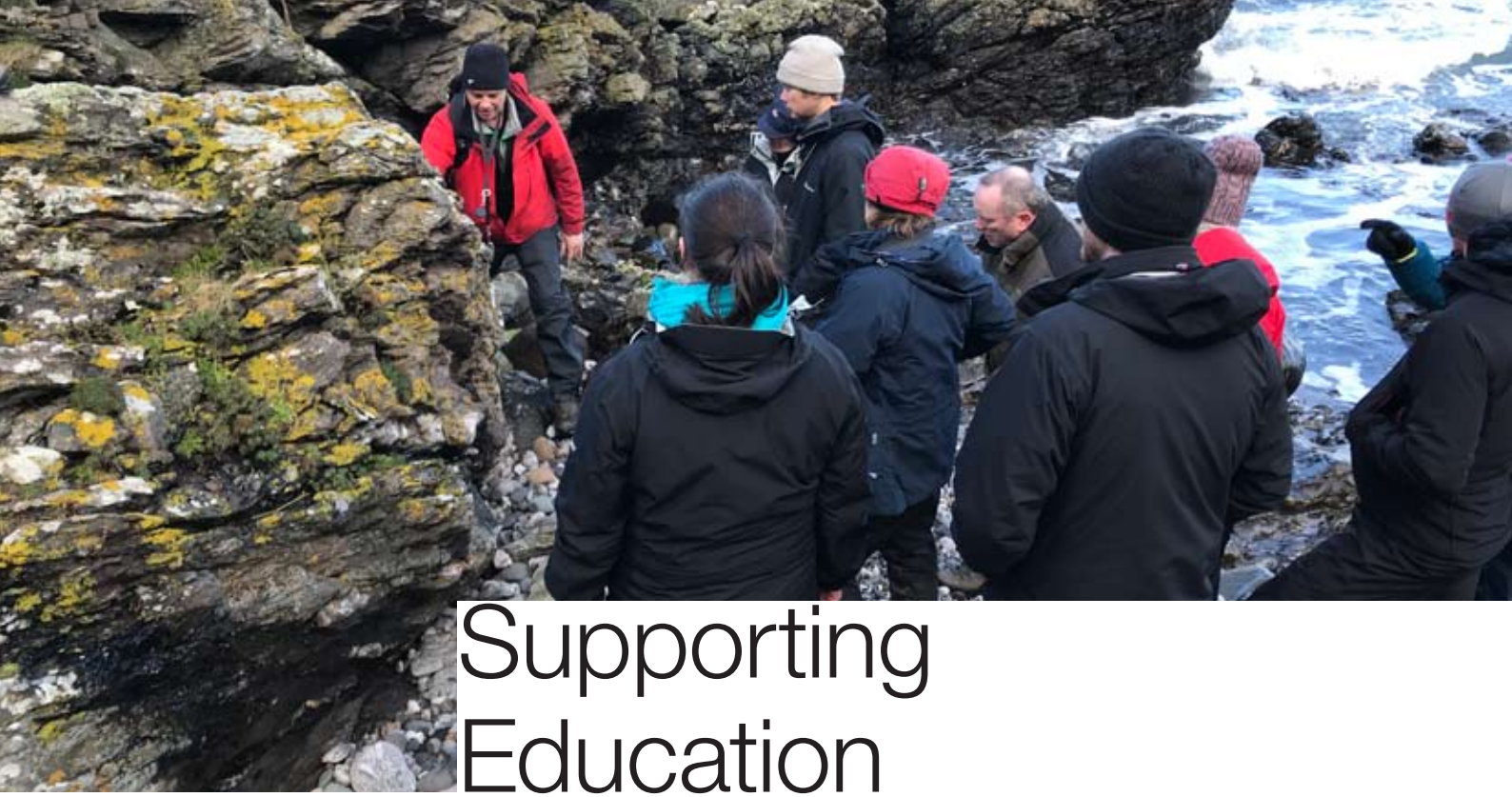
Abandoned Mines Emergency Response Plan Exercise

We have been working closely with the Police Service of Northern Ireland (PSNI) and the Department of Justice (DoJ) Strategic Oversight Group to develop an Emergency Response Plan for all abandoned mine incidents in NI. This has been undertaken through a number of stages.

Firstly we delivered a number of presentations on abandoned mine risk and limitations of ensuring an adequate response. Information guides were produced for the PSNI, Northern Ireland Fire and Rescue Service (NIFRS) and regional resilience groups to inform them of the risk and precautionary measures they may encounter. The available abandoned mine data was provided for incorporation into each of their systems.

The next stage entailed facilitating a series of round table discussions with stakeholders including PSNI, NIFRS, Northern Ireland Ambulance Service (NIAS), utility operators and regional contingency groups. This culminated in GSNI drafting abandoned mines emergency response cards for emergency control centres and a response plan.

Further discussions took place with voluntary groups including Irish Mine Rescue, Irish Cave Rescue and Irish Mountain Rescue. This in turn led to a live exercise to test capability in the event of a major incident which was held at Marble Arch Caves on 21st September 2018. This was carried out and overseen by PSNI, NIAS, NIFRS, the Health and Safety Executive (HESNI), GSNI, the Department, FODC, NW Mountain Rescue Team, Irish Cave Rescue, HM Coastguard, Irish Mine Rescue and representatives from regional resilience groups.



Supporting Education

Geoscience training for scientists from the Northern Ireland Environment Agency.

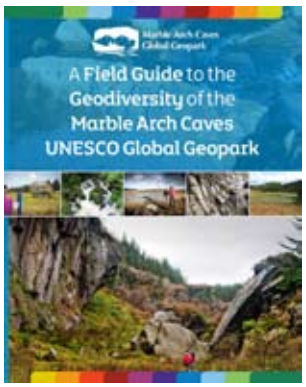
Geoscience Training for Civil Servants

Providing basic geoscience training to civil servants has become a growing service that we provide as the role that geoscience plays in the wider civil service becomes increasingly apparent. This has been through both the DfE and NIEA SLA's.

Twenty NIEA staff with minimal geoscience knowledge but whose roles require them to have a degree of awareness of geoscience matters (conservation management and designation or water management) were taken through a three day course by our Chief Geologist and Hydrogeologist, including both class room and field based learning. They were introduced to some of the basic principles of geology, trained to identify rock types and taken through some of the different types of geology found in Northern Ireland.

A day at Murlough Bay near Ballycastle and the karstic Loughareema project provided an excellent opportunity to see almost everything learnt in the classroom in reality.

This work was carried out through a Service Level Agreement between the UKRI (BGS) and DAERA (NIEA).



Drifting Apart supported the development of new post primary education resources.

Post-primary Education Resources

Through the Drifting Apart project (see Enhancing Tourism, page 13) we have delivered a comprehensive post-primary education resource to be used by teachers of science and geography at the Marble Arch Caves UNESCO Global Geopark. The resource is based on a model that was developed together with the Magilligan Field Study Centre and CCGHT, and has a proven success rate in helping to deliver key geoscientific concepts safely in an outdoor setting.

The post-primary education resources provide background information to assist those teachers with limited geological knowledge, in addition to site-specific detailed information that is directly linked to the national curricula. The package comes complete with detailed instructions and information and activity sheets for pupils that allow for ease of use in the field.

The resources were accompanied by teacher training sessions delivered at the Marble Arch Caves visitor centre. In the two sessions that were delivered, teachers attended from all across Northern Ireland helping to build a network of geoscience education specialists across the country and improving the capacity for sharing this knowledge amongst their peers.

How we performed

Governance

Under the Minerals (Miscellaneous Provisions) Act (Northern Ireland) 1959, a recurrent three-year Service Level Agreement (SLA) to undertake a research programme exists between the Department for the Economy (DfE), Northern Ireland and the UK Research Institute (UKRI) represented by the BGS and carried out by the GSNI. The GSNI Director reports monthly, quarterly and annually to the DfE on the delivery of this research programme. The governance of GSNI and the performance of its work programme is also audited and reviewed as required by DfE. In addition, as a science Director at BGS, the GSNI Director reports to the BGS Executive.

Procedures Manual

All aspects of GSNI governance is detailed in its Procedures Manual, an internal organisational document, which is updated as required, reviewed and signed by all staff annually and is also audited cyclically by DfE.

Date	Version	Ammendment/Additions
12 June 2018	Version 2017.3	Sick Absence (Page 10) Addition of Appendix 4. How to record and manage staff sick absences. External Enquiries (Page 19) Appendix 1. Updated Organogram
10 October 2018	Version 2017.4	Change of Division Name (Page 9)
19 February 2019	Version 2017.5	GDPR (Page 19) Conference Reporting (Page 15) Incident Reporting and Risk Assessments (Page 11)
27 February 2019	Version 2017.5	Social Media Reporting (Page 20)

Health and Safety

The GSNI Director undertook a three-day course entitled *Safety Management in the Research Environment* and passed the associated Institute of Occupational Safety and Health examination. Health and Safety courses undertaken by all GSNI staff are summarised on page 25.

In the financial year 2018–2019, there were no events comprising accidents, near misses and/or observations. Nor were there any reportable injuries under the RIDDOR regulations (reporting of injuries, diseases and dangerous occurrences regulations) and no formal investigations.

Research Programme - Objectives and Results

The research programme covers three distinct areas: Energy, Minerals and Waste; Information and Infrastructure; Geology and Groundwater. Each of these research areas has clearly defined objectives, including applied research and communication activities, as outlined in the tables that follow and a number of supplementary targets identified within each objective.

Energy, Minerals and Waste		
Objective No.	**Objective**	**Targets Achieved in FY 2018–2019**
1	To support the regulatory and administrative functions of DfE MAPB for mineral exploration development and enhance the knowledge and understanding surrounding mineral resources in NI	Yes
2	To support the regulatory and administrative functions of DfE MAPB for petroleum exploration and development and enhance the knowledge and understanding surrounding oil and gas, and geothermal resources in NI	Yes
3	To develop professional capacity within GSNI, provide technical information and advice on natural resources in NI, and carry out geological and geophysical monitoring to establish baseline parameters across NI in support of energy and economic infrastructure development	Yes

Information and Infrastructure		
Objective No.	**Objective**	**Targets Achieved in FY 2018–2019**
1	Provide DfE with advice on abandoned mines and reduce the associated risks	Yes
2	Increase the awareness of geological hazards and their impact on the NI economy	Yes
3	Provide advice and data to a diverse range of stakeholders and customers to underpin and support DfE	Yes
4	Realise the full potential of geological tourism and the benefit that it has for the NI economy	Yes
5	Deliver a set of free environmental data and information in the context of hazard mitigation and adaptation, environmental management etc.	Yes

Geology and Groundwater		
Objective No.	**Objective**	**Targets Achieved in FY 2018–2019**
1	Undertake baseline geological survey of prescribed areas of NI and provide digital outputs to support DfE and stakeholder functions	Yes
2	Produce thematic geological maps and supporting data for specific stakeholder groups	Work programme moved into 19/20
3	Advance 3D geological models and their uptake by stakeholders at national and city scales to allow visualisation and assessment of the subsurface volume	Yes
4	Identify and undertake collaborative, high impact research and funding bids to support DfE and stakeholder needs	Yes
5	Develop a better understanding and assessment of groundwater as an economic resources	Yes

Publications

A bibliography of papers, reports and abstracts can be found on page 39.

Type	Quantity	Description
Papers	7	Peer-reviewed publications
Reports	6 published, 36 unpublished	Internal and external reports
Conference Abstracts	16	Abstracts for conference presentations
Enquiries	700	Requests for information dealt with through the enquiry system
Responses to planning consultations	176 (included within the 700 total enquiries)	Responses to consultations via the NI Planning Portal
Responses to MAPB	9 EIR and 8 FOI	Responses for inclusion in FOI and EIRs

Data and core store

GSNI data are published on a number of platforms including Spatial NI and Open Data NI. These platforms enable ease of access to the data. A summary of key updates to these services are presented below.

GSNI GeoIndex

- 10k Geology added.
- Mineral Resources added.
- Hydrogeology theme - Karst features added.
- WMS (Web Mapping Services) created for each theme.

www.spatialni.gov.uk

- Data sharing agreement signed with LPS in preparation for Spatial NI relaunch in FY19.
- 10K Geology added.
- >250 Tellus Soil, Sediment and Water grids added.

www.opendatani.gov.uk

- Mineral Resources published.
- GSNI Core and Cuttings published.
- Tellus Geophysics Grids published in ASCII, ESRI and Geosoft Grid format.

Data Ingestion

- The National Geoscience Data Centre (NGDC) ingestion portal was updated to accept Northern Ireland AGS data.

GSNI Core Store

GSNI manages Northern Ireland's core store and sample repository which currently holds over 20 km of rock core from boreholes, approximately 30,000 rock samples collected during geological mapping and 130,000 geochemical samples from the Tellus surveys. In 2018–2019 it received 138 visitors including 2 guided tours of the collection, visits by work experience students, A-level geology students and a core workshop with the University of Birmingham was undertaken. There were also visits for research on the cores from undergraduate students, doctoral and post-doctoral researchers and industry appointments.

Our staff

Learning and Development

Learning and Development (L&D) is primarily managed by the L&D team at BGS who provide and support training in leadership and management, behavioural / soft skills, IT, science, Health and Safety, bespoke coaching, mentoring and other training opportunities as they arise.

All staff carried out mandatory training on the following:

- GDPR awareness (NERC and NICS)
- Display screen equipment awareness (NERC and NICS)
- Fire safety awareness (NERC and NICS)
- Anti-slavery awareness
- Online driver training

In addition, L&D courses were delivered under a number of themes to GSNI staff throughout the year:

Course Type	No. Courses	Total no. of courses undertaken
Leadership and Management	7	10
Behavioural / Soft Skills	2	2
Technical	3	4
Health and Safety	7	29
Bespoke Coaching	1	1

Continuing Professional Development (CPD)

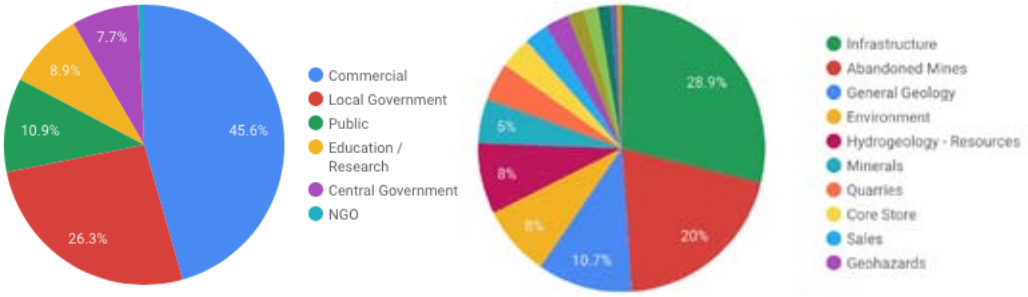
Continuing Professional Development is encouraged and supported at all levels. The CPD highlights for 2018–2019 are as follows:

- One staff member was admitted as Professional Geologist (PGeo) at the Institute of Geologists of Ireland (IGI)
- One staff member graduated with a MSc in Mining Engineering (Professional) with a Distinction
- One staff member, after a year of study and examination, was awarded the Institute of Directors (IoD) Certificate in Company Direction
- Three staff members are working towards Chartership and/or PGeo from either the Geological Society of London or the Institute of Geologists of Ireland

Our clients and collaborators

Clients

GSNI responded to 700 enquiries. Our clients, the sector they represent and enquiry type are collated from the enquiries database and shown in the charts below.



This graphic shows clients scaled by frequency of enquiry. It does not include individuals or clients who have downloaded or accessed GSNI data through GeoIndex, GeologicalMaps.net, Open Data NI or Spatial NI, as information required to identify users is not collected.

Collaborations

GSNI collaborates with numerous stakeholders to deliver a number of strategic objectives. A list of the main collaborations is provided below:

Stakeholder Type	Stakeholder	Description
International	BGS, GSI and GSNI Directors	Memorandum of Understanding between three geological surveys in the UK and Ireland
	GSI, EMD, InvestNI, Geoscience Ireland, Enterprise Ireland	PDAC - a global forum for the minerals industry; GSNI provides data, research and technical advice.
	UNESCO	Work with the UNESCO Global Geoparks council and UNESCO Secretriat to maintain and develop UNESCO Global Geoparks internationally and to raise profile of NI.
	North-East Atlantic Geological Surveys	Partnership of 10 Geological Surveys within the Northeast Atlantic area exploring geological themes where there is a significant overlap in interest.
	Royal Irish Academy	Geosciences and Geographical Sciences Committee
	Irish Geoscience Network	Attend annual meeting hosted by the Institute of Geologists of Ireland, together with 20+ other organisations, and produce annual report on GSNI highlights
	International Union Geological Sciences (IUGS) and The International Geoscience Programme (IGCP)	GSNI reports to IUGS annually on its work programme highlights and participates in national votes as required through the Irish Adhering Committee chaired by GSI
Research	Leeds University	Ongoing visits from staff and students and the development of research projects on ore deposits in NI
	Queen's University, Belfast	GSNI and BGS led brownfield workshop at the QUB Remediate Conference
	iCRAG	Members of the the Irish Centre for Research in Applied Geosciences Governance Board
Central Government	DoJ/Emergency Services	Liaise with DoJ, emergency services and local resilience groups to maintain the Abandoned Mine Emergency Response Plan
	DfI	Leading on the development of the Minerals Working Group
	DAERA/NIWater	Development of the Groundwater Working Group
	DfE/DfI	Representation on UK Minerals Forum together with GB government, industry, professional bodies and NGOs
	All, Strategic Planning Group	Ensure that GSNI interests are well considered as part of the local development plan process
	DfE, HSENI	Northern Ireland Mines Oversight Committee
	OGA, HSE	UK Unconventional Hydrocarbons Regulators Group

Stakeholder Type	Stakeholder	Description
Members of local Assembly (MLAs)	NI Assembley All Party Group on STEM	Forum includes MLAs and representatives of learned societies and professional bodies engaging on STEM and related policies
Industry	IAEG	GSNI holds the Irish Association of Economic Geology Presidency
Professional Body	GSLNI	GSNI Chair the Northern Ireland Regional Group of the Geological Society of London
NGO	Belfast Geologists Society	GSNI contribute to the delivery of fieldtrips and lectures.

Potential Future Collaborations

A number of discussions have taken place with stakeholders in 2018–2019 that are likely to lead to key collaborations with GSNI. A list of these potential future collaborations is provided below:

Stakeholder Type	Stakeholder	Description
Research	QUB	Exploring the possibility of developing geological mapping using machine learning
Research	QUB, Aberdeen	Supervision of new QUADRAT till properties PhD
Research	INQUA	Organisation of 2019 INQUA Congress and Associated Outreach and Fieldtrips
Research	BGS, DfE, DIAS	Space Weather and and Natural Seismic Monitoring Station installation
Research	Li4UK	Research project (funded by Innovate UK Industrial Strategy Challenge Fund) assessing UK lithium potential within the UK to ensure UK supply for electric vehicles.
Central Government	DfI/DAERA	Assessment of NI Coastal Vunerability and adaptation to climate change. Group includes DfI, DAERA and representatives from local councils.
Central Government	Housing Executive	Exploring the potential of developing the shallow geothermal potential for local councils
Central Government	Coal Authority	Potential collaboration on shared knowledge on managing abandoned coal mine sites including public and environmental impact

Our engagement

Finding Planet B at the Northern Ireland Science Festival.

Public Engagement Highlights
NI Science Festival
One of the key events in our public engagement calendar is the NI Science Festival that takes place in February. This annual festival is made up of 180 different events in over 50 venues across Northern Ireland all of which promote science technology, engineering and maths (STEM).

In 2019, we organised three events as part of the NI Science Festival all of which were fully-booked or in the case of a drop-in event, were very well attended. In total, the GSNI NI Science Festival events attracted 450 people.

Finding Planet B: Hosted in association with the Armagh Observatory and Planetarium this family event took the form of a role-play exercise to encourage people to think about the resources needed to sustain life on a planet and the links between geology and those resources.

Dye-tracing experiment: Hosted in association with the Marble Arch Caves UNESCO Global Geopark, this annual event explored the hydrogeology of the complex karst systems of Co. Fermanagh through an active demonstration of a dye-tracing experiment.

Violent Earth: Hosted in association with Newry Mourne and Down District Council, the Violent Earth event took place in Slieve Gullion courtyard, within the confines of the Ring of Gullion igneous complex. This was a hands-on event for children and their families that explored earthquakes and volcanoes and their role in shaping Northern Ireland's landscape.

The Irish Quaternary Cycle
In March 2019, our Quaternary geologist embarked on an epic cycle that took him from one end of the island of Ireland to the other to promote Quaternary geology and landscapes.

The route covered 1000km over 13 days and took in some of the most dramatic and iconic Quaternary landscapes that the island of Ireland has to offer. Along

The Irish Quaternary Cycle.

the way, there were regular tweets about these iconic sites and how they related to and are formed by Quaternary environments and processes.

Geologists from the Irish Quaternary Association, the Geological Survey Ireland and the BGS joined in for parts of the journey and helped promote this inspiring event. A mid-way lecture was delivered at NUI Galway entitled 'Irish Quaternary Cycle – its landscape legacy'.

This event was organised as part of the public outreach programme in the run up to the INQUA (International Union for Quaternary Research) Dublin Congress in July 2019.

Mid-Ulster Public Meeting

As part of the ongoing engagement with the District Councils and in response to the increased profile of mineral exploration, DfE and GSNI accepted an invitation to address a public meeting, at the request of Mid Ulster District Council. The combination of publicity surrounding the application by Dalradian Gold for planning permission to open an underground gold mine in the Sperrins and an airborne geophysics survey carried out in the vicinity of Slieve Gallion in Mid Ulster, had resulted in a public desire for information concerning mineral development. The meeting clarified the role of the planning authority and explained the licensing process, and responses were given to questions that related to environmental concerns. GSNI contributed to the meeting by explaining the exploration process and gave details on the techniques commonly employed by companies operating in Northern Ireland.

The information provided at this meeting has subsequently been delivered to a number of councils, to further engagement and provide accurate information on the work of Minerals and Petroleum Branch and the GSNI in the economic development of our mineral resources.

Fieldtrip Highlights

Friends of the Earth Fieldtrip

We organised an informational field trip for members of Friends of the Earth NI in August 2018. Dedicated to protecting the natural world and the well-being of everyone in it, Friends of the Earth NI is part of an international community that leads campaigns, provide resources and drives solutions to environmental problems.

The fieldtrip was aimed at outlining the scope and scale of the work of GSNI as well as their position within NI Government and the BGS. The fieldtrip included an overview of GSNI, information on mining heritage and our abandoned mines programme, information on the geology of the Antrim Plateau and work that has

Friends of the Earth fieldtrip.

been carried out with the Belfast Hills Partnership, a discussion on landslide research and its impact on the roads infrastructure in Northern Ireland, a summary of groundwater research at Loughareema and of the groundwater monitoring quality at Magilligan, information on geoconservation, tourism and education work with the CCGHT, and a discussion on the geology of the Sperrins and minerals overview.

Solution Mining Research Institute Conference Fieldtrip

GSNI was instrumental in attracting and facilitating the Annual Fall Meeting of the Solution Mining Research Institute in Belfast in September 2018. The conference was attended by 260 delegates. GSNI delivered a presentation and led the post conference field trip (44 participants) along with a core workshop (28 participants).

Birmingham University Fieldtrip

In promoting the rich geology of Northern Ireland as a teaching resource, we assisted staff at Birmingham University who planned and implemented a new undergraduate geology field trip to Northern Ireland. The first trip in November of 2018 was a week-long course involving 60 students and 7 staff. We provided advice during planning of the itinerary for the trip and supplied data. GSNI went to visit the trip in the field at Belshaw's Quarry near Lisburn and at the iconic Waterloo Foreshore near Larne. A one-day introduction to the geology of Northern Ireland and series of core workshops was provided by GSNI at the core store. At this the students were trained how to make methodical records of the sedimentary succession in a graphical log using cores of Sherwood Sandstone Formation from the geothermal test borehole, Kilroot No. 1.

Lectures and Talks

10 fieldtrips led for external stakeholders
6 lectures / talks as invited speaker

Digital Communications

Twitter followers increased by 40% to 1843
Facebook followers increase by 27% to 998

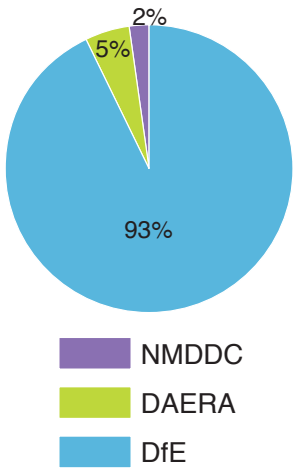
Total impressions 905.8k
Total reach 48k

@GeoSurveyNI

Finance

2018–2019 Resource Spend	Actual	Percentage
Northern Ireland Public Science* (for breakdown see pie chart below)	£ 811,131.00	77.6%
Additional Research	£ 118,451.06	11.3%
BGS Teams (NERC)	£ 43,800.15	4.2%
Professional Development (NERC)	£ 71,659.47	6.9%
	£ 1,084,681.67	

*includes sales of £23,400



Northern Ireland Public Science Income

Northern Ireland Public Science
GSNI predominantly provides public science research services to government departments and NI councils, primarily for DfE as part of its three-year recurrent work programme managed under a service level agreement (SLA), for DAERA under an annual SLA, and in this financial year, for Newry, Mourne and Down District Council (NMDDC) on its UNESCO Global Geopark bid.

Additional Research
GSNI also has research income from the Natural Environment Research Council (NERC) via BGS, EU programmes and the Queen's University of Belfast.

BGS Teams
GSNI staff work on BGS Teams (NERC) either on external research or internal projects.

Professional Development
As GSNI staff are UKRI employees, BGS (NERC) pays for their continuing professional development (CPD) and mandatory health and safety training and updates.

Sales
Most of GSNI's data is free and openly available online but for analogue data or data that needs to be retrieved, we charge for staff time and this accounts for a modest income.

Forward look

New GSNI Science Strategy

In 2019, in response to new challenges and opportunities with regards to resources, hazards and environmental change, we embarked upon preliminary discussions on the development of a GSNI Science Strategy. This strategy would provide a basis for, and be complementary to, future Service Level Agreements that are delivered for the Department as well as with the new BGS Science Strategy (see below) and our work with external partners. In addition, it would provide scope for the organisation to develop and expand, and be better equipped to respond to social, economic, environmental and geopolitical developments that may arise in the future. This process is ongoing and is scheduled to be completed in the 2019-2020 financial year.

BGS Science Strategy

In late 2018, BGS produced its draft Science Strategy that focuses on solving problems around three science challenges:

- Decarbonisation and resources management
- Environmental change, adaptation and resilience
- Multihazards and resilience

The vision for this Science Strategy is to contribute to a safer, more sustainable and prosperous planet that will be fundamental to future research both at home and internationally.

The new BGS Science Strategy was finalised after a period of consultations with stakeholders, staff and the general public and it will be launched in early Summer 2019.

Contribution to EU projects

GSNI is currently a partner in two EU-funded projects, both of which are complementary to our current research programmes and potentially supportive of future research. These projects are in the initial stages of delivery and their outputs will be reported in subsequent Annual Reports. A summary of the main projected outcomes of these projects follows.

Catchment Care

The BGS is a partner on the Interreg funded Catchment CARE project. This is being managed through the Groundwater Directorate. It is a 5 year project that

includes the requirement to install 51 groundwater monitoring stations in the cross border area. This requires significant hydrogeological knowledge and support. Therefore the GSNI's hydrogeologist has been working on identifying areas where there is a need for groundwater monitoring and liaising with community groups, public bodies and landowners to secure permissions to install groundwater monitoring stations. The final network aims to better equip the region to monitor groundwater status and undertake new and innovative research to better understand our groundwater resources.

When the drilling commences, our hydrogeologist will be directly involved in the supervision of the works, ensuring that they are constructed to a high standard. Each borehole will be hydraulically tested and analysed to determine baseline hydrogeological properties and water quality.

Atlantic Geohazards Network (AGEO)

The Atlantic Geohazards Project (AGEO) is funded under the Interreg VB Atlantic Area programme and is for a total of €2.5 million. AGEO is being led by the University of Lisbon and is made up of 6 partners in Portugal, 3 in Spain, 2 in France, 1 in the UK (GSNI) and 1 in Ireland. The project will kick off in June 2019 and will have a 3 year duration.

The overall aim of the project is to establish a cooperation network on geohazard risk prevention, to facilitate the uptake of new technological solutions and concepts into geohazard prevention and disaster management and to create a number of Citizens Observatories to help achieve this.

GSNI is leading one of the pilot projects that aims to establish a Citizen Observatory on Cuilcagh Mountain (part of the Marble Arch Caves UNESCO Global Geopark) to allow for the monitoring of environmental changes as a result of high tourism footfall. This will help to establish effective management practices for geohazard mitigation and will also help to create a better awareness and understanding of geohazard principles amongst Geopark staff as well as visitors.

Publications

GSNI produces numerous publications each year in the form of peer-reviewed papers, reports, conference abstracts, magazine articles, and various online publications. A list of all those produced in 2018–2019 are listed below:

Scientific Papers

Anderson, H., Walsh, J.J. & **Cooper**, M.R. 2018.The geometry and growth of Palaeogene conjugate strike-slip faults in the north of 1 Ireland; the far-field effects of Alpine collision. Journal of Structural Geology, 116, 47-63.

Bonsor, H; MacDonald, A; Casey, V; Carter, R; **Wilson**, P. 2018 The need for a standard approach to assessing the functionality of rural community water supplies. Hydrogeology Journal, 26 (2). 367-370.

Flood, R P, Barr, I D, Weltje, G J, **Roberson**, S, Russell, M I, Meneely, J, and Orford, J D. 2018. Provenance and depositional variability of the Thin Mud Facies in the lower Ganges-Brahmaputra delta, West Bengal Sundarbans, India. Marine Geology, 395, pp.198-218.

Lemon, K. and Gatley, S. 2018. UNESCO Global Geoparks in Ireland. Irish Committee for UNESCO Global Geoparks. 32pp.

Merritt, J., **Roberson**, S. & **Cooper**, M. 2018. A critical review and re-investigation of the glacigenic deposits exposed between Cranfield Point and Kilkeel, Northern Ireland: New evidence on the deglaciation of the northern Irish Sea basin with implications for regional sea-level models and glacial reconstructions. Proceedings of the Geological Association, 129 (5), 583-609.

Delhaye R., Rath V., Jones, A.G., Muller, M.R. and **Reay**, D.. 2019. Quantitative geothermal interpretation of electrical resistivity models of the Rathlin Basin, Northern Ireland. Geothermics, 77, 175-187.

Roberson, S. 2019. Francis Synge (1923-1983), In Giants of the Irish Quaternary, Dalton, C. and McGlynn, G. (Eds). Irish Quaternary Association, Dublin, p.116.

Published Reports

Cooper, M.R., Schofield, D., Haslam, R., **Wilson**, P., Lewis, M., Bloomfield, J. P., Lee, J. R., Baptie, B., Shaw, R. P., **Reay**, D. M., Bide, T. and McEvoy, F.M.. 2018. National Geological Screening: Northern Ireland. British Geological Survey Commissioned Report, CR/17/96. 61pp

Fallas, HC, MacDonald, AM; Casey, V; Kebede, S; Owor, M; Mwathunga, E; Calow, R; Cleaver, F; Cook, P; Fenner, RA; Dessie, N; Yehualaeshet, T; Wolde, G; Okullo, J; Katusiime, F; Alupo, G; Berochan, G; Chavula, G; Banda, S; Mleta, P; Jumbo, S; Gwengwaya, G; Okot, P; Abraham, T; Kefale, Z; Ward, J; Lapworth, D; **Wilson**, P; Whaley, L; Ludi, E. 2018 UPGro Hidden Crisis Research Consortium : project approach for defining and assessing rural water supply functionality and levels of performance. Nottingham, UK, British Geological Survey, 27pp. (OR/18/060)

Lemon, K. and Asmah Rahmah binti Abd Hamid, R. 2018. Evaluation mission report for the aspiring UNESCO Global Geopark Toba Caldera, Indonesia. UNESCO.

Lemon, K and Matsubara, N. 2018. Revalidation mission report for the UNESCO Global Geopark Longhushan, China. UNESCO.

Wilson, Paul.; White, Debbie (2019) Bann Estuary & Magilligan Umbra Groundwater Monitoring – Interim Report 2019. GSNI report for the NIEA.

Wilson, P., Burke, S., Hunter Williams, N.H., O'Connor, S. (2018) Groundwater Monitoring Stations: Site Selection Criteria. Catchment Care Project Report.

Conference Abstracts

Campanyà, J.; Gallagher, P.T.; Blake, S.P.; Hogg, H.; Scanlon, R.; Jackson, D.; Gibbs, M.; **Reay**, D.; Kiyan, D.; Fullea, J.; Rath, V. (2018). SWEMDI: Space Weather Electromagnetic Database for Ireland. Electromagnetic Induction Workshop, Helsingør, Denmark, 12-19 August 2018 (poster).

Reay, D.M. & **Raine**, R.J. 2018. Deposition at the edge of the European Permo-Triassic salt province: basin history and sedimentation in Northern Ireland. Fall 2018 SMRI Conference, Belfast Northern Ireland.

Flood, R., Barr, I., Weltje, G.J., **Roberson**, S., Russell, M., Meneely, J. & Orford, J. 2018. Provenance of the Thin Mud Facies in the lower Ganges-Brahmaputra delta. EGU General Assembly Conference Abstracts 20, 4948

Flood, R., Orford, J., McKinley, J. & **Roberson**, S. 2018. Overcoming the data constraints: a CoDa approach to grain size analysis of tidal--deltaic lihtofacies in the lower Ganges-Brahmaputra delta. EGU General Assembly Conference Abstracts 20, 16493

Lemon, K. 2018. A Tale of Two Oceans; developing a new UNESCO Global Geopark in Mourne, Gullion and Strangford, Northern Ireland. 8th International Conference on UNESCO Global Geoparks. 11th-14th September, Madonna di Campiglio, Italy.

Boomer, I., Azmi, A., **Raine**, R., Copestake, P., Fenton, J. & Page, K. 2019. Late Triassic to early Jurassic stratigraphy & palaeoenvironments from Co. Antrim. 62nd Irish Geological Research Meeting, University College Dublin.

Campanya, J. Gallagher, P.T., Hogg, C., Blake, S.P., Kiyan, D., Scanlon, R., Jackson, D., Gibbs, M., **Reay**, D., Fullea, J. & Rath, V. 2019. SWEMDI_1.0: Space Weather Electromagnetic Database for Ireland. 62nd Irish Geological Research Meeting, University College Dublin.

Hollis, S.P., Doran, A.L., Menuge, J.F., Daly, J.S., Guven, J., Piercey, S.J., **Cooper**, M., Turner O. & Unitt, R. (2019) Mapping Pb isotope variations across Ireland: from terrane delineation to deposit-scale fluid flow. SGA 2019, Glasgow, 27th-30th August.

Hollis, S.P., Menuge. J.F., Doran, A., Piercey, S.J., **Cooper**, M.R., Daly, J.S., Turner, O., Unitt, R. & McConnell, B. (2019) Mapping the basement of Ireland through Sm-Nd and Pb isotopes. Mineral Deposits Studies Group Winter Meeting, 3rd-5th January, 2019. Camborne School of Mines, University of Exeter.

Hollis, S.P., Menuge, J.F., Doran, A.L., Piercey, S.J., **Cooper**, M.R., Daly, J.S., Badenszki, E., Unitt, R., Turner, O. & McConnell, B. 2018. Pb isotope mapping of the pre-Carboniferous basement of Ireland: implications for Zn-Pb mineralization. Resources for Future Generations. 16th-21st June, Vancouver Conference Centre, Vancouver, B.C., Canada.

Jamieson, E., Stevenson, C, **Cooper**, M., & **Raine**, R. 2019. Magnetic Fabrics and Remnant Magnetism of the Fair Head Sill, Co. Antrim: Testing Emplacement Linked to the Great Gaw Fault. 62nd Irish Geological Research Meeting, University College Dublin.

Jamieson E., Stevenson, C., **Cooper**, M., & **Raine**, R. 2019. Magnetic Fabrics and Remnant Magnetism of the Fair Head Sill, Co. Antrim: Testing Emplacement Linked to the Great Gaw Fault. 62nd Irish Geological Research Meeting, 1st-3rd March, University College Dublin.

Lemon, K. and McAuliffe, F. 2019. Celebrating two decades of Earth Science Ireland. 62nd Irish Geological Research Meeting, 1st-3rd March, University College Dublin.

Roberson, S.L. & Hughes, L. 2019. A Quaternary Geological Map at 1:10,000 scale for the Keady Region, Northern Ireland. 62nd Irish Geological Research Meeting, 1st-3rd March, University College Dublin.

Shaw, J.I., Torvela, T. M., Chapman, R.J., **Cooper**, M.R., O'Meara, C., Hollis, S.P., & McKenna, O. 2019. Structural controls on the geometry of the Curraghinalt gold deposit, Northern Ireland: Implications for the Grampian Orogeny. AMEBC Roundup Conference, 28th-31st January, Vancouver, Canada.

Whitbread, K., Ritchie, C., **Cooper**, M., **Raine**, R. & **Reay**, D. 2019. Northern Ireland one 14 new Regional Geological Visualisation Models. 62nd Irish Geological Research Meeting, University College Dublin.

Magazine Articles

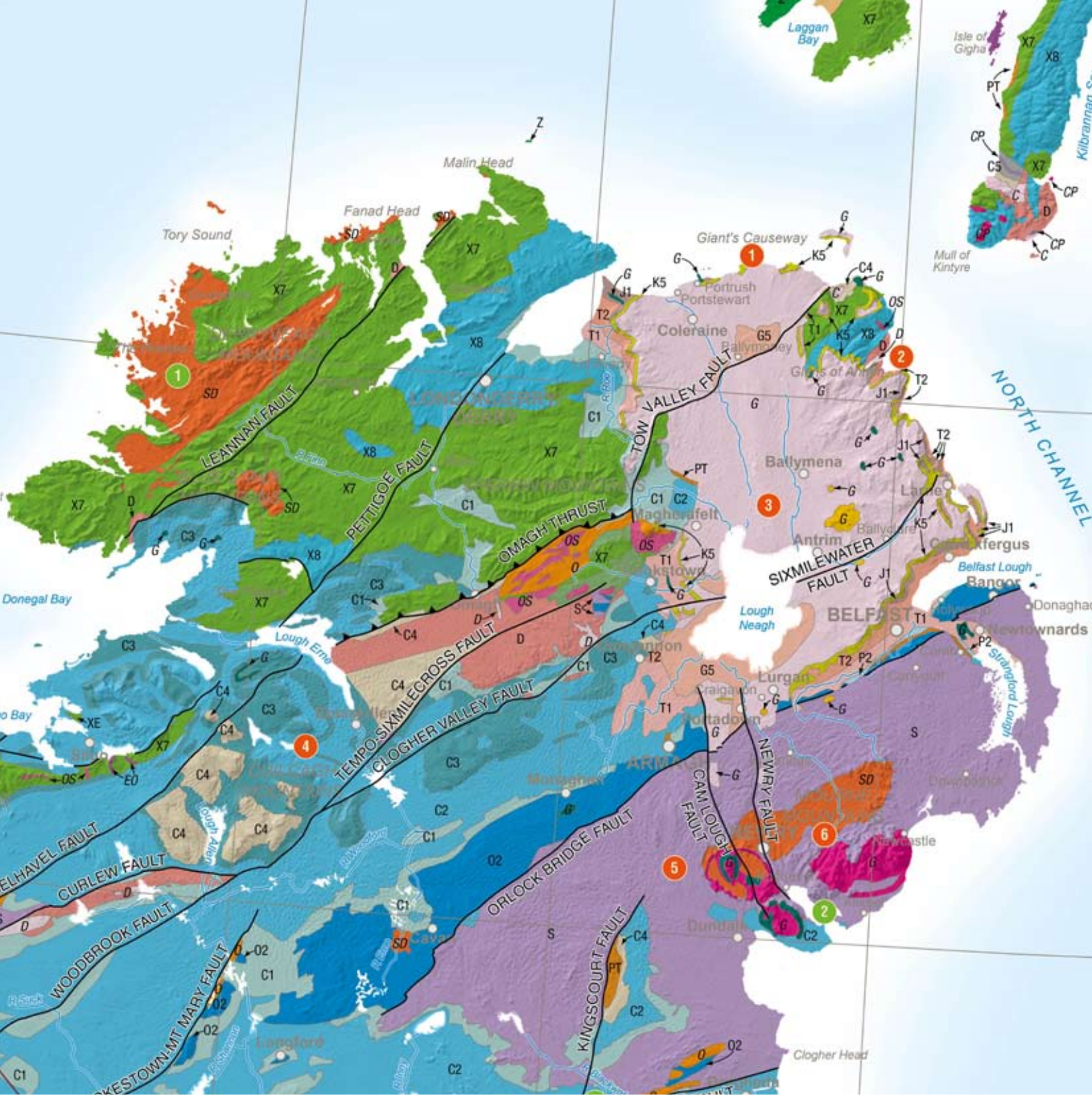
Wilson, P. Re-examining a major resource beneath Northern Ireland. AgendaNI, January 2019

Blogs

Raine, R. & **Parker**, K. Cores reunited: surprising secrets from the GSNI core store. Geoblogy October 2018.

Lemon, K. Football Rocks: World Cup Geology Tour. Geoblogy July 2018.

Strategic partners



Extract from the 1:625k map of the United Kingdom and Ireland

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