



IGRM 2026

Irish Geoscience Research Meeting

# Book of Abstracts

Friday 27th February – Sunday 1st March 2026

School of Biological, Earth and Environmental Sciences

University College Cork



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# IGRM 2026 – Irish Geoscience Research Meeting

## Oral Presentation Abstracts

## IGRM 2026 Keynote Address – Friday 27<sup>th</sup> February 2026

### **Determining the correlates of extinction on long time scales**

Prof. Erin Saupe

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Most species that have ever lived are now extinct. Therefore, to understand the processes that generate life on Earth, we need to look to the past. The record of past life allows us to test whether there are particular factors that make some species more susceptible to extinction than others. I will discuss some of my recent work on the factors that govern marine invertebrate extinction over millions of years, and how these factors can be used to better understand the present-day biodiversity crisis.

## IGRM 2026 Keynote Address – Saturday 28<sup>th</sup> February 2026

### **The NASA Curiosity rover at Gale Crater, Mars: 13 years and counting**

Prof. Susanne P. Schwenzer

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The Curiosity rover landed in Gale Crater, Mars, on the 6th of August 2012 (GMT). Since then, it has traversed over 36 km and made several groundbreaking discoveries, which led to our understanding of the geologic events that shaped the rock record. Curiosity travelled across lakebed and fluvial sediments, and found aeolian rocks, which together give a detailed picture of the evolution of the Gale lake. Investigations of the rock record include structure and texture, geomorphology, geochemistry and organics. The rover has also investigated the atmosphere and its chemistry, and wind behaviour. The rover is, at the time of writing (February 2026) located at the Boxwork terrain, a unique geomorphological feature comprised of ridges and hollows, and will continue its traverse up Aeolis Mons (Mt. Sharp). The rover's findings are summarized regularly in overview and specialist publications, the following of which are excellent starting points to understand the full scope of the mission and its findings:

Grotzinger et al. (2014, 2015a,b; doi:10.1126/science.1242777; doi: 10.1126/science.aac7575; doi:10.2113/gselements.11.1.19);  
Vasavada et al. (2014, and forthcoming; doi:10.1002/2014JE004622);  
Vasavada (2022; doi:10.1007/s11214-022-00882-7);  
Rampe et al. (2020; doi:10.1016/j.chemer.2020.125605);  
Eigenbrode et al. (2018; DOI:10.1126/science.aas9185);  
McAdam et al. (2022, doi:10.1029/2022JE007179);  
Trainer et al. (2019, doi:10.1029/2019JE006175).

Thanks to the engineering and science team!

## **Microbial (and fungal?) ecosystem during a late Ediacaran biotic crisis – insights from the Mohyliv-Podilsky Group, Moldova**

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The Moldova-Podillya Basin (Baltica palaeocontinent), exposed in Moldova, Romania, and Ukraine, contains a nearly continuous succession of Ediacaran siliciclastic rocks and hosts Ediacara-type macrofossils. The maximum depositional age for of the Mohyliv-Podilsky Group was constrained to c. 556.8 to 551.2 Ma. Here we report a moderately diverse assemblage of organic-walled microfossils (OWM) co-occurring with soft-bodied macrofossils and simple trace fossils, from the latter two units exposed in the northeastern Republic of Moldova. The microfossil assemblages include filaments of microbial mat- building bacteria, vesicles with branching hyphae-like structures, budding vesicles similar to yeast, and unicellular morphotypes commonly interpreted as prasinophyte algae. While the mat-builder taxa are common throughout the sequence, the strata displaying an absence of macrofossils host abundant fungal analogue OWM, in Zinkiv and Kalyus members. These intervals are also characterized by the onset of anoxic conditions. The strata overlying the ‘fungal intervals’ contain prasinophyte OWM including *Tasmanites*, often termed ‘disaster taxa’ which occur in abundance during/following intervals of biotic and environmental crises. The fossil distribution in the Mohyliv-Podilsky Group offers an insight into a complex microbial community of primary producers and decomposers, and paints a picture of an ecosystem decline and successive recovery over 5 million years.

## Can we improve models to predict fossil feather colour?

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Melanin pigments, contained within melanosomes, underpin visual communication in feathers either by producing colours directly or by serving as a backing pigment for structural colours. Melanosome geometry has been used to predict the colour of fossil feathers and infer the colour of several extinct birds and dinosaurs, albeit with low accuracy (< 60%). Our study tests the hypothesis that predictive models for feather colour are more accurate if they incorporate data on additional melanosome and feather characters. We used a fully quantitative approach based on spectral data for feather colour, coupled with data on melanosome geometry and synchrotron X-ray fluorescence data on melanosome elemental chemistry. We analysed 293 feathers from representatives of all 44 extant avian orders. We use spectrally supported categories of feather colour: black, brown, grey, dark rufous, light rufous, iridescent, non-iridescent structural colour and penguin-type. Analysis of melanosome geometry reveals significant differences among colour categories. Predictive models for feather colour using geometry alone, however, yield low accuracy (up to 47%). There are no systematic differences in elemental chemistry among feather colours. This is reflected in low accuracy of predictive models (25%). Our results suggest that synchrotron X-ray fluorescence data cannot be used to discriminate colour in modern samples and geometry data alone do not provide enough information to confidently differentiate different colours or predict reflectance spectra. Future attempts to improve the accuracy of colour prediction models should consider the use of different analytical techniques to investigate differences in melanin chemistry.

## Using long telecom fibre cables as geo-sensors: the IMAGFib project

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Telecommunication optical fibre cables carry the majority of the world's internet traffic, crossing oceans, cities and land masses. New sensing technology allows geophysicists to measure how these cables strain in response to ground vibrations, turning each fibre into a dense array of seismic sensors. Recently, fibre sensing has been utilised for a range of geophysical and environmental applications, including the detection of earthquakes, typhoons, vehicular traffic, and even whalesong. The difficulty in accessing long telecom fibres, however, together with the novelty of the instruments, their range limitations and massive data output, has mostly constrained the application of this technology to fibre <100 km long.

In this study, we showcase the first results from the new project IMAGFib (multiscale seismic IMAGing with optical FIBre telecom cables), acquiring high resolution on-/offshore fibre sensing data on commercial telecom fibres in the North Atlantic Ocean, Irish Sea and across Ireland, as well as long range, lower resolution data on a cable connecting Ireland to Iceland. We show how we can use these fibres to detect local and distant earthquakes, quarry blasts, vehicular traffic, marine tides and ocean storms.

With a strong focus on long-range and low-frequency sensing and integration with live telecom infrastructure, IMAGFib is centred on the establishment of fibre sensing as a global geo-sensing tool. Our results using live telecom fibres, and developing sensing technology that uses affordable, off-the-shelf components, represent a key step in advancing efforts to broaden trusted research utilising existing commercial telecom cables.

## **Integrating radon into the 5<sup>th</sup> European Code Against Cancer**

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Radon is a naturally occurring radioactive gas generated from the decay of uranium in rocks, sediment, soils, and water. Long-term exposure to elevated indoor radon levels increases the risk of developing lung cancer and represents the leading cause of lung cancer among non-smokers. Across Europe, radon exposure is estimated to contribute to approximately 19,000 lung cancer deaths each year, making it arguably the most significant geogenic health hazard on the continent.

Despite its well-documented risks and the availability of effective mitigation measures, public awareness of radon remains low, resulting in limited household testing and remediation efforts. Addressing this gap requires stronger integration between geoscience, public health policy, and communication strategies.

The European Code Against Cancer (ECAC) is a flagship initiative of the European Commission that offers evidence-based recommendations for reducing cancer risk through informed lifestyle and environmental choices. The newly released fifth edition (ECAC5), coordinated by the International Agency for Research on Cancer and the World Health Organization (IARC/WHO), represents a major European Commission-funded effort to enhance cancer prevention and health promotion across Europe.

Integrating radon into ECAC5 highlights the essential role of geological knowledge in advancing public health initiatives. It demonstrates how interdisciplinary collaboration, linking geoscience, environmental protection, and health policy, can support evidence-based strategies to reduce cancer risk and address global health challenges rooted in the natural environment.

## Combined UAV LiDAR and radiometric surveys of Ireland's peatlands

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Peatlands cover around 23% of Ireland's land area, comprising approximately 62% blanket bogs and 36% raised bogs. Only approximately 10% of raised bogs and 28% of blanket bogs remain relatively intact, with the rest degraded by drainage, cutting, afforestation, and reclamation.

Ireland's Climate Action Plan has banned large-scale peat extraction, pivoting the focus of peatlands toward nature-based solutions for flood mitigation, biodiversity enhancement, and carbon storage. Despite the policy change aimed to protect Ireland's peatlands, critical data gaps persist on baseline conditions, peat thickness, and carbon storage potential, hindering compliance with EU regulations on Land Use, Land Use Change and Forestry (LULUCF).

Here we present a novel methodology integrating high-resolution UAV surveys with LiDAR and gamma spectrometry across diverse Irish peatland sites. A LiDAR system was used to generate Digital Elevation Models (DEMs), and a sodium iodide (NaI) gamma detector was used to collect gamma spectra and measure the gamma dose rate at 2 m intervals. Empirical Bayesian Kriging (EBK) regression modelling using gamma dose rate and DEM was used to predict peat thickness with between 85-92% accuracy when compared to legacy ground penetrating radar (GPR) data. Our standardised approach enables estimation of the carbon stock for peatlands and peat-rich soils, thereby providing robust data for national carbon accounting and LULUCF reporting.

## **Imaging the Lough Neagh Basin: magnetotelluric insights into subsurface structure (GEMINI Project)**

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The subsurface structure of sedimentary basins in Northern Ireland remains incompletely constrained, despite increasing interest in their potential for low- to medium-temperature geothermal resources. The Lough Neagh Basin exhibits elevated geothermal gradients relative to much of Ireland and contains sedimentary sequences ranging from at least Permian to Upper Cretaceous age, overlain by thick Paleogene basalt flows. Within this stratigraphy, the Triassic Sherwood Sandstone Group is considered a principal geothermal reservoir target, while deeper Permian sandstone units may also be prospective. To better constrain basin architecture and the distribution of electrically conductive sedimentary units, a regional three-dimensional magnetotelluric (MT) investigation was carried out using more than 250 broadband MT stations, including 118 newly acquired sites from the GEMINI (Geothermal Energy Momentum on the Island of Ireland) project. Data dimensionality and lateral variability were assessed using phase tensor and induction arrow analyses. Three-dimensional inversion of impedance tensors and vertical magnetic transfer functions was then performed, with multiple inversion runs used to evaluate sensitivity to starting models and regularisation parameters. The resulting resistivity models consistently image a laterally extensive conductive package beneath a resistive basalt cover. The upper boundary of this unit typically occurs at depths of approximately 0.7–1.0 km and extends downward to roughly 2–2.5 km, with substantial lateral variation in thickness and continuity across the basin. These electrical characteristics are compatible with a combined Mercia Mudstone Group–Sherwood Sandstone Group succession and provide new regional constraints on sedimentary architecture relevant to geothermal assessment.

## Climatic controls on the evolution of herbivory in theropod dinosaurs

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Theropod dinosaurs, such as *Tyrannosaurus rex*, are renowned for their predatory nature, yet several clades independently shifted from ancestral carnivory to omnivory or herbivory, including the therizinosaurs and ornithomimosaurs. It has been hypothesised that this shift was influenced by climatic changes and the evolution of angiosperms, but this has not yet been quantitatively tested. Further, it is not understood how these emerging herbivorous theropods interacted with other herbivorous dinosaurs, especially in avoiding competition.

We examined the interplay between herbivorous dinosaurs and the abiotic and biotic factors in their environment using comprehensive fossil occurrence data, ecological trait data, and a newly-constructed Bayesian time-calibrated supertree of phylogenetic relationships for dinosaurs of the Middle Jurassic—when the first herbivorous theropods appear—to the end of the Cretaceous (~175–66 Ma). These data were integrated with palaeoclimatic reconstructions from a general circulation model (HadCM3L) to directly quantify the 'palaeoclimate niche space' occupied by each major dinosaur group.

Our phylogenetic comparative analyses detected a shift in 'palaeoclimatic niche space' at the base of Coelurosauria, suggesting common traits enabled herbivorous theropods to adapt to cooler climate conditions, leading to their global distributions. We found evidence of niche partitioning between herbivorous theropods and thyreophorans (armoured herbivorous dinosaurs) during the Early Cretaceous, implying resource availability and biotic competition controlled herbivorous theropod distributions. Together, our results support the hypothesis that both climate and biotic competition played a key role in driving herbivorous theropod biogeography.

## Tracking groundwater flow through blanket peat: implications for slope stability

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Recent developments across Irish upland areas have elevated landslide risk in many blanket bogs, yet the widely recognised influence of groundwater on slope stability remains poorly defined. Addressing this knowledge gap has proven especially problematic in areas that display limited evidence of prior disturbance, and where peat-accumulating vegetation may occur. The hydrogeological role played by the acrotelm layer, which contains these plant communities, requires particular attention.

The GSI-sponsored Peatland Hydrogeological Assessment for Slope Stability Evaluation (PHASSE) study implemented a programme of field-based investigations, examining groundwater flow and artificial tracer transport through a relatively intact Irish blanket bog. Conventional views consider groundwater flow through peat a slow process. However, preliminary tracer testing at the Garron Peatland Hydrological Research Facility, Co. Antrim indicated that it could travel more rapidly than previously suspected, even though resulting breakthrough curves revealed non-ideal responses. Repetition of testing, coupled with focused water level monitoring, between March to June 2025, suggested differential water table fluctuations gave rise to variations in hydraulic gradient, that helped explain the responses observed.

Further examination of breakthrough data revealed limited tracer movement during a prolonged dry spell and with an anomalously low water table. By contrast mobility increased following intensive late spring rainfall, with time-lapse electrical resistivity tomography (geophysical) monitoring showing more rapid mass transport, dominated by an acrotelm layer that was highly sensitive to water table conditions. Findings highlight the importance of transient processes in controlling hydrogeological processes that can promote slope instability in areas of rapid groundwater fluctuation.

## **The Fold: an exploratory model for artist–geologist collaboration**

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The Fold is a cross-disciplinary research group founded in 2024 to support sustained exploratory collaboration between artists and geologists. It positions geology as a shared point of inquiry for creative practice, explored through dialogue, open investigation, and hands-on engagement with materials and environments. The group operates independently while maintaining strong relationships with the School of Biological, Earth and Environmental Sciences at University College Cork, enabling access to expertise, collections, and technical resources.

The group brings together artists across dance, film, visual art, poetry, photography, sound, and sculpture, alongside geologists affiliated with UCC, industry, and retired professional practice. This diverse cohort fosters reciprocal exchange, allowing participants to collaborate in ways that encourage reflection, experimentation, and fresh perspectives on geological research.

Co-designed with artists to ensure a creative-led ethos, The Fold meets bi-monthly through seminars, open days, and field trips. These activities provide a structured yet flexible framework in which participants explore materials, landscapes, and ideas without predefined outputs, letting collaborations emerge organically through curiosity and shared interests.

Early collaborations demonstrate the value of this approach. Sculptor Helle Helsner has developed work through fieldwork with structural geologist Pat Meere, alongside a workshop for his new doctoral training network, while painter Orla Whelan is developing a solo exhibition inspired by UCC rock collections, to be presented alongside specimens at the Lavit Gallery in June 2026.

This presentation will outline the development and operation of The Fold, highlight forthcoming activities, and invite geologists interested in exploratory creative collaboration to engage with the group.

## Tellus about Tellus in 2026

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Tellus is Geological Survey Ireland's national geophysical and geochemical mapping programme. Over the last 15 years we have been gathering soil, sediment and stream water samples for multielement analysis and flying airborne EM, magnetic and radiometrics sensors across the country. 2026 will mark the completion of the airborne survey along with continued data releases of geophysical and geochemical data. These launches include new geophysical data for county Clare, geochemical datasets for urban surveys in Cork, Limerick, Galway and Waterford and new regional soil survey data from the southeast and mid-west.

Over the next couple of years, we will release final blocks of data as they become available and create merged maps and datasets with all-island coverage. In addition to the collection, processing and release of new data, we have also been busy using the data to improve our geological understanding and in developing new tools and outputs. We plan to continue our collaboration with Teagasc in the next phase of the Terra Soil project to develop agronomic indicators and grain size data from the soil samples. We also have plans to undertake a pilot litho-geochemistry project.

## Modern and fossil foliar mercury concentrations reflecting atmospheric mercury levels

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Gas emissions during large-scale volcanism, which are comparable to the modern anthropogenic emissions, significantly affected the composition of Earth's atmosphere, not only by increasing atmospheric  $p\text{CO}_2$  but also by enhancing the concentrations of gaseous or aerosol-bound toxic metals, like mercury (Hg). Present-day environmental pathways of mercury are highly monitored; however, environmental Hg fluxes and atmospheric concentrations are largely unconstrained both for the pre-industrial and geological past.

As the terrestrial flora acts as an intermediate sink in the natural mercury cycle, and deciduous leaves gain their Hg concentration dominantly through direct atmospheric uptake, we propose a new approach to reconstruct changes in atmospheric Hg concentrations by analysing Hg levels in modern and fossil leaf tissue. The natural variability of Hg concentration was determined in modern *Ginkgo biloba* leaves from different localities with varying atmospheric Hg levels. Subsequent analyses of the Hg concentration in fossil leaf-cuticle from the Triassic–Jurassic mass extinction event (~201 Ma) spanning Astartekløft (Greenland) sedimentary succession, which has a temporal correlation to the volcanic activity of the Central Atlantic Magmatic Province (CAMP), show significantly higher plant Hg concentrations than the observed modern natural variability. This suggests that fossil plant tissue may be used to examine Hg variations in past atmospheres and to detect the timing and environmental signature of past volcanic activity.

## **Morphologic evolution and storm response to Booterstown spit, south Dublin Bay**

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Sea level rise and increasing storm intensity pose growing risks to highly urbanised coastlines, particularly where sedimentary landforms provide natural protection to critical infrastructure. In south Dublin Bay, the Booterstown spit has developed over the past two decades into a vegetated sand spit and back-barrier lagoon that now functions as an important natural coastal defence. This study examines the formation and morphodynamic evolution of the spit, and its response to recent extreme storm events. Analysis of historical aerial imagery, topographic profiles, grain size data, and hydrodynamic and meteorological records indicates consistent north-westward progradation of the spit, reflecting dominant northward longshore sediment transport in the bay. Southeasterly winds and waves, combined with sufficient sediment supply, have driven growth from an initial sand bar to an approximately 415 m long sand spit. Storm impact analysis from 2019-2025 shows early resilience, with vegetation recovery and restabilisation following storms from 2020-2023. However, a sequence of storms from 2024 onwards resulted in limited vegetation regrowth and the development and expansion of a washover fan. LiDAR profiles reveal elevation changes of nearly 1 m and landward sediment intrusion of up to 34.7 m into the back-barrier lagoon. These findings highlight the importance of vegetation succession, storm sequencing, and proactive multi-annual monitoring for managing dynamic, dissipative coastal systems in urban environments.

## Current controversy on fluffy fossils: new insights into the evolution of feathers and skin from dinosaurs and other Mesozoic reptiles

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Feathers are remarkably complex integumentary structures that underpin the evolutionary success of birds. Since the mid-1990s, our understanding of feather evolution has been transformed by a series of revolutionary discoveries of feathers in non-avian reptiles, including non-avian dinosaurs, pterosaurs, and more recently, the early-branching drepanosauromorph reptile *Mirasaura*. Co-evolution of feathers with other anatomical features of the integument has traditionally been overlooked, but new research indicates the stepwise and spatially localized acquisition of key anatomical features that characterize the integument of extant birds. Despite these advances, progress continues to be stymied by research biases, poor integration of data from fossils and extant vertebrates, and technological limitations. Here, we critically examine recent progress in overcoming these research barriers and outline key directions and approaches for future research.

## The formation of metasomatic halos around crystallizing spodumene pegmatites

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Spodumene ( $\text{LiAlSi}_2\text{O}_6$ ) in pegmatites is currently the principal global source of lithium, especially for electric vehicle batteries. Spodumene pegmatites are commonly surrounded by metasomatized wall rock that may be enriched in Li, Rb, Cs, B, Be, Ta and Sn, elements also enriched in the pegmatites themselves. Metasomatic halos vary greatly in size, intensity, and spatial regularity. Drawing on observations from southeast Ireland, the Austrian Alps and Nova Scotia, Canada, we present empirical evidence that the fabric, or lack thereof, in wall rocks is a key factor in controlling halo characteristics. Wide (1 – 100+ m), often macroscopically visible, halos develop in mica schists with strong planar fabric. In contrast, isotropic wall rocks, including granite and metabasite, host narrow (usually <1 m, often <0.1 m) halos both at pegmatite contacts and isolated from pegmatites, often localized into small shear zones, and in more distal veinlets. It has been argued that halo formation accompanies pegmatite emplacement, explaining the common scarcity of muscovite and other hydrous minerals in early pegmatite crystallization. However, halo chemistry in southeast Ireland is more consistent with formation after spodumene crystallization. We demonstrate how expulsion of halo-forming fluids may be related to the chemical evolution of these fluids within crystallizing pegmatites. In particular, we explore the relationship between halos and patchily developed parts of spodumene pegmatite intrusions that consist mainly of Li-poor saccharoidal albite and quartz-muscovite alteration, whose formation has been ascribed to autometasomatism.

## **Bedrock mapping of the offshore Irish coastal and shelf regions through standard and semi-automated techniques**

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With a reinvigorated interest in offshore geology driven by the critical need for evidence-supported strategies for marine spatial planning - including offshore renewable energy (rock anchors for floating wind devices), marine infrastructure and marine protected areas - a detailed reappraisal of the shallow marine bedrock geology of Ireland is urgently needed. At present only a low-resolution solid geology map is available on the EMODnet portal, however, with the acquisition of novel high-resolution multibeam echosounder (MBES) data from the INFOMAR programme, significant improvements can be made. The INFOMAR MBES dataset allows for an extension and improvement of the geological interpretation of the shallow marine regions but must rely on computer algorithms to effectively facilitate the task. The Carraig Bháite project used machine learning techniques (FCNNs) to separate sediment cover from bedrock outcrops thus delineating the mappable areas, and discriminate bedrock into different morphotypes. Machine learning produced confidence scores and provided repeatable methodologies for future application. In addition, the bedrock morphotypes was further characterised coupling semi-automated geomorphometry techniques with manual supervision, quality control and classification. This allowed the classification of the bedrock and major structural elements over the offshore West Irish shelf.

## Quantifying rates and identifying drivers of rocky cliff retreat along Ireland's west coast

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More than half of the Irish Coast can be considered rocky, featuring cliffs and shore platforms in various environments and comprising different lithologies. In the face of climate and sea-level change, cliff retreat and its drivers had become an important research subject. For investigating coastal changes on millennial scales, modelling maximum likelihoods of possible exposure histories of shore platforms based on beryllium-10 (<sup>10</sup>Be) concentrations have become regularly used in the past decade. We applied <sup>10</sup>Be analysis at four sites along Ireland's west coast to study the interaction between local environment, changes in relative sea level (RSL) and cliff retreat. Our preliminary results indicate decreasing erosion rates during the Holocene, with till cliffs and hard rock cliffs retreating a few centimetres and millimetres annually, respectively. Depending on factors such as lithology, local RSL change, and exposure to the North Atlantic, initial retreat rates at each site were as much as one order of magnitude higher. Our findings indicate that slower rates of RSL change lead to decreasing cliff retreat rates, raising the question of whether retreat of certain cliff configurations has shifted from marine-driven erosion towards more terrestrially driven erosion, and, if so, whether we might anticipate a shift back towards marine forcing as global sea-level rise accelerates.

## Palaeo-glacier archives in western Ireland as a vantage on abrupt climate shifts during the last glacial termination

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Numerical models simulating potential future climate scenarios are first tested against different proxy-based reconstructions of past climate events. In the North Atlantic region, palaeoclimate datasets indicate that the last glacial-interglacial transition was interrupted by multiple rapid, high-amplitude reversals (Heinrich Stadial 1 and Younger Dryas), during which mean annual temperatures are inferred to have returned to nearly ice age conditions.

Terrestrial glacial deposits provide a high-resolution perspective on abrupt climatic shifts, thanks to the direct relationship between glacier mass balance and melt-season temperature. Previous studies in the Northern Hemisphere based on <sup>10</sup>Be surface-exposure dating of glacial landforms indicate that glacier retreat occurred during HS1 and during the YD, at odds with the paradigm of year-round stadial cooling. Therefore, mapping former extents of palaeoglaciers at different locations and dating their fluctuations allows us to determine whether this pattern is consistent throughout the Northern Hemisphere.

Our study focuses on the west coast of Ireland, where climate is directly influenced by the interaction of the mid-latitude westerlies and North Atlantic Ocean. New <sup>10</sup>Be-dated glacier records from Co. Mayo indicate ice retreat during Heinrich Stadial 1. This pattern agrees with emerging dated glacial records from elsewhere in Ireland and Europe but raises questions about the seasonality of temperature changes during the termination.

## **In the eyes of monsters: testing the phylogenetic affinity of the enigmatic *Tullimonstrum* from the Mazon Creek Lagerstätte (Carboniferous, USA)**

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Melanins are black to orange pigments that are widespread in extant organisms and play important roles in coloration and physiology. In vertebrate animals, melanin is produced by cell organelles called melanosomes. Evidence of melanosomes has been reported from fossils, from the Cambrian to the Pliocene. Recent advances in our understanding of melanosome attributes, including distribution, abundance, morphology and chemistry, have highlighted strong tissue- and taxon-specific signals in extant and fossil vertebrates, prompting the use of those melanosome attributes to investigate phylogenetic affinities in fossil problematica. *Tullimonstrum gregarium* is an enigmatic marine animal from the Mazon Creek Lagerstätte (Carboniferous, USA), of uncertain phylogenetic position. Previous studies focusing on the preservation of ocular melanosomes have suggested two hypotheses: a vertebrate affinity supported by available melanosome geometry data, and an invertebrate affinity supported by data on the melanosomal metallome and histology. Here, we test the hypothesis that *Tullimonstrum* is an invertebrate using Raman spectroscopy and further analysis of melanosome geometry. We analysed the eyespots of 41 fossil specimens from the Mazon Creek Lagerstätte, including known vertebrates and invertebrates. Raman analysis reveals that only vertebrate eyespots preserve a chemical signature consistent with melanin. SEM analyses confirm that melanosomes are preserved exclusively in the eye spots of fossil vertebrate specimens. Critically, our analysis of melanosome geometry in diverse extant fish suggests that *Tullimonstrum* has a strong affinity with jawed vertebrates (gnathostomes). The study is a cautionary tale, highlighting how our interpretations of soft-bodied fossils can differ based on the analytical techniques used.

## Carbon isotopic study of the Mississippian in Ireland

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Past changes in Earth's global carbon cycle are recorded as stratigraphic variations in the carbon isotopic composition of sedimentary archives. Integrated chemo-, bio- and lithostratigraphic study of sedimentary successions therefore allows for constraining links between past carbon cycle perturbation and climatic/environmental/depositional change on a local–global scale. Furthermore, carbon-isotope chemostratigraphic studies can be employed as high-resolution correlation technique, commonly at a finer resolution than biostratigraphy, to correlate sedimentary successions within and between basins.

Here, we first present new organic carbon isotope ( $\delta^{13}\text{C}_{\text{org}}$ ) data from deep-time, Mesozoic sedimentary records to show the power of this technique for stratigraphic correlation (and past carbon cycle reconstruction), as well as to assess preservational and geological influences on the sedimentary signature. We then employ this technique for the first time on Irish Carboniferous successions in outcrop (Rush foreshore outcrops) and core (GSI Grangegorm core). With this, we assess whether organic carbon-isotopic study of the Irish Carboniferous can be reasonably used i) for high-resolution chemostratigraphic correlation within the Dublin Basin, and ii) to assess Tournaisian–Visean global carbon cycle evolution by reference to the global Mississippian carbon isotope record.

## Two andesitic magmas in contact in Erg Chech 002: a reassessment of the ancient meteorite's creation and chronology

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The meteorite called *Erg Chech 002*, which was found in Algeria in 2020, is one of very few meteorites made from andesite. It crystallized  $4565.56 \pm 0.12$  Myr ago, or just  $1.80 \pm 0.01$  Myr after the beginning of the solar system, making it the oldest-known igneous meteorite and a key to the magmatism and chronology of the earliest small planetary bodies. Here we add to its story. We identify, describe and discuss a little-known second kind of andesite within the meteorite. This second andesite is finer-grained than the well-described 'normal' andesite in Erg Chech 002, it is more Ca-poor and Mg-rich, and it has spectacular spinifex-like dendritic plates of pyroxene rather than pyroxene prisms. Its undulating, apparently chilled, contact suggests that, while molten, it mingled with 'normal andesite' magma which was cooler. It carries embayed green megacrysts of uniformly Mg-rich orthopyroxene that evidently were dissolving, sinking and indenting the magma-magma interface leaving possible way-up evidence. We suggest that its dendritic texture reflects substantial, rapid undercooling of initially super-heated ( $>1270^\circ\text{C}$ ) magma that, perhaps, became super-heated internally by radioactive decay of enriched aluminium-26. We tentatively propose that the meteorite's initially published age of  $2.255 \pm 0.013$  Myr after the beginning records a hit-and-run impact and associated fragmentation and quenching following  $\sim 450,000$  years of post-crystallization equilibration at  $\sim 950^\circ\text{C}$ . Finally, we speculate that andesite genesis was not via  $\sim 25\%$  melting of primitive solar system rock, as is widely supposed, but via  $\sim 75\%$  crystallization of primitive magma-ocean slurry.

## **Influence of vein geometry and fracture opening mode on grade distributions at the Curraghinalt gold and polymetallic deposit, Northern Ireland**

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Quartz vein-hosted gold and polymetallic deposits are widely documented to exhibit complex, heterogeneous distributions in grade. Effectively targeting high-grade ore is becoming increasingly important in the context of declining mined grades globally and the strategic importance of recovering Critical Raw Materials (CRMs) from these deposits. To investigate what primary parameters control grade and ore shoot geometries, we present a relatively rare case study of a quartz vein-hosted gold-polymetallic deposit that has accommodated little progressive deformation after its initial formation: the Curraghinalt deposit in the Sperrin Mountains of Northern Ireland. The vein system is easily characterised as it is exposed in a series of underground exploration tunnels and consists of: (1) sheared veins that dip moderately NNE and record moderately ENE-plunging slickenlines, indicative of normal-dextral kinematic movement; and (2) bridging dilational jogs and horsetail branches that are sulfide rich and dip steeply to subvertically NE. Au, Ag, Cu, Bi, Te, Fe, and S grades in underground channel and drill core samples can be systematically linked to variations in fracture opening mode and vein infill texture, with vein geometry further accounting for a significant degree of variance in Au, Bi, and most likely Te grades; wall rock alteration does not appear to be significant. From these observations, we conclude that the paleostresses and kinematics of wider syn-ore fracturing processes are the first-order control on ore grade and vein infill texture, with the dilation of jogs and horsetail branches and associated fluid pressure drops forming particularly favourable structural ‘traps’ for ore precipitation.

## **Engaging the public with geoscience through the Ireland's Fossil Heritage project: optimising impact 2024 – 2025**

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Ireland's Fossil Heritage is a STEM engagement project based at the School of Biological, Earth and Environmental Sciences at UCC, since 2019. The project aims to foster interest in palaeontology and Irish fossils, but also in STEM subjects and the natural world. The project is characterised by its multi-faceted strategy for reaching the public, including a co-created programme of school workshops, a STEM kit loan scheme, public exhibits and exhibitions, STEAM collaborations, public campaigns, public walks and a citizen science strand. The project also offers diverse online resources including an interactive fossil map of Ireland and walking trails. During the most recent project cycle (2024–2025), we interacted with > 34,000 people. The highlights of this cycle of the project are the development of revised and curriculum-integrated school workshops, a STEM kit loan scheme which allows teachers to deliver STEM hand-on activities in their classrooms autonomously and a nationwide public campaign which resulted in an updated fossil map of the island. Critically, participation in the project changed attitudes to STEM, as pre- and post-workshop assessments show that school students report more positive attitudes towards science and fossils following participation. Qualitative feedback from public audiences after our various events and exhibitions further supports the project's positive educational and societal impact. Evaluation of project activity demonstrates a sustained increase in Google searches in Ireland for fossil-related terms.

## Exploring the potential for carbonate carbon stable isotope ratio ( $\delta^{13}\text{C}_{\text{carb}}$ ) chemostratigraphy as a new tool for stratigraphic correlation in the Irish Carboniferous

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Correlating the various Carboniferous basins throughout Ireland has proven to be a challenging task over the years. Classic approaches include detailed sedimentological and palaeontological work. This contribution aims at exploring the potential for the use of an additional tool for stratigraphic correlation in these basins: carbonate carbon stable isotope ratio ( $\delta^{13}\text{C}_{\text{carb}}$ ) chemostratigraphy. The underlying principle supporting the use of this technique is the idea that global carbon cycle perturbations can be captured in the  $\text{CaCO}_3$  skeletons of carbonate producing organisms, which today make up large parts of the Carboniferous limestones. Here we present initial  $\delta^{13}\text{C}_{\text{carb}}$  data from the Grangegorm Core drilled in 2021 by the Geological Survey Ireland in the Dublin Basin for geothermal exploration purposes. We evaluate the preservation of its  $\delta^{13}\text{C}_{\text{carb}}$  original signature, and its suitability for regional and global correlation.

## **A complete offshore geomorphological map of Ireland: the NoMansTif project**

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Geomorphological mapping of offshore landforms is fundamentally essential for habitat mapping and environmental protection, offshore renewable resource management, national security and marine planning. Over 90% of the designated Irish seafloor has been surveyed by the INFOMAR programme, but prior to the NoMansTif project (Novel Mapping of the Shallow Water INFOMAR Data Set: Towards Irelands First Shallow Water Atlas), a geomorphological map of Irish seafloor was lacking. Through NoMansTif - a high resolution geomorphological map of the Irish shelf (<200 m water depth) has been released created using semi-automated algorithms and fully-automated CNN approaches.

This presentation outlines progress towards a geomorphological map for Ireland's deep water territories (>200 m water depth). This region presents unique challenges including significant noise/artifacts and variable data resolution. Using semi-automated (GIS-based) and fully automated (CNN-based) techniques, it was found that semi-automated techniques produced the best results in successfully delineating geomorphological features such as canyons, canyon-channels, submarine channels, volcanic and carbonate mounds, seamounts, escarpments, sediment bedform fields, and planar seabed. The NoMansTif project is on target to deliver a comprehensive Irish deep-water geomorphological map. Ireland will be the first country to produce a geomorphology map of its entire offshore region.

Arosio, R., Wheeler, A.J., Sacchetti, F., Guinan, J., Benetti, S., O'Keeffe, E., van Landeghem, K.J., Conti, L.A., Furey, T. and Lim, A., 2023. The geomorphology of Ireland's continental shelf. *Journal of Maps*, 19(1), pp.2283192-2283192.

## Using traditional and modern petrographic methodologies to understand the provision of friction in roadstone aggregates

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The overall frictional performance of road wearing courses is directly related to the microtexture of the included stone particles. Recent studies have developed a detailed understanding of how mineralogy, petrography, and microstructure in different rock types, used as high performance surfacing in Ireland, is related to the provision of frictional resistance.

Whilst the surface microtexture of any stone particle is predominantly a function of grain-size, it is mostly the distribution and shape of surface topographic peaks and dales (asperities) that determines its frictional properties.

In addition to traditional petrographic and engineering testing, novel modern methodologies, such as digital metrology and Raman spectroscopy, have been developed to provide a better understanding of how the petrography of stone particles affects surface microtexture.

The results of these studies have led to the introduction of changes to the Irish Standard for road surfacing (TII\_DN\_PAV\_03023) to be utilised by road engineers to design sustainable surfaces by matching frictional demand with available local resources.

## **Controls on subsurface fracture apertures: learnings from core and downhole datasets in the Dublin Basin**

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Fractures provide critical fluid flow pathways in otherwise low porosity and permeability lithologies. The hydraulic aperture of a fracture is a key control in the volume of fluid it can channel, with variations in aperture having a cubic influence on the flow moving through it. However, data on in-situ natural fracture apertures at reservoir conditions are difficult to obtain due to chemical and mechanical aperture enhancement in outcrop, and lack of datasets at depth, where confining pressures are likely to be substantially greater, acting against aperture opening compared with surface analogues.

Using core and optical image logs obtained from the walls of two deep geothermal boreholes drilled within the Mississippian carbonates of the Dublin Basin, we demonstrate how depth, local structure, and alteration influence natural fracture apertures in the subsurface. We found that fracture aperture augmentation in the near surface was linked with karstification, while at greater depths both structural deformation and lithology-selective dolomitisation were spatially correlated with wider apertures and evidence of fluid flow in downhole logs. Fracture apertures outside of altered and deformed intervals continually reduced with increased depth, presumably as confining pressure increased. These results demonstrate the role structural diagenesis plays in enhanced aperture widening in the subsurface, with implications for resource management and targeting across deep carbonate reservoirs worldwide.

## **PETM (?) submarine volcanism: the petrology of Eriador Ridge and Edoras Bank**

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Seismic profiles suggest that the North Atlantic Large Igneous province is responsible for volcanic features on the Rockall Rise including an overlapping, aligned seamount chain forming the Edoras Bank on the edge of Ireland's continental crust. The nearby Eriador Ridge, on oceanic crust, has been postulated as a remnant segment of the Mid-Atlantic Ridge abandoned in the early opening of the North Atlantic. Magnetic anomalies on the ocean crust surrounding Eriador are inconclusive but support a Palaeogene-Eocene age with thickening of the crust suggesting abnormal heating supportive of a Palaeogene-Eocene Thermal Maximum formation theory. Dates for vast Edoras Bank volcanic complex have not been obtained. Whatever the validity of these interpretations, no groundtruthing or visual inspections of these edifices have been achieved until now.

In July 2025, Eriador and Edoras were visited by the RV Celtic Explorer with the Holland 1 ROV. Visual inspections revealed exposed bedrock above tallus slopes, pillow lava fields and rocky escarpments. Video footage, improved multibeam echosounder coverage and rock samples were collected for geochemistry, petrology and Ar/Ar dating (submitted). Both features are composed of mafic rocks with Edriador showing greater fractionation and silica. Petrologically Eriador samples shows porphyritic basalts with abundant microcrysts and rare glomerocrysts. Edoras shows a greater variety of lithologies including porphyritic basalts, vesicular basalts, anorthosite and gabbros also with microcrysts and plagioclase-dominated glomerocrysts as well as sericization. Edoras Bank is topped by lithified sandstones.

Similar petrology and composition point to comparable magma sources and the overprinting of seamount volcanism on Eriador is not discounted.

# IGRM 2026 - Irish Geoscience Research Meeting

## Poster Presentation Abstracts

## What geochemistry and plant microfossils tell us about the aftermath of Earth's largest mass extinction

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Earth's most severe biotic crisis of the Phanerozoic, the End-Permian Event (EPE, ~252 Ma), profoundly disrupted global environments and reshaped ecosystems for millions of years. Understanding how life recovered from this catastrophe is essential for interpreting the long-term consequences of climatic change. This study integrated high-resolution plant microfossil records with stable carbon-isotope ( $\delta^{13}\text{C}$ ) geochemistry to reconstruct Early-to-Middle Triassic plant assemblages within the Sydney Basin of Australia, situated at ~70°S during the Early Triassic.

By anchoring floras to the global chronostratigraphic framework with  $\delta^{13}\text{C}$  measurements, we produced an age-controlled continental record of ecosystem change spanning the entire Early Triassic. South-polar floral communities re-established relatively quickly (<100 thousand years) post-mass extinction. Subsequent climatic perturbations, most prominently the Late Smithian Thermal Maximum (~250 Ma), the Smithian-Spathian cooling event (~249.4 Ma), and the Early-Middle Triassic cooling Event (~247.5 Ma), brought ecological turnover of the standing floras. These shifts coincided with global carbon-cycle instability, as shown by a pronounced shifts in the  $\delta^{13}\text{C}$  signal across this time interval.

This study demonstrates how climatic volatility can reorganize continental ecosystems over multimillion-year timescales. More broadly, it underscores the value of deep-time fossil archives for communicating the long-term consequences of environmental change and for informing society's understanding of present-day climate trajectories.

## Palaeontology of the Oyster Hall Breccia Formation, County Kerry

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A significant collection of marine fossils has been made from Mississippian (late Viséan) strata between Tralee and Fenit, in County Kerry. These bioclasts occur in prominent carbonate breccias hosting much larger lime-clasts, which are mapped locally as the Oyster Hall Breccia Formation [OHBFm]. Despite being effectively reworked in these breccias, fossil preservation is sometimes spectacular, with many fine details preserved such as spines on brachiopod shells. The invertebrate fossil fauna also includes crinoids, echinoids, corals, bryozoans and gastropods. Vertebrates are represented by fish and conodonts; the latter group indicates placement in the late Asbian to Brigantian regional substages. The OHBFm appears to have developed in close association with Asbian-aged carbonate mudmounds in a mid to outer shelf setting. The sedimentology and broad range of fossil taphonomies observed in the OHBFm suggest the fossil fauna was remobilised and transported by a series of sudden, highly energetic gravity-induced debris flows on the flanks of these bioherms, where the cohesive muddy matrix encased bioclasts and facilitated the preservation of delicate features.

## **Paragenesis of the Munster Basin Upper Devonian polymetallic veins, SW Ireland**

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The Late Paleozoic Munster Basin of SW Ireland is predominantly composed of the non-marine, siliciclastic-dominated, fine-grained alluvial sediments of the Upper Old Red Sandstone magnafacies. Copper mineralisation in this sedimentary basin is important, either as abundant polymetallic vein deposits or relatively minor sediment-hosted stratiform. In the polymetallic extensional veins, the ore phases include chalcopyrite, tetrahedrite-tennantite, galena, and molybdenite, with gangue minerals commonly quartz, carbonates, chlorite, barite, and Fe-oxides. Re-Os geochronology on molybdenite revealed a pre-Variscan orogeny vein generation (ca. 367–366 Ma), corresponding to Upper Devonian basinal extension, and a syn-Variscan vein generation (ca. 316–312 Ma). However, the role of these two major geodynamic events on copper mineralisation was never studied in detail, such that the vein-hosted copper mineralisation and remobilisation processes are still poorly understood. A collection of mineralised vein samples from the western Munster Basin are characterised using Raman spectrometry to better define the mineralised vein paragenesis. We have identified a pre-mineralisation chlorite (chamosite) veinlet generation. This generation appears to have been reopened by the quartz-rich polymetallic veins in a syntaxial manner, such that the chlorite rims the polymetallic veins. These veins show evidence of Variscan deformation (i.e., buckling, stylolites, brecciation, tectonic cleavage development). This set of new observations is critical as: 1) the presence of chlorite may allow for precise geothermometry on the veins, and 2) the veins appear to have used the same conduits, which may indicate important physicochemical variations (e.g., T, P, pH,  $fO_2$ , etc.) and/or a pivotal switch in the fluid source(s).

## Rocky coast monitoring and community engagement: integrated approaches from the CMAP Project

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This research presents elements of the cross-border project, CMAP (Coastal Monitoring and Adaptation Planning) developed under the PEACEPLUS Programme. CMAP is led by Ulster University and involves twelve partners from across the island of Ireland, including universities, research institutes, and local authorities. The project aims to foster sustainable development, strengthen education, and support a resilient marine economy by improving understanding of coastal processes and enhancing community engagement in adaptation planning. By generating robust environmental data, the project supports evidence-based decision-making while actively involving local communities in monitoring and resilience strategies. The Geological Survey of Northern Ireland (GSNI) is leading on the development of a scalable and replicable blueprint for rocky coast monitoring by contributing expertise on rocky coasts through detailed investigations at three contrasting sites.

- At Downhill, County Derry, a basalt cliff environment susceptible to erosion, a novel monitoring protocol is being developed, inspired by recent research in France. This integrated approach combines seismometers, a meteorological station, a pressure sensor deployed on the platform, a camera, LiDAR surveys, and GNSS beach monitoring to characterise the influence of hydrodynamic forcing (waves, tides, and storm conditions) on cliff fracturing and rockfall-driven erosion.
- At Kearney, County Down, the focus is on a gravel barrier coupled with a rocky shore platform. The study will examine how the combined presence of the rock platform and gravel barrier dissipates wave energy and may contribute to shoreline stability and back-barrier protection.
- At Cushendun, County Antrim, repeated LiDAR surveys are used to quantify the morphological evolution of the bay-scale headlands, with particular focus on the hard-rock metamorphic lithologies forming the northern headland, while terrestrial laser scanning (TLS) is employed to investigate fracture development and detailed morphological changes within the conglomerate cave-forming softer lithologies, at the southern end of the bay.

Across all sites, citizen engagement is central to the project, ranging from community workshops and coastal field days to citizen-science initiatives such as CoastSnap in Cushendun. Together, these case studies highlight the value of integrated monitoring and cross-border collaboration for building coastal resilience in a changing climate.

## Deep-sea ferromanganese crusts and polymetallic nodules formation: Tropic Seamount environmental setting and development

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Tropic Seamount is an Eastern Atlantic guyot possessing thick ferromanganese crusts and polymetallic nodules. To understand the palaeoenvironmental development of this locality, high resolution multibeam echosounder bathymetry and backscatter and 23 TOPAS-acquired seismic lines were analysed. Seven morphological classes, and eight seismic (sub)facies delineating five seismic units were identified across the seamount's summit. Correlation between data reveals a link between geomorphologies and seismic units, allowing for the reconstruction of the morphogenetic processes which have likely originated the landforms. Fe-Mn crusts are preferentially located along the summit's portions parallel to the SE and NW flanks, while sediment drifts cover the widest portion of the summit. Tropic Seamount originated as a volcanic island; after the end of its eruptive activity, it began to sink. Wave action washed away the islands' terrigenous sediment. Tropic Seamount may then have experienced reefal deposition, with the formation of syn-depositionally cemented hardgrounds. When its summit encountered the oxygen minimum zone (OMZ), reduced Fe and Mg ions underwent oxidation and subsequent precipitation on the seamount's summit, forming Fe-Mn crusts and nodules. The onset of the glacial/interglacial climate pattern and the consequent aridification of the Sahara may have led to ocean fertilization due to iron-rich continental dust input, which in turn may have enhanced pelagic sedimentation. Finally, submarine resedimentation processes have reshaped the seamount's summit. The reconstruction of the palaeoenvironmental changes of the Tropic Seamount set the Fe-Mn deposits into context with a palaeoenvironmental development model which also reveals areas sedimentation as well as seabed exposure.

## **Bedrock map and structural enhancement of the Longford-Down terrane, Northern Ireland**

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As part of the Geological Survey of Northern Ireland's ongoing commitment to delivering strategic improvements to its baseline datasets, we are undertaking a suite of enhancements to the Longford-Down geological map covering counties Armagh and Down. Bedrock mapping of the area is currently mostly at 1:250,000 scale and was completed in 1997 prior to acquisition of the Tellus Project airborne geophysical and geochemical surveys. Since then, the Geological Survey of Ireland (GSI) have made improvements to their adjoining 1:100,000 bedrock geology in County Monaghan.

Here we present a series of improvements to the Ordovician-Silurian, Leadhills Supergroup, Gala Group and Hawick Group greywacke-dominated tracts, and intervening Moffat Shale Group packages. These regional scale enhancements have been achieved through interpretation of Tellus Project electromagnetics (EM) dataset combined with targeted field truthing. Interpretation of Tellus magnetics has also proven useful in determining where significant Late Caledonian and younger Paleogene faults are located.

Other improvements to the map include inclusion of previously mapped and interpreted linework for the Late Caledonian Newry Igneous Complex, and the Paleogene Mourne Mountains and Slieve Gullion complexes, acquired mainly through previous and ongoing academic research collaborations.

## **Assessment and applications of INFOMAR bathymetric data for mapping seafloor features in Dublin Bay**

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INFOMAR (*Integrated Mapping for the Sustainable Development of Ireland's Marine Resource*) aims to supply information about the physical, chemical and biological features of Ireland's coast and shelf territory. The DCEE funded project is jointly run by Geological Survey Ireland and The Marine Institute and aims to map Ireland's seabed using high resolution multibeam echosounder. The project is a continuation to the Irish National Seabed Survey (INSS) which ran from 2000–2006. Apart from bathymetry, the project also provides information on sediment type, sub-bottom structures, marine habitats and shipwrecks.

The combination of these datasets has been applied to assess a given study area surrounding Dublin Bay at broad, medium and fine scales. The high-resolution bathymetry data reveals detailed surface expressions of key features. These datasets are freely available and hold significance in the face of Dublin's future relating to marine spatial planning and the impacts of climate change. Furthermore, INFOMAR data is actively shared with the European Marine Observation and Data Network (EMODnet) allowing access to users further afield than Ireland.

The bay also holds cultural and social importance, recognised by UNESCO and the Dublin Bay Biosphere project. INFOMAR data can be used to increase public knowledge of offshore features and habitats. To understand the underwater cultural heritage within the bay, shipwreck surveys have been carried out on all 68 shipwrecks within the study area, with identification carried out when possible. These surveys and subsequent models can be used to share the history that lies offshore the designated biosphere area.

## What life (as we know it) could look like on Mars

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The potential for life on Mars, past and/or present, has been a driving force for those in geomicrobiology and biogeochemistry. Since Viking 1 landed at Chryse Planitia in 1976, we have a growing body of knowledge about Mars, its geology, geochemistry, geomorphology, radiation, days/sols, even its weather. Since the mid-1970s on Earth, there have been great scientific advances in aseptic techniques, genetic sequencing and in branches of taxonomy e.g. bacteriology. Evolution proceeds in a plethora of different directions and there are many limitations to geological and conceivable comparisons for biology between Earth and Mars. Our planet's still partially molten interior, copious surface waters and our protective atmosphere all present obvious, but merciful, challenges for us. We explore the interplay between our deeper understanding of Martian lithologies, regoliths and clays with the possibility of life from early in the evolution of Mars up to the present time. We work from extant epilithic and endolithic biota of Earth across similar geochemical settings to suggest organism Bauplans and analogues that are potentially relevant for identifying biofilms and other lifeforms on Mars. We review experiments and learnings on the exposure of saxicolous lichens, other cryptogams and bacteria to cosmic radiation in space and in laboratory experiments on Earth. The recognised igneous lithologies in common between Mars and Earth are tholeiitic basalts and potassic granites. The mineral groups phyllosilicates, zeolites, phosphates, pyroxenes plus olivine are therefore the main substrates for informing what life on Mars could look like.

## Feldspar Pb isotopes constrain tectonic models for the Lewisian Complex (NW Scotland)

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Archaean gneisses of the Lewisian Complex (NW Scotland) were originally interpreted as a contiguous block variably deformed and metamorphosed) during the Palaeoproterozoic Nagssuqtoqidian/ Laxfordian collisional orogeny. Some authors have subdivided the Lewisian into multiple terranes [1] while a simpler “two-plate” model has also been proposed [2] involving the collision of the Rae and North Atlantic cratons.

Feldspar Pb isotopic analyses of Lewisian Archaean gneisses have identified three geographically-distinct Pb isotopic domains favouring the two-plate model. West of Shetland, borehole samples define a paleogeochron representing the pristine foreland of the Rae Craton [3]. Gneisses from most Scottish mainland and Outer Hebrides outcrops fall on a Pb isotopic growth curve with a  $^{238}\text{U}/^{204}\text{Pb}$  ( $\mu$ ) value of 7.8. These are Rae craton rocks extensively reworked during the Laxfordian and constitute the orogen’s lower plate. The upper plate, exposed mainly in the Assynt to Gruinard regions of the mainland, is distinctive in Pb isotopic terms, with a higher  $\mu$  value of 8.5 and represents the North Atlantic Craton. The Laxfordian suture separating the latter two Pb domains is marked by high strain zones and generally by belts of juvenile Palaeoproterozoic rocks.

A fourth Pb isotopic domain is identified within the sub-Moinian “Lewisianoid” inliers in the hanging wall of the Moine Thrust (previously considered equivalent to the Lewisian Complex) are consistent with a Baltic affinity [4].

[1] Friend & Kinny 2001 Contrib Min & Pet,

[2] Park 2005, 2022 Scot. J. Geol,

[3] Holdsworth et al. 2019. Precam Res,

[4] Strachan et al. 2020 Geology

## **Shoreline Dynamics along Tramore Bay, SE Ireland: A 24-Year Analysis of Coastal Change (2000-2024).**

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Coastal erosion is a significant environmental challenge in Ireland and globally, threatening the stability and resilience of coastal shorelines. As part of Geological Survey Ireland's National Shoreline Change Assessment, this study examines erosional and accretional patterns in Tramore Bay, County Waterford, over a 24-year period (2000-2024). An integrated research approach was employed, combining time-series analysis of aerial and satellite imagery with manually digitised vegetation lines. Shoreline change rates were analysed using Digital Shoreline Analysis System. Significant wave height and mean wave direction data were retrieved from the SWAN model and Met Éireann storm event records were examined. Geomorphological baseline information was sourced from original GSI maps. Tramore Bay is comprised of varied coastal deposits, with a sandy spit known as Tramore Bay and an intertidal area called Backstrand. The results show high erosion along the eastern side of the sand spit, moderate erosion to the west, and relative stability at the back, with localised accretion. Preliminary findings identified erosion hotspots where rates exceeded the average of -1 m/yr over the 24-year period. Severe erosion occurred between 2011 and 2014, particularly along the eastern side and was linked to major storm activity in late 2013/2014 and Storm Darwin. These findings provide insights into the spatio-temporal variability of the Tramore Bay and indicate a correlation between increased storm activity and enhanced erosion. This study supports coastal management, evidence-based decision making, and provides a crucial foundation for future monitoring frameworks and for the Inter-Departmental Group on National Coastal Change Management Strategy.

## **SmartScape: Distributed Strain Sensing on a Dublin City Telecom Fibre for Smart City Applications**

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Rapid urban growth in Dublin is increasing pressure on transport networks, construction, and environmental management, creating a need for improved observations of urban processes at surface and subsurface levels. This study presents the first stage of a project exploring whether existing optical telecommunication fibres can be repurposed as a city scale sensing system using Distributed Strain Sensing (DSS). DSS allows optical fibres to record ground vibrations continuously along their length, providing a cost-effective way to monitor urban activity over large areas.

We present results from a pilot deployment on a dark fibre ring of approximately 80 km crossing the city centre, residential neighbourhoods, tram lines, and the Port Tunnel. Several recording configurations were tested, with the most stable setup continuously recording around 60 km of fibre for 10 days.

The analysis is preliminary and focuses on data quality and signal content. The measurements clearly capture signatures of road traffic, LUAS activity, and distant earthquakes, including a magnitude 7.4 event in the Philippines. Signal quality decreases beyond about 30 km from the recording unit, where noise becomes dominant, highlighting limitations related to signal attenuation and fibre ground coupling.

Ongoing work focuses on improving signal identification and linking fibre measurements to their geographic locations. These results will be combined with independent datasets such as traffic records and environmental noise maps. This study establishes a baseline for what anthropogenic and environmental information can realistically be extracted from early-stage urban fibre optic sensing deployments.

## Predicting CH<sub>4</sub> emissions and removals from Irish peatlands

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Peatlands in their natural condition are a critically important carbon sink. In Ireland, peatlands cover approximately 23% of the country, but 84% has been degraded through draining to facilitate conversion to forestry, agriculture or harvesting for fuel [1]. This research will combine multiple data streams and apply advanced statistical and process-based modelling methods to advance knowledge of the key factors governing peatlands as a CH<sub>4</sub> source/sink. We will introduce insights into the project which aims to develop a research framework to help enhance existing methods to refine national-level peatland CH<sub>4</sub> emission and removal estimates. Once complete, this study is expected to significantly advance understanding of peatland CH<sub>4</sub> dynamics and support the role of Irish peatlands in climate change mitigation strategies.

### Acknowledgements:

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## **The Sedimentary Geochemistry and Paleoenvironments Project (Phase 2)**

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The Sedimentary Geochemistry and Paleoenvironments Project (SGP) is a research consortium that seeks to address questions of environmental evolution across Earth history through statistical analyses of the sedimentary geochemical record. The project is centred around open data and community-driven development of tools and resources. The Phase 1 dataset primarily included Neoproterozoic-Palaeozoic shale data. Phase 2, released in February 2025, expanded coverage to include more Palaeoproterozoic and Mesoproterozoic samples and, in addition, focused on better accommodation of carbonate data. The dataset was built through the direct involvement of >200 researchers worldwide in academia, government, and industry. It also incorporates data from United States Geological Survey (USGS), Geoscience Australia OZCHEM, the Alberta Geological Survey, and the Deep-Time Marine Sedimentary Element Database (DM-SED) compilation. Here, we describe the complete Phase 2 dataset in terms of age, geography, lithology, and other geological characteristics, and highlight examples of its use. The dataset is available through our search website and API and includes 126,006 samples and 4,132,371 geochemical analyses, representing the largest publicly available sedimentary geochemical data resource. It supports research in a broad range of fields, including geochemistry, palaeontology, sedimentology, tectonics, Earth history, and paleoclimate, and we welcome participation from new collaborators.

## **A re-evaluation of the Colonsay gneiss, Inner Hebrides, Scotland, and its role in the late Laxfordian Orogeny**

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This study of the Colonsay gneiss is testing a tectonic model [1] for the late Laxfordian orogeny which envisages that accretion of an arc, i.e. the c. 1805-1780 Ma Rhinns Complex, deformed and metamorphosed the Archaean Lewisian Complex (NW Scotland).

Previous work [2] included the Colonsay gneiss within the Rhinns Complex, but new field and isotopic data point to a separate origin:

- U-Pb zircon geochronology dates the Colonsay gneiss to  $1880 \pm 10$  Ma, significantly earlier than the c. 1780 - 1805 Ma Rhinns Complex.
- Colonsay gneiss has calc-alkaline chemistry and strongly-depleted Hf isotopes pointing to a juvenile arc origin in contrast to the syenitic composition and less-depleted Hf of the Rhinns Complex.
- Colonsay pegmatites cutting F2 folds of the D1 gneissic fabric show that the latter occurred prior to c. 1800 Ma, whereas the Rhinns Complex foliation on southern Islay formed after c. 1780 Ma [4].
- Pb loss in zircon at c. 735 Ma, likely occurred during D3 deformation coincident with the Knoydartian Orogeny northwest of the Great Glen Fault[3].

These results permit the Colonsay gneiss to represent the colliding arc responsible for the late Laxfordian orogeny, and to be the intruded host of the Rhinns Complex. However, the record of Knoydartian events and its tectonic contact with the Colonsay Group allow the Colonsay gneiss to be part of the Lewisian Complex, displaced by the Great Glen Fault.

[1]Park 2022, Scot J Geol;

[2]Muir et al. 1994, Tr Roy Soc Ed;

[3]Tanner & Evans 2003, JGSL;

[4]Marcantonio et al. 1988 Nature.

## Multi-sensor AUV Seabed Mapping for Offshore Wind: Insights from the DMAND Project

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Ireland's offshore wind development relies on seabed characterization methods that are consistent, repeatable, and applicable for both site assessment and environmental monitoring, while minimizing survey time, costs, and environmental impact. These metrics are critical within Ireland's first sub-national marine spatial plan, the South Coast Designated Maritime Area Plan (SC-DMAP), where repeatable seafloor data is a key enabler of informed decision-making processes.

The DMAND (Unmanned Marine Mapping and Monitoring for Offshore Energy) project addresses this need through the active development of fully unmanned workflows for offshore mapping and monitoring. Within DMAND, autonomous underwater vehicles (AUVs) deploy to collect high-resolution bathymetry and three-dimensional side-scan sonar (3DSS) data, as well as hydrodynamic measurements, supporting offshore wind de-risking and replicable seabed characterization. Integrating workable speed and altitude close to the seabed, AUV surveys aim to produce spatially self-similar datasets that can be compared across various campaigns.

This poster shows one element of the DMAND project, focusing on multi-sensor seabed mapping using AUVs. It highlights how the combined use of bathymetry and 3DSS enables detailed characterisation of seabed texture, morphology, and spatial variability relevant to offshore wind site assessment.

Overall, this contribution demonstrates how multi-sensor AUV surveys within DMAND can support reproducible, lower-impact seabed characterization and provide decision-relevant information for offshore wind development and monitoring in Ireland.

## **Using AI and fibre optics to enhance seismic event detection and classification in the Irish National Seismic Network**

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The Irish National Seismic Network (INSN), operated by the Dublin Institute for Advanced Studies (DIAS) and co-funded by DIAS and the Geological Survey Ireland (GSI), monitors regional seismicity using 12 permanent stations. From January 2025 to present, the INSN detected 75 regional earthquakes and over 2,100 quarry blasts.

As roughly half of all the regional earthquakes detected by the INSN occurred in northern Donegal, a temporary network of seismic stations has been installed in this region between December 2024 and August 2025. The purpose of this deployment is primarily to improve earthquake detection and hypocentral accuracy in Donegal. The data recorded by this new network, combined with the deployment of community-based Raspberry Shake seismometers of the QuakeShake outreach program, has resulted in a significant increase in the number of earthquakes detected in northern Donegal.

The vast majority of the seismic events detected by the INSN are however anthropogenic in nature, mainly consisting of quarry and mine blasts. A tool to discriminate between seismic event classes (i.e. earthquake vs quarry blast) based on S-wave spectral ratios has been in operation for several years at the INSN. In the past year a new automated, machine-learning based approach to seismic event classification has been implemented at the INSN, which is able to correctly identify quarry blasts and earthquakes with 99% and 95% accuracy respectively.

We also examine new developments in seismic event detection, namely Distributed Acoustic Sensing (DAS) of fibre-optic cables and its potential for enhancing the INSN's earthquake detection ability.

## **AgriTherm: A Spatial Analysis of Northern Ireland's Agri-Food Sector and Geothermal Energy Resources**

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Northern Ireland, in line with the rest of the United Kingdom aims to achieve a 100% reduction in greenhouse gas emissions (GHG) by 2050 compared to a 1990 baseline. Currently the heat sector within Northern Ireland accounts for 59% of all energy consumption, and the agriculture sector is responsible for 29% of Northern Ireland's GHG emissions.

Geothermal energy has been utilised globally within the Agri-Food sector, across a range of temperatures (20°C–100°C+), providing year-round readily available heat supporting decarbonisation within the dairy, horticulture, drying and distillation industries. All these sectors are prevalent within Northern Ireland.

Northern Ireland has three main lithologies with geothermal potential: Carboniferous Sandstones, Radiogenic Granites, and Permo-Triassic Sandstones. These Permo-Triassic sandstones extend across much of the North of Northern Ireland and across into Great Britain, reaching as far as mainland Europe, such as the Netherlands, where they are utilised for horticulture. Despite this opportunity to decarbonise heat in Northern Ireland's highest emitting sector, geothermal energy remains undeveloped and underutilised.

Due to the spatial limitations on transporting heat, it is essential that end-users are co-located with the resource. The project aims to demonstrate the potential for direct use geothermal energy within the Agri-Food sector in Northern Ireland by utilising spatial analysis approaches to match geothermal prospectivity with existing carbon-intensive agri-food applications to maximise decarbonisation potentials. By further exploring the reasons for the lack of uptake to date, the project aims to develop tangible stakeholder-focused approaches to support the adoption of geothermal energy across the Northern Ireland agri-food sector.

## **Tellus' new shallow topsoil geochemistry maps of midwest Ireland: observations and insights**

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Tellus is Geological Survey Ireland's national mapping programme that collects and examines geophysical and geochemical data across the island of Ireland. Tellus' geochemical data of the topsoil provides a baseline from which future changes in soil composition can be compared whilst also providing insights into regional bedrock geology, mineralisation, anthropogenic activity and environmental processes.

GSI has completed geochemical mapping of the shallow topsoil of the midwest (G10) block of the national survey. This block spans an area of 13,476 km<sup>2</sup> across counties Clare, Cork, Galway, Kerry, Limerick, Offaly, Tipperary and Waterford. Between 2023 and 2024 a total of 3,499 sites were sampled with one shallow topsoil sample, referred to as 'A' and one deeper sample, referenced 'S' taken per 4km<sup>2</sup>. Each sample was analysed for over fifty elements, pH and organic matter by ALS Minerals Ltd. This data was then mapped using Inverse Distance Weighting (IDW) in ArcGIS Pro. Data for S samples will be available next year.

This poster presents a few of the interpolated maps of the shallow topsoil geochemistry across the midwest block, highlighting some interesting geochemical anomalies such as those associated with the Clare shales, the Limerick volcanics and mineralisation and the mining industry (Zn, Pb) e.g., Silvermines. This demonstrates that these geochemical data, which are freely available, are a hugely useful tool to identify geological, anthropogenic and environmental effects on topsoil geochemistry. Furthermore, these data have a wide range of potential applications across multiple sectors, including agriculture, mineral exploration and environmental management.

## **A magnetotelluric investigation of seismicity in northern Donegal, Ireland**

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Although seismic activity in Ireland is relatively low, persistent microseismic events have been documented in the Fanad Peninsula in northern County Donegal, north-west Ireland. In 2013, a magnetotelluric (MT) survey was conducted across this region with the primary objective of identifying potential geothermal fluid pathways associated with fault-controlled secondary porosity within crystalline bedrock. The survey area encompasses the known epicentres of local microseismic events, providing an opportunity to investigate the relationship between subsurface electrical structure and low-magnitude seismicity. Electrical resistivity of Earth materials is sensitive to mineral composition, alteration, temperature, and the presence and distribution of fluids. Given the primary objective of the MT survey, resistivity modelling focused on identifying reductions in resistivity (increased electrical conductivity) associated with secondary permeability pathways related to microseismic activity. These anomalies were expected to appear as sub-vertical conductive features resulting from the presence of fluids along faults. As part of the survey, broadband MT data, covering frequencies from 300 Hz to 0.001 Hz, were collected on a loose grid of six parallel profiles oriented southeast–northwest, with up to seven sites per profile. The study focuses on resolving these fault-controlled resistivity structures and assessing their spatial relationship to the distribution of microseismic hypocentres. Interpretation and modelling of the dataset are ongoing, and the resulting resistivity models, along with their geological and seismological implications, will be presented.

## **Characterizing the rock alteration associated with vein-hosted Cu sulphide mineralization at Allihies, SW Ireland, using short-wave infrared hyperspectral imaging**

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The Allihies region on the Beara Peninsula, SW Ireland possesses a mining history for structurally controlled vein-hosted Cu sulphide mineralisation. Structural and chronological control of the deposit has been studied extensively. However, the spatial distribution of fluid alteration in the host rock and associated mineralogy remain unstudied. Thus, the ongoing research aims to study the country rock alteration with regards to mineral assemblages, different phases, and the extent. The current study focusses on the Mountain Mine, Allihies, which the mineralisation/lodes are oriented in E-W and N-S. Systematic sampling either side of the main E-W vein across the alteration zone will help determining the fluid alteration variations from image spectra. Hyperspectral imaging data from the Shortwave Infrared (SWIR) wavelength range (900–2500nm) is used for carrying out the analysis. Several alteration minerals linked with the Cu mineralisation have been recorded, such as chlorite, muscovite, siderite, calcite, dolomite, kaolinite, montmorillonite, and goethite. All these minerals except goethite have their diagnostic absorption features in the reflectance spectra, in SWIR range. The current study uses laboratory HS data from a rock scanner. Principal Component Analysis (PCA) is used for extracting the relevant information from the large amount of hyperspectral information. Subsequently, Minimum Wavelength Mapper (MWM) is incorporated for further analysis of dominating mineral occurrences identified from the PCA. Mineral groups such as chlorites, carbonates, and clays possibly be differentiated of the existing sericitic and propylitic alteration phases, as one moves away from the veins into the country rock.

## **Tidal and aperiodic flushing of Lough Hyne, a hypoxic saline lough with restricted exchange**

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The tidal and aperiodic flushing of a restricted saline lough that tends towards deep water hypoxia, Lough Hyne, was assessed in the summers of 2024/2025 in situ hydrographic timeseries measurements.

Seasonal stratification followed well known variability with oxygen reduction below the thermocline during summer months, with a thermos/oxycline depth between 20–30m by August. With limited vertical mixing, deeper layers experience reduced oxygen over time with occasional anoxia recorded. Significant oxygen depletion was recorded at 13 m, shallower than previously recorded which indicates advection of low O<sub>2</sub> waters from the deeper layer. The exact mechanism is currently uncertain and requires further study.

Although extensive studies have been carried out on this lough in relation to the effect of hypoxia and resident ecosystem response, knowledge is somewhat unknown of the hydrographical dynamics driving these conditions. Such research projects are important for the management of Irish coastal bodies and work to protect them against climate change and its effects.

## **The role of LiDAR and water table dynamics, in the restoration of Béal Átha Fearna bog, Co. Sligo**

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The 2025 Article 17 report showed that Active Blanket bogs were in Unfavourable Conservation status, with their condition declining. [1] It is therefore imperative to actively restore and conserve blanket bogs. Identifying the threats to blanket bogs which disrupt their ability to create peat, is essential knowledge for restoration efforts. The threats facing Béal Átha Fearna bog is drainage, these drains were cut for peat extraction and change of land use (farming/forestry). Methods used to gather necessary data, to inform restoration plans, are drain mapping and profiling, piezometer installation and LiDAR drone survey. This data combined with other various data (e.g. climate data, Met Éireann), are intended to be utilised to improve our knowledge of site hydrology and water dynamics, and where best to deploy drain blocks. This work aims to aid in the extension and restoration of active blanket bog on-site, while contributing to the national understanding of restoring severely degraded blanket bog sites in the West of Ireland.

Acknowledgements: The authors are grateful to Éire Drone Services for their LiDAR survey, and providing maps, processed data and images for analysis.

[1] NPWS (2025) The Status of EU Protected Habitats and Species in Ireland: Article 17 Reports. 4<sup>th</sup> assessment submitted under the Habitats Directive. NPWS, DHLGH. URL: <https://www.npws.ie/publications/article-17->

## **Understanding the regional structural framework and controls on Ni-Cu-Co mineralization, in the Ringerike Metallogenic Province, Norway**

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The Ni-Cu-Co mineralisation in Ringerike, Norway, is associated with a suite of magmatic intrusions occurring within the Eastern Kongsberg Complex (EKC). The complex formed during the Gothian Orogeny, and the most significant local Ni-Cu deposits are predominantly correlated with this magmatism (Orvik et al. 2025). Historically, nickel and copper were produced in this area until 1920 (Mathiesen & NGU, 1977).

In recent years, both industry and academia have shown renewed interest in the region. Current publications have advanced the understanding of the tectonic evolution of the EKC and its implications for mineral exploration (Orvik et al. 2025). Mansur et al. (2025) discussed the formation and constraints of the most significant past producers, the Ertelien and Langedalen deposits. However, beyond several master's theses, there has been little to no focus on the other intrusions hosting the mineralisation, the mineralisation itself, and the structural framework and controls on fluid flow.

The current license holder, Kuniko Limited, carried out a range of exploration activities and defined a Mineral Resource Estimate (MRE) for the Ni-Cu-Co Ertelien deposit (Kuniko Limited, 2024). The remaining magmatic intrusions received less attention, with large but disparate datasets being produced over the years.

This PhD aims to utilise the collected data, supported by field and laboratory work, to increase the understanding of the structural regime across the region and the controls on mineralisation. Current research aims to use open-access data to develop a Machine Learning model capable of detecting outcropping bedrock to aid efficient exploration planning.

## **Constraining the structure of the Leinster Granite using joint seismic, gravity and magnetotelluric inversion**

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The Leinster Granite is the largest of the Caledonian batholiths of Ireland and Britain and is a key target for Enhanced Geothermal Systems (EGS) exploration, as well as a potentially significant source of critical elements. Effective exploration of the Leinster Granite requires a good understanding of the subsurface geometry of its constituent plutons and of the state of the underlying lithosphere. We reprocessed legacy seismic and magnetotelluric (MT) data from the LEGS (Leinster Granite Seismics) 1999 wide-angle survey and the IREATHERM project, and integrated them with a dense land gravity dataset. A 3-D joint inversion of seismic first-arrival traveltimes and gravity data was performed using a velocity–density coupling based on the Nafe–Drake relation, with density constraints from laboratory measurements on local rock samples. Two MT profiles were initially inverted in 2-D; the resulting models were interpolated and combined with a regional resistivity model to build the starting model for 3-D inversion. The 3-D MT inversion was constrained using cross-gradient and the joint total variation regularisation with seismic and gravity models. The resulting model resolves the lateral extent and internal architecture of the Leinster batholith, providing improved constraints on its crustal-scale structure.

## **An initial analysis of 320 million-year-old micro-coprolites from Doolin**

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This is the first record of fossil micro-coprolites from the Carboniferous Period of County Clare. In this research I am looking at micro-coprolites from a phosphate layer exposed on the coast at Doolin.

My aims were:

- To see if sediments found near Doolin contain micro-coprolites (fossil faeces)
- To classify samples of micro-coprolites from the Phosphate Member of the Clare Shale Formation into different shapes and sizes with a view to seeing if it is possible to suggest the makers of the coprolites.

Having removed any limestone in the sediments I examined them under a powerful digital microscope. I picked out the coprolites and placed them in a new dish. I recorded the length, width and the shape of each coprolite.

Micro-coprolites were found to be relatively common in the samples examined and 55 specimens were measured. The shape of the coprolites was fairly consistent, and most (90%) could be described as cylindrical, while some were curved. The cylindrical micro-coprolites ranged from 0.23-0.57mm in length and 0.07mm -0.19mm in width. The curved micro-coprolites ranged from 0.42-0.67mm in length and 0.12-0.24mm in width. It is likely that some of these specimens were broken and were originally longer.

Since the sizes are consistent it is possible only one producer was responsible for them. Due to the fact that the samples are from a marine environment the micro-coprolites could have been produced by, small crustaceans, annelid worms, small fish, conodonts, gastropods, bivalves or some other unknown maker.

## **Stratigraphy in three deep boreholes in Cork drilled in 2025**

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The boreholes were drilled in Cork City and at Cork Airport by the Geothermal unit of the Geological Survey Ireland.

Boreholes GSI-25-002, Cork 1, and GSI-25-003, Cork 2, were drilled in the Cork County Council machinery yard near the city centre. Cork 1 terminated at 305 m, Cork 2 at 176.2 m. Both boreholes were drilled into lower Carboniferous limestone of the Cork Syncline near its East-West trending axial trace and in proximity to an approx. North-South orientated fault. Both cores show fracture zones and a steep tectonic fabric. The Stratigraphy consists of extensively recrystallized Waulsortian limestone facies of the Little Island Formation and the Cork Red Marble Formation. Red-coloured beds were penetrated in both boreholes.

Borehole GSI-25-004 is situated at Cork city airport and was drilled to a depth of 1001 m. The borehole collared in upper Devonian mudstone, siltstone and sandstone, all with various occurrences of caliche and calcrete horizons, of the Variscan 'Great Island Anticline' near its East-West trending axial trace. The borehole provides a unique data point for the stratigraphic interpretation of the area due to its location and depth. The core contains minor fracture zones and a steep tectonic fabric. The Stratigraphy consists of 3 distinct units, all initially assigned to the Ballytrasna Formation (Sleeman and Pracht 1994) and can tentatively correlated with the Castlehaven, Gun Point and Caha Mountain formations to the west as suggested by (Sleeman and Pracht 1994).

## **Introducing the AIMINGPEAT Project: from CO2PEAT to AIMINGPEAT – integrated measurements and modelling approaches for CO<sub>2</sub> and CH<sub>4</sub> emissions/removals reporting in Irish peatlands**

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The Irish EPA-funded AIMINGPEAT research project focuses on advancing the national capacity to assess greenhouse gas (GHG) carbon emissions/removals from Irish peatlands. It builds strongly on the foundations of the CO2PEAT project, which identified key data-gaps, and highlighted challenges in modelling previously degraded peatlands under restoration. AIMINGPEAT brings this work to the next level by incorporating both CO<sub>2</sub> and CH<sub>4</sub>, and focusing on the development of integrated statistical, machine-learning, and process-based modelling approaches to support higher-tier national inventory reporting. The project seeks to identify key drivers of GHG dynamics, strengthen links between site-level measurements and national-scale assessments, inform effective peatland management/restoration, and contribute to Ireland's progress toward climate-neutrality goals. Insights will be provided into how this research builds from CO2PEAT to AIMINGPEAT. Presented will be also the insights into AIMINGPEAT's development of an advanced research framework seeking to complement and enhance current approaches for refining national estimates of Irish peatland CO<sub>2</sub> and CH<sub>4</sub> emissions/removals.

### **Acknowledgements**

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## **QuakeShake: an earthquake outreach programme connecting research, schools, and communities**

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QuakeShake is a community seismology programme established in 2023 as the outreach component of the Irish National Seismic Network (INSN), co-funded by DIAS and the Geological Survey of Ireland. The programme supports a nationwide community of citizen seismologists operating low-cost Raspberry Shake seismometers in homes, schools, museums, and geoparks. With more than 56 seismometers currently online it significantly enhances seismic monitoring in Ireland. QuakeShake combines data collection with extensive public engagement through workshops, public events, and online communication, increasing earthquake awareness.

This poster highlights how QuakeShake has greatly strengthened the INSN capability to detect local earthquakes in Ireland. The deployment of a large number of Raspberry Shakes in Northern Donegal (mainly due to the distribution of 25 Raspberry Shakes at a public workshop in 2024), led to the detection of ten Donegal earthquakes that couldn't have been located without using the additional data from the Raspberry Shakes. Cork has its own seismic activity highlighted with the magnitude 1.6 earthquake on 19/11/2024 near Bandon. This event was captured by multiple QuakeShake Raspberry Shakes and station S6730 (Irish Fossil Heritage).

QuakeShake has proven to be more than an earthquake monitoring network: QuakeShake seismometers have also detected fin whale song off the coast of County Waterford and also recorded cultural events such as live concerts including Oasis and Taylor Swift in Dublin. These unexpected observations demonstrate the broader scientific and outreach potential of the QuakeShake programme beyond traditional earthquake detection.

## **Multi-instrument observations on borehole GSI-24-007, Clonminch/Tullamore**

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The borehole is situated on the southern periphery of Tullamore Town and was selected by the Geothermal Unit in the Geological Survey Ireland. The borehole collared in 1.4m overburden, penetrated 999.6m of Lower Carboniferous limestone and terminated at 1001m. In total 64 samples for litho-, hyperspectral-facies, structural and microfacies analysis have been collected (2024). The borehole was drilled into a fault zone separating the 'Tullamore Trough' in the southeast from the shelf limestone of the Tullamore- Borrisokane Block to the northwest (Gatley et al. 2005) and the core is accordingly extensively fractured. Fault block rotation and probable partial stratigraphic repetition is likely.

The stratigraphy comprises 722.6m of 'Tullamore Limestone Formation' interbedded (1.4m to 82.4m, 322.95m to 442.5m and 545.0m to 724.25m) with basinal limestone facies. Below the 'Tullamore Limestone Formation 81.75m of limestone and dolomite have tentatively been assigned to the Allenwood Formation (724.25m to 806m). The Allenwood Formation is underlain by 96.1m of proximal Waulsortian Facies, followed downhole by 93.9m of Lucan Formation and terminating in 5m of proximal Waulsortian Facies.

This hole has been subjected to significant data collection; core has been scanned using the Geological Survey Ireland core-scanning suite, pXRF analysis has been carried out at 50cm intervals and downhole geophysical testing was performed. Combinations of these data allow for a comprehensive characterisation of the geology, particularly the facies variation. We present here some initial observations from these techniques.

## Regional CRM prospectivity using multivariate analysis of soil geochemistry in Southeast Ireland

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Volcanic-hosted massive sulphide (VHMS/VMS) deposits represent an important source of Critical Raw Materials, a secure supply of which is now a major EU priority. Member States are now mandated to develop National Exploration Programmes under the EU CRM Act and this study presents a multivariate workflow for regional VMS prospectivity analysis using Geological Survey Ireland's (GSI) Tellus soil geochemical data from southeastern Ireland. This area is analogous with the substantial VMS belt on Newfoundland, Canada.

Recently released Tellus 'S' soil data represent deeper topsoil samples collected at 35-50cm depth by hand auger on a 4km<sup>2</sup> grid across the G7/G9 study area. 2,820 soil samples were analysed by ICP Aqua Regia for 59 geochemical variables as well as for pH and Loss on Ignition. Post analytical multivariate data processing consisted of a combination of principal component analysis (PCA), K-Means clustering and spatial visualisation.

Samples with >10% Loss on Ignition were initially removed from the dataset to limit the impact of organic and peaty soils on later processing steps. PCA score plots show clear separation between volcanic-dominated populations and sedimentary background populations within the Lower Paleozoic. Spatial mapping of these populations reveals coherent belts and domains that align with known volcanic stratigraphy in the Campile and Avoca Formations. Clustering techniques (K-means) indicate close groupings of elements associated with VMS style mineralization which align with the volcanic domains.

The resulting regional prospectivity map highlights several zones characterised by elevated Cu–Zn–Pb signatures within volcanic domains in southeast Ireland.

## Is pXRF applicable to mineral exploration in Cr-Ni-Cu-PGE prospects?

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Using the Blue Draw Metagabbro - a mineralised, layered mafic intrusion in South Dakota, USA - as a natural laboratory, this project investigates the utility of pXRF in mineral exploration. Focusing on the critical metals Cr, Ni, Cu and Pd, this work explains how method, analysis and caution should be applied when using this technology to explore the economic potential of such systems.

Optical petrography and reflected light microscopy were used alongside geochemical analysis to help understand mineralisation within the region. PXRF data for powdered rock and hand specimen samples were compared with established inductively coupled plasma (ICP) geochemical data from previous work.

This comparison of data allows for assessment of the pXRF's accuracy and precision when sampling. The key findings of the project were the pXRF's inability in accurately detecting copper within the samples. In contrast, the machine's ability to detect nickel, palladium and chromium is remarkably accurate.

Overall, the project successfully shows the ability of pXRF as an exploration tool for certain critical metals. Though the project also highlights pXRF's limitations as well, such as its inaccuracy in finding copper. The best form of practice found during sampling was having a fine-grained matrix, powdering the samples and taking multiple readings.

## Seismostratigraphic and paleoenvironmental reconstruction of the Late Glacial Celtic Deep sedimentary succession

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At the end of the last glaciation, rapid global warming assisted the collapse of the Irish Sea Ice Stream (ISIS), a mega-glacier which flowed out of the Irish Sea and across what is now the Celtic Sea. This study aims to reconstruct the geological and glacial processes which shaped the environment of the ISIS' middle reaches (Celtic Deep Sea) during its collapse in the Late Glacial and the consequent rapid sea-level rise. Seismic imaging reveals multiple stratigraphic units, presumed to have formed during and after the ISIS collapse. These include tills and channelised units, many of which show onlapping lower reflector contacts. The upper unit mantles the entire sequence and is interpreted as the Holocene marine transgressive sequence. The most interesting unit is a large, well-preserved and heavily laminated unit extending across a substantial section of the study area. Two sediment vibrocores (5.5 m each) provide consistent confirmation of the mapped seismic units. The laminated unit corresponds to silty clays alternating with coarser laminae and de-watering structures. Within these muddy units several dropstones were located, confirming an aquatic glacial deposition environment. The more recent units are shell-rich and coarser-grained, suggesting rapid environmental changes, possibly the early Holocene transgression, which greatly impacted the area. It is important to understand when these changes occurred to accurately determine the processes that caused them. The deposition timing remains uncertain, however, radiocarbon dating on shells and microfossils will provide time constraints for the reconstructed models. Furthermore, grain-size, XRF, shell Mg/Ca ratios and eDNA data will provide more details on environmental conditions during each unit's deposition.

## **Fluid migration, albitization, and metal concentration in the Munster Basin, SW Ireland**

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Fluids exert a fundamental control on mineral reactions and mass transfer in intracratonic basins, yet the drivers of Na-metasomatism in basins lacking classical evaporite sequences remain poorly understood. The Devonian–Carboniferous Munster Basin of SW Ireland, hosting widespread Cu mineralization, has been traditionally described as super-mature arenites with limited feldspar content. However, new Raman spectrographic mapping reveals pervasive albitization and the presence of three distinct structural varieties of albite, implying complex histories of fluid–rock interaction, and metal concentration, across multiple scales.

This study investigates the spatial and temporal evolution of albitization in the Munster Basin and its relationship with sediment leaching, faulting, fluid flow and metalliferous deposit genesis. Three N–S traverses across the basin integrate in-situ portable XRF measurements with systematic hand-sampling for laboratory analyses. Basin-scale observations are combined with micro- to nano-scale analytical approaches to investigate the distribution and timing of albitization, the identification of precursor feldspar compositions through Raman geochemistry, and the implications for sediment leaching and trace-metal mobilization. Portable XRF data are complemented by 2D confocal Raman imaging, petrography, and targeted LA-ICP-MS analyses to constrain fluid chemistry, flow pathways, and the conditions driving feldspar alteration. Particular attention is given to areas adjacent to volcanic centres and major faults, which may have acted as conduits for downward-migrating saline fluids during transgressive events.

Preliminary results show systematic variations in albite structural types and associated geochemical signatures that correlate with basin architecture and fault-controlled fluid pathways, providing new insights into fluid migration, diagenetic alteration, and metalliferous enrichment in post-orogenic intracratonic basins.

## Geological data compilation for southeast Ireland: a re-mapping exercise

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The Leinster Massif in southeast Ireland was assembled in the Lower Palaeozoic and consists of a series of NE-SW trending tectonostratigraphic terranes (Max et al., 1990). The Duncannon Group Campile Formation, part of the Wicklow-Waterford terrane, extends from north Wexford to the Copper Coast and displays a complex geology which has potential to host volcanogenic massive sulphide (VMS) deposits.

Existing geological maps of the area (e.g. Geological Survey Ireland (GSI) Bedrock 100k map, terrane maps from literature (Max et al., 1990), mineral exploration reports from the GSI Open File) display a wide range of interpretations. This variation is likely due to poor outcrop exposure in the region and varying mapping goals and may contribute to the lack of modern exploration.

This re-mapping project aims to address uncertainties within the current Bedrock 100k map to improve geological understanding of the area, aiding any future exploration for VMS deposits. To improve understanding, 75 maps from open file exploration reports containing geological data were georeferenced and digitised. These were from the 1970s–1990s and cover a predetermined ~1200 km<sup>2</sup> study area proximate to Enniscorthy Co. Wexford. This compilation can be easily compared to the Bedrock 100k map and other geospatial datasets such as 19th century outcrop descriptions, the GSI borehole database and geophysical and geochemical surveys from the GSI Tellus programme. This large and varied data source can inform a re-interpretation of the geology of the area, with initial efforts focused on the Campile Formation.

## Thank you to our Sponsors:

