IRISH GEOLOGICAL RESEARCH MEETING 2025

Hosted by

Geology, School of Natural Sciences, Trinity College, Dublin

February 28th to March 2nd 2025

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Welcome to IGRM 2025

Welcome to the 68th Irish Geological Research Meeting. We are delighted to welcome you to Trinity College Dublin between February 28th and March 2nd 2025. We have an exciting and diverse range of talks and posters to share with you over the week-end.

Many thanks to our sponsors for their generous support in making this a meeting which is free for all to attend.

Thanks to Debora Dias for administrative support, and Christine Monahan for support with the IGRM website and social media communications.

A special note of gratitude to our two keynote speakers Prof Gavin Foster (University of Southampton) and Prof Frances Wall (University of Exeter) who are travelling to Ireland especially to deliver their presentations.

We hope you enjoy the week-end!

IGRM 2025 Organising Committee

David Chew, Quentin Crowley, Gerald Dickens, Chris Nicholas, Emma Tomlinson.

Geology, School of Natural Sciences, Trinity College, Dublin.

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

IGRM 2025 Venues

Ocean Drilling workshop Friday afternoon: Museum Building, Trinity College, Dublin

Registration Friday: Kennedy's Bar & Restaurant, 30-32 Westland Row, Dublin, D02 DP70

Registration Saturday: Arts Block, Trinity College, Dublin

Talks: Edmund Burke Theatre, Arts Block, Trinity College, Dublin

Posters: Area outside the Edmund Burke Theatre, Arts Block, Trinity College, Dublin

Friday evening icebreaker reception: Kennedy's Bar & Restaurant, 30-32 Westland Row, Dublin, D02 DP70

Saturday IGRM dinner: Harbourmaster Bar & Restaurant, Customs House Dock, IFSC, Dublin, D01 W0X8

Click on the link, or scan the QR code for an interactive map of the IGRM venues and other places of interest:

Self Service Conference Wi-Fi

Instructions are below -

To connect to the 'TCDconferenceWIFI' guest Wi-Fi network:

1. Ensure Wi-Fi is turned-on on your device.
2. Open the Wi-Fi configuration screen of your device.
3. Select the 'TCDconferenceWIFI' SSID.

4. A login page should automatically open. If it does not, open a web browser and try go to an external webpage.
5. On the TCDconferenceWIFI landing page, if you do not have a username and password, select the link to self-register. Otherwise enter your username and password.
6. On the 'Self-Registration' page, enter the following details:
    - Conference ID **TCDCONF3D**
    - Mobile phone number: this will be used to send you a password and will also become the username.
7. On the 'Self-Registration Receipt' page, select 'Sign-In' and enter the credentials you received via SMS.

Additional info:

1. To get back to the login page at any stage, go to your device's Wi-Fi configuration screen and re-select the 'TCDconferenceWIFI' SSID
2. A number of devices can be registered using the same mobile phone number, however, you can only log onto the self-service guest Wi-Fi the device from which you sent the request.

IGRM 2025 Sponsors

Many thanks to our sponsors for supporting the 68th Irish Geological Research Meeting

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Department for the Economy
www.economy-ni.gov.uk
GSNI Geological Survey of Northern Ireland
www.bgs.ac.uk/gsni

The Geological Society

IRISH GEOLOGICAL ASSOCIATION

INSTITUTE of GEOLOGISTS of IRELAND

iCRAG
SFI RESEARCH CENTRE IN APPLIED GEOSCIENCES

TOBIN
Consulting Engineers

RML
YOUR RESEARCH SUPPORT PARTNER

IKC3
CARBON, CLIMATE & COMMUNITY ACTION

IGRM 2025 Programme

Friday			
14:00	17:00	Irish Scientific Drilling Meeting, Trinity College Dublin, Musuem Building	
17:00	19:00	Registration and ice-breaker, Kennedy's Bar and Restaurant (downstairs)	
19:30	20:30	Keynote Lecture, Edmund Burke Theatre, Arts Block, Trinity College, Dublin	
		Prof Gavin Foster University of Southampton	Past, Present and Future of Stable Isotopes in Palaeoclimate

Saturday			
9:00	9:50	Registration	
9:55	10:00	Opening Remarks	
Saturday Session 1: Paleoenvironment			
10:00	10:15	Micha Ruhl	Timing of the end-Triassic mass extinction and global carbon cycle change
10:15	10:30	Antonietta Knetge	Regional vegetation response to the end-Triassic mass extinction at the Jameson Land Basin, East Greenland
10:30	10:45	Blanka Kovacs	Astronomical modulation of enhanced environmental mercury (Hg) fluxes during early Toarcian LIP volcanism

10:45	11:00	Amanda Perera	Orbital time scale calibration of the early Jurassic Sinemurian-Pliensbachian boundary event and global carbon cycle perturbation: Cheshire Basin, UK (ICDP JET Project)
11:00	11:15	William .J. Matthaeus	Trait-based paleo-ecosystem simulations reveal shifting forest cover across the Triassic-Jurassic biotic crisis
11:15	11:30	Catarina Barbosa	How counting method influences the interpretation of paleoecological data
11:30	12:00	Break & Posters	
12:00	12:15	Georgia Ballabio	Variation in chemical weathering intensity in response to large igneous province volcanisms across the Early Jurassic: Osmium isotope record from the UK Prees and Mochras Boreholes
12:15	12:30	Clara Crowell	Constraining palaeo-ice sheet thickness during the last glaciation of Ireland using in situ cosmogenic ^{10}Be and ^{14}C
12:30	12:45	Nikata Turton	Assessing volcanic influence on clay minerals as weathering proxies during the Paleocene-Eocene Thermal Maximum from Modgunn Hydrothermal Vent (IODP Expedition 396)
12:45	13:00	Matthias Sinnesal	Deep-time astronomical cycles in Ireland
13:00	14:30	Lunch	

Saturday Session 2: Geoscience & Society

14:30	14:45	Subhash Chandra & Rose Dunne	Ireland's Knowledge Centre for Carbon, Climate and Community Action: A Call to the Geoscience Community on the Island of Ireland
14:45	15:00	Jess Franklin	Engaging adult audiences with geoscience
15:00	15:15	Laura Reilly	What is the QuakeShake Outreach Programme? How are earthquakes being brought to the attention of Irish society?
15:15	15:30	Michael Dempster	Scrabo Area of Special Scientific Interest - geoconservation and geosite management
15:30	15:45	Paul Dunlop	Research insights into the cause of Ireland's defective concrete crisis
15:45	16:00	Tiernan Henry	Down to the river: building resilience and characterising natural solutions to baseflow maintenance and flood mitigation in a catchment in the Burren, Co Clare, Ireland
16:00	16:15	Aoife Braiden	The GEMINI Project: supporting a new geothermal sector for the island of Ireland
16:15	16:45	Break & Posters	

Saturday Session 3: Flash Talks (short 3-minute talks, with 1 minute for speaker handover)			
16:45	16:48	Seán Jordan	GenesisLinks: From the origin of life on Earth to the search for life on Mars
16:49	16:52	Jean Baptiste Tary	Can individual Bryde's whales be identified using ocean bottom instrument data and machine learning?
16:53	16:56	Nick O'Neil	The Theology of Extraction
16:57	17:00	Tarig Mohamed	Towards an Early Warning Groundwater Drought Modelling Ensemble: Understanding Aquifer Responses to Climate Extremes Across Irish Catchments
17:01	17:04	Audrey Recouvreur	Seismic facies and geometries of Tropic Seamount: Where are the sediments?
17:05	17:08	Bernard Asare Owusu	Determining the subsurface temperature at Krafla, Northern Iceland through joint inversion of seismic, elevation, heat flow, and thermal data
17:09	17:12	Eshbhal Geifman	Assimilation-Induced Outcrop Scale Liquid Immiscibility in the Portrush Sill, Northern Ireland
17:13	17:16	Ruairi O'Neill	Review of Standard Test Methods for Assessing Fines Quality of Aggregates.
17:17	17:20	Paulo Rodriguez	Preliminary cosmogenic ^{10}Be surface-exposure dating of glacial deposits in the Gaddah Valley, McGillycuddy Reeks, Ireland: Implications for late glacial climate variability.
17:21	17:24	AnnaMei Chan-Kinsella	The Identification and Delineation of Candidate Turloughs with Very Small Plan Areas from High Resolution Remote Sensing Data
17:30	18:30	Posters	
Saturday Session 4: Keynote Lecture			
18:30	19:30	Prof Frances Wall University of Exeter	Critical Rare Earths
20:00	Late	IGRM Dinner	Harbourmaster Bar & Restaurant, Customs House Dock, IFSC Dublin 1, D01 W0X8

Sunday

09:15	09:35	Registration	
09:40	09:45	Opening Remarks	
Sunday Session 1: Contemporary Environment			
9:45	10:00	Jerry Dickens	Massive carbon input and hydrothermal vent complexes: present-day observations suggest the link lies through an accelerated hydrological cycle
10:00	10:15	Leon Berry-Walshe	Using Distributed Fibre Optic Sensing to Monitor the Seismo-Acoustic Noisefield in Galway Bay
10:15	10:30	Gregor Rink	A combined cosmogenic-photogrammetric approach to quantifying and identifying drivers of rocky coastline erosion
10:30	10:45	Quentin Crowley	Use of UAVs in the Geosciences
10:45	11:00	Emma Chambers	Subsurface temperature models of Ireland from joint geophysical-petrological-lithological inversion
11:00	11:15	Ray Scanlon	Tellus: New regional topsoil geochemical data released for the southeast of Ireland
11:15	11:45	Break & Posters	
Sunday Session 2: Igneous & Economic Geology			
11:45	12:00	Jack Beckwith	Multi-Stage Inflation and Mineralisation within the Carlingford Complex Layered Intrusion, Ireland
12:00	12:15	Eshbal Geifman	Rare Earth Element Indicators of Assimilation in Magmas of the British and Irish Paleogene Igneous Province
12:15	12:30	La Donna Fredricks	Geometry, nature and timing of inversion structures at the Rapla Prospect, Rathdowney Trend, SE Ireland
12:30	12:45	Anna Morrison	A national survey of the Platinum Group Element abundance in the Irish lithospheric mantle
12:45	13:00	Hilde Koch	Critical Raw Material Prospectivity Mapping in the north of Ireland
13:00	14:30	Lunch	

Sunday Session 3: Geochemistry, Geochronology & Geostatistics

14:30	14:45	Carlos Corella Santa Cruz	Developing matrix-matched reference materials for in situ Rb-Sr geochronology: twists, turns and new candidates
14:45	15:00	Veronica Peverelli	Advancements in epidote U-Pb geochronology by LA-ICP-MS
15:00	15:15	Tom Manzocchi	A 3D bed-resolution model of the Ross Sandstone Formation around Loop Head
15:15	15:30	Ian Sanders	Magma mingling and platy pyroxene in an ancient andesitic meteorite, Erg Chech 002
15:30	16:00	Prizes and Closing Remarks	

IGRM 2025 Keynote Speaker – Friday

Keynote lecture Friday February 28th 19:30-20:30

Edmund Burke Theatre, Arts Block, Trinity College, Dublin

Prof Gavin Foster, University of Southampton

Past, Present and Future of Stable Isotopes in Palaeoclimate

The measurement of the stable oxygen isotope composition of marine carbonates such as foraminifera has underpinned the study of ancient climates for over 75 years since Nobel laureate Harold Urey "…suddenly found [himself] with a geologic thermometer…" in 1948. Since then, advances in mass spectrometry technologies, hand in hand with the establishment of deep ocean drilling, have not only led to foraminiferal oxygen isotopes becoming the workhorse of modern palaeoclimatology, but have also enabled us to describe the climate of the past 65 million years (and beyond) in exquisite detail. Foraminiferal carbonates contain a number other major elements and impurities and it seems that as soon as methods are developed to measure the stable isotopic composition of these elements they are applied by ingenious palaeoclimatologists to study the climate of our past. One element present in parts per million level in the shells of foraminifera that is proving particularly useful is boron, which has two stable isotopes ^{11}B and ^{10}B first measured in foraminifera in 1991. It was quickly recognised that the ratio of $^{11}B/^{10}B$ in marine carbonates was a close function of the pH of the seawater in which the foraminifera lived. Since surface water pH is in turn tightly related to the CO_2 content of the atmosphere this gave palaeoclimatologist a means to reconstruct CO_2 back in time – way beyond the reach of the gas bubbles trapped in Antarctic ice cores. We now have a palaeo-CO_2 record from boron isotopes in foraminifera stretching back 65 million years consisting of >700 analyses. By marrying this CO_2 record with climate records from oxygen isotopes and other methods, we have been able to not only test the climate models used to predict our changing future but can also constrain the sensitivity of natural climate change to CO_2. Both these provide vital constraints on the causes of past climate change and also help narrow the uncertainties in our projections of anthropogenic climate change. Advances in mass spectrometry continue at pace and the determination of the boron isotopic composition of single foraminifera has become possible in the last couple of years using laser ablation methods. This allows an unprecedented picture of ancient climate but is of course not without its challenges.

In this talk I will outline how we got to where we are today in terms of stable isotope geochemistry and conclude with presenting some of my groups latest research on single foraminiferal boron isotopes, showcasing a new way to study the climate of our past.

IGRM 2025 Keynote Speaker - Saturday

Keynote lecture Saturday March 1st 18:30-19:30

Edmund Burke Theatre, Arts Block, Trinity College, Dublin

Professor Frances Wall, University of Exeter

Critical Rare Earths

Critical minerals are back at the top of the agenda, with talk of tariffs and trade wars and proposals to buy Greenland, as well as the concern about changes in the global dynamic, as the power of access to deposits of the minerals needed for all our green and digital technologies takes over from the geopolitical power that currently comes from fossil fuel resources.

Rare earths are always near the top of critical minerals lists. Their magnetic and luminescent properties make them essential components of digital and low carbon technologies but their supply is vulnerable to disruption because the whole value chain of mining, processing and manufacturing is dominated by China.

The rare earth elements (REE) comprise 17 elements that include scandium, yttrium and the 15 elements lanthanum through to lutetium. The name 'rare earth' was given by early chemists in reference to the difficulty in separation of the elements from each other – nothing to do with rare earths being scarce. The crustal abundance of light REE is about the same as copper and even the less abundant heavy REE are much more abundant than precious metals such as gold.

So, it should be easy to open up a few more mines and diversify supply outside of China, right? Well, history has proved this wrong. Since REE first hit the headlines in 2010, there is still only one new major REE miner outside of China. The geology, mineralogy and geochemistry of REE, combined with finance and geopolitical constraints have all conspired to slow down new REE production.

This talk considers the vital role that geologists, working with colleagues in minerals processing, responsible sourcing and finance, play in the REE story.

We will consider carbonatite-related deposits, that host most REE mines; alkaline rocks, like those that occur in large deposits in Greenland but have mineralogical challenges; ion adsorption clays that are a responsible sourcing disaster story in China and Myanmar but might prove a viable source of REE elsewhere; and mineral sands that can produce monazite as a by-product. The talk will review the many studies have sought to produce REE as by-products of other mines, ranging from coal, to bauxite and phosphate but none have yet come to fruition. The last deposit type for geologists to consider is the urban mine, our anthropogenic REE deposits that are in products all around us.

IGRM 2025 Abstracts - Oral Presentations Saturday

Arranged in order of presentation

Timing of the end-Triassic mass extinction and global carbon cycle change

Ruhl, M.[1], Perera, A.[1], Silva, R.L.[2], Xu, W.[3], Al-Suwaidi, A.[4], Raine, R.[5], Goodhue, R.[1], Hesselbo, S.[6]

1 Geology, School of Natural Sciences, Trinity College Dublin, The University of Dublin, Ireland

2 Department of Earth Sciences, Clayton H. Riddell Faculty of Environment, Earth, and Resources, University of Manitoba, Canada

3 School of Earth Sciences, University College Dublin, Ireland

4 Earth Science, Khalifa University of Science and Technology, United Arab Emirates

5 Geological Survey of Northern Ireland, Northern Ireland, UK

6 Department of Earth Sciences, Camborne School of Mines, University of Exeter, UK

micha.ruhl@tcd.ie

Timing of the end-Triassic mass extinction and Early Jurassic biotic recovery, and contemporaneous global climatic, environmental and carbon cycle disturbance are poorly constrained because of the lack of (bio)stratigraphically complete and expanded sedimentary successions spanning this time interval. Such understanding is however essential to identify the causes of these events and the fundamental Earth system processes at play at this time.

Here, we present new sedimentary geochemical data from the CRN-2 core of the Larne Basin, Northern Ireland. The stratigraphically well-constrained sedimentary succession in this core spans the upper Rhaetian (Upper Triassic) to lower Sinemurian (Lower Jurassic) and presents one of the most expanded and complete sedimentary successions spanning the Triassic-Jurassic transition.

Utilising the obtained data we show astronomical forcing of the depositional environment within the Larne Basin at this time. We show that the end-Triassic mass extinction interval in this sedimentary archive is characterized by a major negative carbon isotope excursion (CIE), inferred to represent a major global carbon cycle disturbance at the onset of Central Atlantic Magmatic Province (CAMP) magmatism. An astronomically paced, step-wise negative shift at the onset of the CIE suggests a periodic release of isotopically light carbon into the end-Triassic global ocean-atmospheric carbon pools, indicating the initiation of positive feedback mechanisms with Earth's climate/carbon-cycle system.

Furthermore, we show that the Early Jurassic Hettangian Stage likely was of relatively short duration (~2.3 Myr) and that initial global biotic recovery occurred within a few 100 kyr after the onset of the end-Triassic mass extinction, and thus coinciding with the continued emplacement of CAMP.

Regional vegetation response to the end-Triassic mass extinction at the Jameson Land Basin, East Greenland

Knetge, A.B.[1], Barbosa, C.[1], Matthaeus, W.J.[1], Barclay, R.S.[4], Glasspool, I.J.[8], Gomez, B.[5], Hesselbo, S.P.[3], Popa, M.E.[9], Ruhl, M.[2], Sunderlin, D.[6], Surlyk, F.[7], McElwain, J.C.[1]

1. School of Natural Sciences, Botany, Trinity College Dublin, College Green Dublin 2, Dublin, Ireland

2. School of Natural Sciences, Geology, Trinity College Dublin, College Green Dublin 2, Dublin, Ireland

3. Camborne School of Mines and Environment and Sustainability Institute, University of Exeter, Penryn TR10 9FE, UK

4. Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, D.C, United States

5. CNRS-UMR 5276 Terre, 5276 Terre, Planètes, Environnement, Université Lyon 1, 2, rue Raphaël Dubois, F-69622 Villeurbanne, France

6. Department of Geology and Environmental Geosciences, Lafayette College, Easton, Pennsylvania 18042, USA

7. Department of Geosciences and Natural Resource Management, University of Copenhagen, Øster Voldgade *10, 1350 Copenhagen K, Denmark*

8. Field Museum of Natural History, Chicago, Il 60605, USA

9. Doctoral School of Geology, Faculty of Geology and Geophysics, University of Bucharest, Bucharest, Romania

knetgea@tcd.ie

The end-Triassic mass extinction event is associated with community change in both marine and terrestrial fossil records at the Triassic-Jurassic transition (TJB). Stable carbon isotope data and the palynological record of the TJB in Greenland support a transitional period (boundary) between the latest Rhaetian and earliest Hettangian. Major macroecological change (80% species turnover) across the TJB has been previously interpreted at a well-studied East Greenland site (Astartekløft, Kap Stewart Group, Jameson Land Basin). However, a regional-scale vegetation turnover has not yet been observed.

A census collected fossil flora of East Greenland Kap Stewart Group locality, South Tancrediakløft, contains 2,369 well-preserved leaf specimens of 28 unique morphogenera, spanning the TJB. Comparing these two Jameson Land Basin assemblages enables a wider comprehension of vegetation dynamics, characterising regional-scale responses to environmental change.

Our study uses relative abundance data, measures of biodiversity (evenness and richness), taphonomic interpretations, and stable carbon isotopic data to assess ecological shifts. We demonstrate a floral turnover occurring before the established TJB, in the Rhaetian, and before the main negative stable carbon isotope anomaly correlated to St. Audrie's Bay, UK. Further, our data indicates a 54% loss of macrofossil leaf generic richness and loss of the mid-canopy habit before the established Jurassic. These findings, paired with the interpretations and reassessment of Astartekløft suggest a regional-scale disturbance for the Jameson Land Basin during the end-Triassic mass extinction.

Astronomical modulation of enhanced environmental mercury (Hg) fluxes during early Toarcian LIP volcanism

Kovács, E. B.[1], Vallner, Zs.[2], Pálfy, J.[3], Müller, T.[4], Ruebsam, W.[5], Goodhue, R.[1], McElwain, J.[6], Ruhl, M.[1]

1 Department of Geology, and Earth Surface Research Laboratory (ESRL), Trinity College Dublin, The University of Dublin, Ireland

2 University of Pécs, *Faculty of Sciences, Institute of Geography and Earth Sciences,* Pécs*, Hungary*

3 Department of Geology, Eötvös University and HUN-REN-MTM-ELTE *Research Group for Paleontology, Budapest, Hungary*

4 Department of Petrology and Geochemistry, Eötvös *University, Budapest, Hungary*

5 Department of Geosciences, Kiel University, Christian-Albrechts-Universität zu *Kiel, Germany*

6 Department of Botany, Trinity College Dublin, The University of Dublin, Ireland

kovacse@tcd.ie

Gaseous emissions from Phanerozoic large igneous province (LIP) emplacements have been implicated as instigators of global carbon cycle perturbations and associated global change and mass extinction events. The volcanogenic release of toxic metal compounds, such as mercury (Hg), is hypothesized to have led to highly elevated global environmental Hg loading and associated terrestrial ecosystem disturbance at those times. However, spatial variances in modern marginal marine environmental Hg levels are suggested to be controlled by local riverine input and distance to the shoreline, whilst temporal variations in (global) environmental Hg loading have been linked to climatic and environmental change affecting terrestrial-to-marine Hg fluxes from e.g. wildfire prevalence or the weathering of (permafrost) soils. Here, we bring together these disparate models and processes controlling past global environmental Hg loading and show them to operate simultaneously during the Early Toarcian Karoo-Ferrar large igneous province (LIP) volcanism.

Early Jurassic carbon cycle disturbance from Karoo-Ferrar volcanogenic degassing, is recognized in sedimentary archives by a large negative carbon isotope excursion (nCIE), with astronomically paced stepwise successive negative shifts in the carbon isotope data at its onset. Utilizing new carbon isotope and sedimentary mercury data from the marine Mecsek Basin (Réka Valley section, SW Hungary), we show that elevated sedimentary Hg accumulation occurred in concert with the negative shifts in the carbon isotope data, suggesting astronomical modulation of secondary environmental Hg fluxes superimposed on globally elevated primary volcanogenic fluxes of Hg release at this time. We hypothesize that eccentricity-modulated precessional changes in seasonality affected the temporary retainment of Hg in intermediate Hg reservoirs, such as terrestrial biomass. Seasonality-forced changes in the hydrological cycle and/or global temperature possibly increased wildfire prevalence and/or (permafrost) soil erosion rates, herewith modulating secondary environmental Hg fluxes into the Early Toarcian atmosphere and oceans, superimposed on overall increased volcanogenic Hg fluxes.

Orbital time scale calibration of the early Jurassic Sinemurian-Pliensbachian boundary event and global carbon cycle perturbation: Cheshire Basin, UK (ICDP JET Project)

Perera, A.[1,2], Ruhl, M.,[1,2], Leng, M.J,[3], Ullmann, C.V.,[4], Hesselbo, S.P.[4]

1 SFI Research Centre in Applied Geosciences (iCRAG), University College Dublin, Dublin 4, Ireland

2 Discipline of Geology, Trinity College Dublin, The University of Dublin, Dublin, Ireland

3 British Geological Survey, Keyworth, Nottingham, NG12 5GG, UK

4 Camborne School of Mines, Department of Earth and Environmental Sciences, University of Exeter, Penryn Campus, Penryn, 20 Cornwall, TR10 9FE, UK

eperera@tcd.ie

The early Jurassic was characterized by recurring episodes of global climatic, environmental, and palaeoceanographic upheaval linked to the initial breakup of Pangea and the associated opening of the Central Atlantic Ocean, as well as large igneous province (LIP) volcanism. Consequently, the early Jurassic was characterized by multiple fluctuations in the global exogenic carbon cycle, including at the Sinemurian-Pliensbachian (S-P) boundary, expressed as positive and negative carbon isotope excursions (CIEs) in sedimentary archives. Here, we studied the Sinemurian-Pliensbachian boundary event in the Prees-2 core of the Cheshire Basin (England, UK), drilled by the International Continental Drilling Program (ICDP) and the Jurassic Earth System and Timescale (JET) project. Using stable isotope and analyses of marine and terrestrial substrates, we show that the S-P boundary is characterized by a significant negative CIE and carbon cycle perturbation and utilizing ITRAX XRF elemental data of the Prees-2 core we cyclostratigraphically constrain the duration and magnitude of carbon cycling during this interval. Cyclostratigraphic analyses of Ca data record shows a hierarchy of dominant frequencies, interpreted to reflect long and short eccentricity, obliquity and precession. The duration of the S-P boundary ~ 3.5 ‰ negative carbon isotope excursion is cyclostratigraphically estimated to be ~2 Myr.

Trait-based paleo-ecosystem simulations reveal shifting forest cover across the Triassic-Jurassic biotic crisis

Matthaeus, W.J.[1], Steinig, S.[2], Lunt, D.J.[2], White, J.D.[3], Peppe, D.[3], Wilson, J.P.[4], McElwain, J.C.[1]

1 Trinity College Dublin,

2 University of Bristol,

3 Baylor University,

4 Haverford College

matthaew@tcd.ie

The Triassic-Jurassic (T-J) boundary is associated with one of the worst Phanerozoic mass extinction events, wherein volcanism elevated atmospheric CO_2 and temperatures. For plants, regional extirpations have been inferred from the palynological and macrofossil records. Further, a partition of community change signals toward continental dry-biomes and coastal wet-biomes has been proposed. However, these global paleoecological trends have been inferred from a patchy fossil record. To fill in where the fossil record is incomplete due to preservational or sampling limitations, we use a trait-based ecosystem modeling approach to simulate vegetation cover. Ecosystem simulations using the Paleo-BGC model were parameterized using paleo-traits based on T-J macrofossil measurements and driven by climate simulations for three time-slices bracketing the time period of peak warming at the T-J boundary (196, 201, 205 Ma; HadCM3B general circulation model). The paleo-locations that allowed simulated plant growth for two middle Mesozoic arborescent plant groups, ginkgophytes, and bennettitaleans, are compared to paleobiogeographic inferences from the fossil record. Our process-based simulations contextualize regionally observed plant extirpation and provide an expectation for global changes in vegetation biogeography based on a synthesis of available evidence for the T-J biotic crisis.

How counting method influences the interpretation of paleoecological data

Barbosa, C.[1], Knetge, A.[1], Glasspool, I. J.[2], Hesselbo, S.P.[3], Matthaeus, W.J.[1], Popa, M.E.[4], Sunderlin, D.[5], McElwain, J.C.[1]

1. School of Natural Sciences, Botany, Trinity College Dublin, College Green Dublin 2, Dublin, Ireland;

2. Field Museum of Natural History, Chicago, Il 60605, USA;

3. Camborne School of Mines and Environment and Sustainability Institute, University of Exeter, Penryn TR10 9FE, UK;

4. Doctoral School of Geology, Faculty of Geology and Geophysics, University of Bucharest, Bucharest, Romania;

5. Department of Geology and Environmental Geosciences, Lafayette College, Easton, Pennsylvania 18042, USA

cbarbosa@tcd.ie

The end of the Triassic period is marked by an extraordinary faunal mass extinction. While the magnitude of the end-Triassic floral extinction is more contested, regional extirpations have been observed across several globally distributed localities, including East Greenland. Here, we use two counting techniques in a community survey of a new plant fossil locality from East Greenland (South Tancrediakløft (STan), Jamesonland) spanning the Triassic/Jurassic extinction event to evaluate whether differences in basic paleoecological techniques affect inferences regarding community turnover in this fossil flora. Specimens were tallied by counting one occurrence per taxon per hand sample irrespective of how many fossils were preserved (Method A) and then by counting the exact number of occurrences up to five occurrences per taxon per hand sample (Method B). A comparison of the results of these two techniques shows that the observed number of occurrences more than doubled (1.4-3.5 times occurrences per bed) when using Method B compared to A. The rank order relative abundance of taxa also changed, which has broader implications for interpreting paleoecological turnovers.

Variation in chemical weathering intensity in response to large igneous province volcanisms across the Early Jurassic: Osmium isotope record from the UK Prees and Mochras Boreholes

Ballabio G.[1], Xu W.[1], Hnatyshin D.[2], van Acken D.[1], Dickson A. J.[3], Hesselbo S. P.[4] and the JET scientists

1 School of Earth Sciences, University College Dublin, Dublin, IE.

2 Geological Survey of Canada, Ottawa, CA.

3 Department of Earth Sciences, Royal Holloway University of London, UK.

4 Camborne School of Mines, Department of Earth and Environmental Sciences, University of Exeter, Penryn Campus, Penryn, Cornwall, UK

georgia.ballabio@ucdconnect.ie

The Early Jurassic (~201-175 Myr) was a period of significant climatic and environmental changes, marked by the end-Triassic mass extinction, the Sinemurian-Pliensbachian Boundary Event, and the Toarcian ocean anoxic event. These events were closely linked to the emplacement of large igneous provinces and shifts in global carbon cycling in response to an increase in greenhouse gas concentrations. However, the understanding on chemical weathering response as one of the primary feedback mechanisms to rising greenhouse gases remains limited. Despite extensive research on these events, most studies have focused on major events rather than the long-term background evolution, leaving critical gaps in our knowledge.

This project is part of the International Continental Scientific Drilling Program (ICDP) project on the Early Jurassic Earth System and Timescale (JET) and aims to improve our understanding of the Earth system response during this time. Marine mudrock samples can record seawater rhenium-osmium (Re-Os) evolution, a powerful tool for tracing variations in chemical weathering by the balance of relative input between continental crustal weathering ($^{187}Os/^{188}Os \sim 1.4$) and mafic-ultramafic bodies weathering ($^{187}Os/^{188}Os \sim 0.13$). Preliminary results show distinct variations in the initial Os isotope ($^{187}Os/^{188}Os_i$) data, shifting towards unradiogenic values at the end-Triassic mass extinction and the Sinemurian-Pliensbachian Boundary Event, while the Toarcian ocean anoxic event is characterised by radiogenic signature. Furthermore, the dataset show strong coupling between $\delta^{13}C_{org}$ perturbation and $^{187}Os/^{188}Os_i$ response, further implying the crucial role of silicate weathering in regulating the carbon dioxide levels for the long-term climate. These findings offer new insights into the feedback mechanisms that influenced the Earth's climate during the Early Jurassic.

Constraining palaeo-ice sheet thickness during the last glaciation of Ireland using in situ cosmogenic ^{10}Be and ^{14}C

Crowell, C.E.,[1,2], Youngeagle, D.D.,[1], Kelley, S.E.,[1,2], Lifton, N.[3], Roberson, S.[4]

1 University College Dublin, School of Earth Sciences

2 Science Foundation Ireland Research Centre in Applied Geosciences

3 Purdue University, Department of Earth, Atmosphere and Planetary Sciences

4 British Geological Survey, The Lyell Centre

clara.crowell@ucdconnect.ie

The thickness of palaeo-ice sheets remains poorly constrained, despite recent advances in ice sheet reconstructions. This contributes significant uncertainty to relative sea-level change forecasts and glacio-isostatic adjustment (GIA) models, two crucial tools for mitigating future hazards in coastal regions. Ireland provides a natural laboratory for investigating past ice thickness. Weathered bedrock in the Irish highlands suggests an landscape much older than the glacially abraded lowlands. This led to speculation that the highlands were either exposed as nunataks or covered by cold-based, less erosive ice during the last glaciation. Currently, neither hypothesis can be rejected based on existing data, however the answer is crucial to our understanding of relative sea level change and local GIA in Ireland. Here, we test a novel methodology for quantitatively constraining past ice thickness using cosmogenic nuclides. We sampled four Irish mountains to use paired cosmogenic nuclides, ^{10}Be and ^{14}C, to determine if the summits were exposed as nunataks during the last glaciation. Our ^{10}Be data is consistent with the existing body of data, indicating variable degrees of inheritance, or a store of cosmogenic nuclides from previous exposure, at high elevations. Our ^{14}C ages provide the timing of deglaciation at four new high-elevation sites around Ireland. We identified evidence of cold-based glaciation at one location, as well as evidence of polythermal/erosive glaciation at our lowest elevation site. At one location, ^{10}Be and ^{14}C results indicate spatially variable basal thermal regimes. Based on our results, we conclude that two of our locations were not palaeonunataks, but cannot rule out the possibility for our other two sites. Future work is necessary to determine if there were palaeonunataks at other sites in Ireland, and we plan on using isotope modelling to explore possible exposure/cover scenarios that best fit our results. These results demonstrate the promise of using paired cosmogenic isotopes to constrain the thickness of former ice sheets, which has implications for improving relative sea-level change forecasts and GIA models, as well as mitigating potential coastal hazards.

Assessing volcanic influence on clay minerals as weathering proxies during the Paleocene-Eocene Thermal Maximum from Modgunn Hydrothermal Vent (IODP Expedition 396)

Turton, N.A.[1], Xu, W.[1], and Pellenard, P.[2]

1 School of Earth Sciences and SFI Centre for Research in Applied Geosciences (iCRAG),

2 University College Dublin, Dublin, Ireland.

Pellenard: Laboratory Biogeosciences UMR CNRS 6282, Universite Bourgogne Europe, Dijon, France

nikita.turton@ucdconnect.ie

Clay mineralogy records provide important climate archives of weathering and hydrology through time, but these paleoclimate signals may be obscured by authigenic or diagenetic overprinting. The International Ocean Discovery Program Expedition 396 drilled an expanded Paleocene-Eocene Thermal Maximum (PETM) succession from the Modgunn Vent in the Northeast Atlantic Norwegian Continental Margin. The PETM succession here is marked by the frequent occurrence of discrete ash beds (centimetre scale) and by thicker ash-rich deposits. Three major lithological units were identified from the Late Paleocene to the Early Eocene in holes U1568A and U1567B: Late Paleocene bioturbated mudstone (Unit VI), laminated mudstone from the PETM onset and earliest PETM body (Unit V), and ash-rich mudstone in the later PETM body (Unit IV). Smectite is the dominant clay mineral throughout the record, with minor components of illite, kaolinite, and chlorite. However, the potential transformation of volcanic ash into authigenic smectite after deposition complicates the use of clay mineralogy as a proxy for paleoclimate and weathering at this site.

We apply X-ray diffraction (XRD) analysis to quantify the mineralogical composition and electron microscopy to characterise the compositional and morphological changes of the clay-sized fraction to discriminate between continental weathering processes indicated by clay mineralogy and early diagenetic processes by the input of volcaniclastic material. Our results reveal two major compositional phases of the clay-sized fraction. In Units VI and V, smectite is predominately Al-rich montmorillonite-beidellite and is highly correlated with other clay types, indicating a common detrital source. In Unit IV, a relative increase in volcanic material to background sedimentation through enhanced bioturbation and/or volcanic production led to enhanced in situ alteration of volcanic ash and the formation of Mg-rich authigenic smectite. This clay mineralogy record establishes a warm and seasonal climate in the latest Paleocene and earliest PETM, with an increase in kaolinite indicating a possible intensification of the hydrological cycle just prior to the PETM. In the later PETM, the dissolution of volcanic material significantly affects any paleoclimate signals in the clay-sized fraction.

Deep-time astronomical cycles in Ireland

Sinnesal, M., Ruhl, M.

Geology, School of Natural Sciences, Trinity College Dublin

sinnesam@tcd.ie

Cyclostratigraphy is an important tool for understanding astronomical climate forcing and reading geological time in sedimentary sequences, provided that an imprint of insolation variations caused by Earth's orbital eccentricity, obliquity and/or precession is preserved (Milankovitch forcing). The principles of cyclostratigraphy and astrochronology are well established within the Cenozoic community, and are increasingly being applied for older time intervals as well. In this contribution we lay out some of the challenges and opportunities to studying deep-time cyclostratigraphy. We equally provide a brief overview of previous, ongoing and potential future applications in Ireland.

Ireland's Knowledge Centre for Carbon, Climate and Community Action: A Call to the Geoscience Community on the Island of Ireland

Chandra, S.[1], Dunne, R.[1], Weadick, G.[1], Crowley, Q.[1,2,3]

1 Geology, School of Natural Sciences, Trinity College, Dublin, Ireland

2 Trinity Centre for the Environment, Trinity College, Dublin, Ireland

3 iCRAG, the Research Ireland Research Centre in Applied Geosciences

ikc3@tcd.ie

Ireland's Knowledge Centre for Carbon, Climate, and Community Action (IKC3) is funded through the Higher Education Authority, Human Capital Initiative. IKC3 is a national Centre established by Munster Technological University (MTU), Trinity College Dublin (TCD), and University College Dublin (UCD). IKC3 promotes collaboration between academia, enterprise, and communities across all subject areas and sectors to support transition to a Net Zero future. IKC3 activities are centred around co-creation and co-delivery of new courses, modules, micro-credentials, and customised training programmes designed to equip all sectors with the knowledge and skills required to reach Net Zero.

IKC3 seeks to engage with the geoscience community on the island of Ireland, to assess current skills gaps and future skills needs across the board area of the geosciences. This information will be used to create a list of priority areas which all education providers can use as a resource for future curriculum development. This information can also be used to design customised training programmes for industry. IKC3 fosters a collaborative, co-creative environment, and welcomes onboarding of additional Higher Education Institutes, research centres, industry partners, government bodies, and local communities to focus on areas of interest, and to share resources to reach common goals.

Engaging adult audiences with geoscience

Franklin, J.,McNamara, M., Sianis, P. D.

School of Biological, Earth and Environmental Sciences, University College Cork, Distillery Fields, North Mall, Cork T23 TK30

Environmental Research Institute, University College Cork, Lee Road, Cork T23 XE10

jfranklin@ucc.ie

Younger audiences, especially school children, are often the go-to target audience for public engagement programmes owing to the convenience of the existing framework of the school system's audience numbers are pre-defined, the venue is free and the participants are often enthusiastic. Adult audiences, however, often seem less accessible because of logistical challenges, groups are often poorly defined in terms of location and size, and also the perception that adults are less interested in engaging with science. There is therefore a risk that adult audiences are underserved by STEM initiatives, especially if resources are limited. The Ireland's Fossil Heritage project has explored several different approaches to engaging with adult audiences and has evaluated their relative success. We have delivered creative programmes targeted to adults such as photo contests, public walks, and exhibits in libraries and at festivals with non-traditional STEM audiences. Preliminary analysis of evaluation data indicates an increased curiosity in geoscience with deeply personal impacts, with participants reporting that they were "inspired to learn more", that our events make "Ireland's rich geological heritage real" and that their "life is forever changed". These results demonstrate the importance of providing opportunities for adults to engage with geoscience. Based on these results we will launch a major national campaign in April 2025 targeted at adults, called the Great Irish Fossil Hunt. This campaign aims to encourage the Irish public to find fossils and to send us georeferenced photographs of their fossil finds, in both natural rock outcrops and in building stones. These data will help build a detailed fossil map of Ireland that the public can use to explore the fossils visible in rural and urban settings around the country, thus making fossils much more accessible to the public.

What is the QuakeShake Outreach Programme? How are earthquakes being brought to the attention of Irish society?

Reilly, L., Möllhoff, M., Bean. C..J., Power, S., Collins, L., Grange, P., Smithers., E, Smith, P., Grannell, J., Mohamed, H.

DIAS

GSI

lreilly@cp.dias.ie

Most people in Irish society, when asked, “do we experience earthquakes in Ireland?” would likely answer, “No we don’t”. However, this is incorrect earthquakes do occur in Ireland and are occasionally felt. This misconception is understandable as Ireland is not located near the edge of a plate boundary and the earthquakes we experience tend to be of very low magnitude (M2.5 is the largest onshore Irish earthquake recorded so far). As a result, earthquakes are not a regular thought for the population of Ireland. Our goal is to raise awareness on this topic.

The QuakeShake programme has these main aims:

- Encourage Irish society to consider seismic activity and monitor seismic events both locally and globally and thereby develop an integrated community of citizen seismologists throughout Ireland.
- Provide teaching resources for educators and school students.
- Inspire interest in Physical and Earth Sciences at tertiary levels.
- Support the government’s STEAM (Science, Technology, Engineering Art and Mathematics) initiative.
- Foster a closer relationship between researchers and citizens.
- Gather and share seismic data to support scientific research in various seismological fields.

The programme is managed by the Dublin Institute for Advanced Studies (DIAS) and co-funded by DIAS, Geological Survey Ireland (GSI), and Research Ireland. QuakeShake functions as outreach programme for the Irish National Seismic Network (INSN), the national earthquake monitoring body in Ireland. It supports and promotes the monitoring efforts of the INSN.

QuakeShake is facilitating the operation of affordable seismometers, known as Raspberry Shakes, in schools, homes, and public institutions. These compact, professional grade seismometers require only power and internet connectivity to operate. In 2024 QuakeShake distributed seismometers via public raffle and workshops for teachers and the public. In 2025 the aim is to distribute even more Raspberry Shake devices and encourage the public and schools to acquire their own units.

Scrabo Area of Special Scientific Interest - geoconservation and geosite management

Dempster, M.

Northern Ireland Environment Agency

michael.dempster@daera-ni.gov.uk

Northern Ireland Environment Agency (NIEA) is responsible for the statutory protection of Northern Ireland's geological heritage. Scrabo Hill in County Down hosts Scrabo Area of Special Scientific Interest (ASSI) which was declared in 1995 for the nationally important geology found here. The ASSI comprises historic quarries within Scrabo Country Park that contain the best vertical exposures of the Triassic Sherwood Sandstone Group in the region, currently a target for ongoing research into geothermal energy potential. The site displays textbook examples of sedimentary structures and has yielded a rich variety of trace fossils, including reptile footprints. Palaeogene igneous rocks intrude the sediments in the form of a transgressive sill, several dykes and an explosive vent agglomerate. The hill itself is a glacial erosional landform often referred to as a crag and tail, however recent research indicates this may be an erroneous description. In 2019 the ASSI was assessed as being in unfavourable conservation condition by NIEA, primarily due to vegetation growth that was preventing or limiting access to, and visibility of, the protected geological features. Managing vegetation throughout the site presents logistical and technical difficulties, so in 2024 a pilot project was undertaken to re-establish access to and visibility of the geology in part of the site, and to investigate best practice management approaches for this and other geosites in Northern Ireland. The project was successful in improving the quality of accessible sandstone exposures in the ASSI and revealing their field relationship to one of the dykes in the site. However, failure in communicating the purpose of the work led to public criticism that underlines a lack of general awareness and understanding of geoheritage and its management, a key issue for geoconservation. Further management work is required to return Scrabo ASSI to favourable conservation condition, so it is crucial that an effective communication strategy is integrated into future work phases.

Research insights into the cause of Ireland's defective concrete crisis

Dunlop, P.

Ulster University

p.dunlop@ulster.ac.uk

In County Donegal, northwest Ireland, thousands of homes built with defective concrete blocks show an increasing degree of severe structural defects that was first attributed to a high mica content in the aggregates by a government report published in 2017. This hypothesized that excessive levels of mica left the concrete susceptible to freeze-thaw degradation and consequently, the problem is popularly known as the "Mica Crisis". Based on this, the National Standards Authority of Ireland was tasked to develop a new testing protocol called I.S. 465, that in addition to testing for excessive mica levels in Donegal homes, also offers remediation options to families. In 2020 the Irish Government launched a grant scheme to assist homeowners to remediate their homes that is estimated will cost the state between €2.5 to €3 billion. Research lead by Ulster University and Empa, Switzerland in 2022 investigated defective concrete homes in Donegal by microstructural and chemical analysis combined with thermodynamic modelling and identified that mica was not the cause of failure. Apart of mica, the aggregates also contain high levels of iron sulphides, mainly in the form of pyrrhotite, and that the sulfur content of the aggregates considerably exceeds the limit value defined by the European standard for concrete aggregates EN 12620. The results demonstrated that the concrete suffers from internal sulfate attack triggered by pyrrhotite oxidation and that this was the primary failure mechanism of defective concrete in Donegal and not freeze-thaw. This research had implications for I.S.465 and the entire grant scheme and the government asked NSAI to undertake a review of I.S.465, that is due to be completed in March 2025. This presentation provides an overview of the research done by an international consortium led by Ulster University who were funded by the Geological Survey of Ireland and the Department of Housing, Local Government and Heritage to investigate the issue further and to share results directly with the NSAI to inform this review. This has concluded once again that the primary failure mechanism of defective concrete in Donegal is internal sulfate attack.

Down to the river: building resilience and characterising natural solutions to baseflow maintenance and flood mitigation in a catchment in the Burren, Co Clare, Ireland

Henry, T.[1], Doyle, E.[2], Lehnhart-Barnett, H.[1]

1 Earth and Ocean Sciences, School of Natural Sciences, University of Galway, Galway.

2 Burren & Cliffs of Moher UNESCO Global Geopark, Clare County Council, Ennistymon, County Clare

tiernan.henry@universityofgalway.ie

Climate change will impact on water resources, as rainfall patterns, intensities, durations and depths shift. Nature-based solutions may provide a means of protecting water resources and may provide approaches that can work with existing morphologies of catchments. However, this requires that there is a clear understanding of how existing systems operate, and in certain complex locations this may not be the case. This study focuses on a catchment in the Burren, County Clare and considers aspects that must be considered when characterising the operation of river systems. The small catchment described here is underlain by pure-bedded limestone where groundwater flows dominate, and the upper portions of the system are underlain by siliciclastic sediments where surface water flows dominate. A blanket bog caps the siliciclastic rocks; during dry spells or extended periods of low or absent rainfall, water released from the bog sustains baseflow to the system and sustains a series of springs across a wider area. During storms and extended wet periods, the bog provides no additional storage (it remains largely saturated), and surface water rapidly moves downhill. A karst conduit network backs up creating a turlough which acts as a temporary storm water sump, mitigating impacts downstream. The resilience of the river system is mediated by the continuous input of baseflow from the blanket bog, and by flood mitigation provided by the turlough. Understanding these natural systems is critical in considering responses to climate change impacts.

The GEMINI Project: supporting a new geothermal sector for the island of Ireland

Braiden, A. K., Noller, N. and the GEMINI Team

RML Ltd

aoifeb@research-rml.com

Geothermal energy has seen a significant increase in activity and investment across the world in the last two decades. This ranges from the development of supercritical geothermal resources in volcanic and high enthalpy systems to generate electricity, to the continued growth of lower enthalpy resources across Europe for heating and cooling applications.

Ireland and Northern Ireland has also seen an increase in activity and interest, particularly in commercial, industrial and district heating cooling applications. This includes the publication of national policy in Ireland in 2023, a new national geothermal database from Geological Survey Ireland, demonstration projects in Northern Ireland, and drilling and exploration projects in Ireland and Northern Ireland.

The GEMINI Project, supported by the PEACEPLUS Programme, managed by the Special EU Programmes Body (SEUPB), will deliver the next phase of development for this emerging sector. It includes four demonstration projects in Belfast, Dublin and Sligo, and new exploration and resource assessment programmes across the island. Critically, the geological, technical and engineering work will be supported by a range of toolkits, training programmes, data products, and best practice for communications and engagement programmes for geothermal energy projects. The aim of GEMINI is to develop and strengthen a new, renewable energy sector across the island of Ireland which can support our transition to local, clean energy and economic growth and prosperity.

IGRM 2025 Abstracts - Flash Presentations Saturday

Arranged in order of presentation

GenesisLinks: From the origin of life on Earth to the search for life on Mars

Jordan S., Foresta V., Jambhule D.

Dublin City University

devyani.jambhule2@mail.dcu.ie

The GenesisLinks project focuses on using our knowledge of the emergence of life on Earth for the development of novel biosignatures to investigate geological samples from Mars. The project is investigating the chemical processes leading to the emergence of life and how their remnants could be preserved in the rock record. These traces may mislead our interpretation of biosignatures by appearing as biomorphs' abiotic microstructures morphologically similar to traces of life. To fully understand the origin and evolution of life on Earth, and potentially elsewhere in our Solar System, we must develop techniques to distinguish between abiological and biological microstructures in geological samples.

A microfluidic device will be used for both prebiotic chemistry and growth of microorganisms and entombment of both in clays and carbonates to create abiotic biomorphs and biological controls, respectively. Artificial diagenesis of biomorphs and microbial controls will be induced in autoclaves under high temperatures and pressures to mimic fossilisation. The characterisation of prebiotic biomorphs, fossilised microorganisms, and relatively recent (Phanerozoic) geological samples containing confirmed microfossils will be conducted using analytical techniques including optical and electron microscopy, FTIR and Raman spectroscopy, and mass spectrometry. The final phase will involve data interrogation and classification to identify novel biosignatures. These novel biosignatures will then be applied to ancient (Archean) geological samples containing putative microfossils to determine their biogenicity.

Eventually we will have a robust approach to biogenicity determination that will help us characterise biosignatures from the early Earth and Mars, increasing our understanding of the emergence and evolution of life on these planetary bodies.

Can individual Bryde's whales be identified using ocean bottom instrument data and machine learning?

Tary, J. B., Peirce, C., Hobbs, R. W.

Geophysics section, School of Cosmic Physics, Dublin Institute for Advanced Studies, Dublin, Ireland

Department of Earth Sciences, Durham University, Lower Mountjoy, South Road, Durham, DH13LE, UK

tary@cp.dias.ie

When whales vocalize, their calls might include information that depend on each individual whale. The attribution of vocalizations to specific individuals is however generally difficult, time-consuming and requiring dedicated instrumentations such as animal tags. On the other hand, using passive acoustic monitoring may hold promise for this task as it can monitor large areas for long periods of time.

In the present study, we focus on well-located calls of five Bryde's whale tracks recorded by ocean-bottom arrays of hydrophones in the Panama basin. The calls under investigation are ~3-5 s long, and consists of two frequency components at ~20 and ~36 Hz. We use their time-frequency content to characterize the information contained in each call. This information is extracted using the 4th-order Fourier synchrosqueezing transform (FSST4), which is a high-resolution time-frequency transform based on the short-time Fourier transform.

Based on this information, we aim to cluster a subset of high-quality calls into different classes, corresponding to the five different whale tracks, using both unsupervised and supervised clustering techniques, namely the t-SNE and Support Vector Machines (SVM), respectively. The t-SNE clustering shows that the whale calls can be separated into different clusters corresponding to the different whale tracks. The SVM results corroborate those obtained by t-SNE clustering, with models reaching classification balanced accuracies of ~86±5%, their statistical significance corresponding to chance classification associated with 25% balanced accuracy at $p < 0.001$. Being able to classify these calls according to their respective tracks indicate that these Bryde's whale calls could include information about individual whales, and that this information can be derived from ocean bottom data.

The Theology of Extraction

O'Neill, Joseph Nicholas

Trinity College Dublin

oneilj23@tcd.ie

The extractive industry is facing a moral dilemma with respect to sustainability and planetary boundaries. Religious traditions provide insights into understanding human relationship with the earth and creation that may influence future extractive industry strategy. This poster explores theological aspects of mineral extraction and tests our current sustainable resource management frameworks against practical reasoning in moral theory and promotes individual ecological conversion as a solution to sustainable mineral extraction.

Towards an Early Warning Groundwater Drought Modelling Ensemble: Understanding Aquifer Responses to Climate Extremes Across Irish Catchments

Mohamed, T., Nasr, A., Hynds, P.

Technological University Dublin

d23125166@mytudublin.ie

Predicting groundwater drought is challenging, particularly in Ireland's temperate climate and complex (hydro)geology. To date, groundwater drought in Ireland has yet to be empirically defined despite considerable potential impacts on drinking water supply, ecosystem health, and agricultural productivity. Groundwater catchments are unique in terms of their recharge mechanism(s), influenced by diverse geology, subsurface soil profiles, and surface water-groundwater interactions. Accordingly, “surface to aquifer” ensemble-based modelling likely represents the best approach for groundwater drought across Irish hydrogeology.

The current study aims to characterise and subsequently predict groundwater behaviour to climate extremes (droughts) within the Irish groundwater network by integrating drought indicators with antecedent climate and local hydrogeological setting using machine learning (ML) approaches. Groundwater level (GWL) time series from 100 stations covering the period 2010 to 2023 were used for drought investigation using the Standardised Groundwater Index (SGI), which normalises GWLs to classify drought severity. The method was validated using the 1-in-100-year 2018 drought event, identifying SGI < -1.5 as a suitable drought threshold.

Groundwater droughts were identified using eXtreme Gradient Boosting (XGB) algorithms which were trained using meteorological factors. These models exhibited a wide range of accuracy and precision therefore, top-performing models with an area under the receiver operation characterise curves (AUC) of > 0.8 were delineated and hydrologically profiled to understand the influence of catchment parameters on groundwater drought propagation. Individual models were subsequently aggregated into a drought prediction ensemble based on their performance in relating hydrogeological response to i) climate variability and ii) local hydrogeological setting.

Results indicate that the first ensemble learner effectively predicts drought in areas characterised by short groundwater memory (71 days) and low mean elevation. A series of non-parametric bivariate tests confirmed this learner profile for groundwater memory ($p=0.005$), soil drainage ($p=0.008$), subsoil type, ($p=0.03$) and bedrock type ($p=0.03$). Further model training showed that topographical features (i.e., Elevation, Slope) significantly enhanced model performance. As might be expected, sensitivity analysis highlighted precipitation as a key precursor to drought propagation, with the top learner identifying antecedent rainfall over 60 days as being particularly significant.

Seismic facies and geometries of Tropic Seamount: Where are the sediments?

Recouvreur, Audrey, Wheeler, Andrew, Commissario, Lucrezi, Batista, Luis

1 School of Biological, Earth & Environmental Sciences / Environmental Research Institute, University College Cork, Cork, Ireland

2 SFI Centre for Research in Applied Geosciences, University College Cork, Cork, Ireland

3 Instituto Portugues do Mar e da Atmosfera, Lisboa, Portugal

arecouvreur@ucc.ie

Tropic Seamount is a guyot, rising from 4300 m to 970 m water depth, located in the Southern Canary Island Seamount Province (also referred as the Western Sahara Seamount Province). Bottom currents and internal tidal-generated currents are strong enough on the summit of Tropic Seamount to ensure near constant exposure of the seabed to seawater and consequently Fe-Mn crusts have formed. As such, Tropic Seamount summit is covered by areas of pavements, nodules and sand. However, the characterization of the substrate at the Tropic Seamount summit and its sediment dynamics are not well-defined.

As part of the EU-funded TRIDENT project, newly acquired sub bottom-profiler TOPAS seismic data were acquired during the TRIDENT-1 cruise on the RV Mario Ruivo (2024) and cover Tropic Seamount flat summit with over 450km of seismic lines. It reveals a large diversity of seismic facies associated with sedimentary processes and deposits. Especially, a high amplitude blind reflector can be followed all over the summit, which could be interpreted as a hardground. This surface is either outcropping, corresponding to pavement mapped over the summit, or buried over sequences of sediment filling.

Lenticular-shaped seismic geometries show up to 0.1 TWTTs thick of accumulation over the high amplitude continuous reflector, depicting long sequences of sediment deposition in the centre-west part of Tropic Seamount and its centre-north part. Other sediment sequences can be observed over Tropic Seamount, differing with the apparent sediment-starved summit of Tropic Seamount. This contrast shows a change of dynamic from accumulation to the present-day low sedimentation rates and erosion processes occurring over Tropic Seamount.

The study of seismic data over this seamount increases our understanding of its surface, as well as its sedimentary dynamics. It helps better understanding the geological baseline of Tropic Seamount and could improve knowledge of the summit environment of seamounts that are unique isolated systems.

Determining the subsurface temperature at Krafla, Northern Iceland through joint inversion of seismic, elevation, heat flow, and thermal data

Owusu, B. A.[1], Chambers, E. L.[1], Bean C. J.[1,2]

1 Geophysics Section, School of Cosmic Physics, Dublin Institute for Advanced Studies

2 iCRAG, SFI Research Centre In Applied Geosciences, Dublin, Ireland

baowusu@cp.dias.ie

The scarcity of downhole temperature measurements in many parts of the world means we have to rely on indirect geophysical measurements to find heat for geothermal exploration. However, individual geophysical methods are limited by parameter sensitivity and such indirect measurements may not match reality. Joint inversion schemes, such as geophysical-petrological inversion (WINTERC, Fullea et al. 2021), provide the opportunity to combine different geophysical datasets with petrophysical data to determine lithospheric structure and the geothermal potential of different regions (e.g., in Ireland, Chambers et al. 2023, 2024).

We are looking to improve the workflow by incorporating 3D lithospheric structure into the previous 1D geophysical-petrological inversion. The new geophysical-petrological-lithological inversion scheme will help to account for lateral heat flow effects as well as inverting for a multi-layered crust in contrast to the 3-layered crust used in Ireland. In addition, we are including melt in the inversion to model high-enthalpy geothermal systems. We are focusing on a high-enthalpy system at Krafla, Iceland, where geothermal heat has been extracted since 1977. This will provide us with the opportunity to test and refine our model against multiple temperature, petrophysical, and geophysical datasets available within the Krafla geothermal area. This new method will then be applied to model geothermal potential in both low and high enthalpy regions around the world.

Assimilation-Induced Outcrop Scale Liquid Immiscibility in the Portrush Sill, Northern Ireland

Geifman, E.[1], Stock, M.J.[1], Holness M.B.[2], Cooper M.R.[3], Andersen J.C.Ã[4]., Huber C.[5], Carter E.[1,6], Chew D.M.[1]

1 Trinity College Dublin,

2 University of Cambridge,

3 Geological Survey of Northern Ireland,

4 University of Exeter,

5 Brown University,

6 Keele University

geifmane@tcd.ie

The Portrush Sill in Northern Ireland is a bowl-shaped, Paleogene (c. 58.5 Ma) intrusion, exposed on the north coast of Co. Antrim. The sill intruded Jurassic sediments containing abundant pyritised macrofossils and disseminated pyrite.

We have undertaken a remapping of the intrusion, together with stratigraphically constrained microstructural and geochemical analysis. The centre of the sill is characterised by a striking magmatic texture comprising centimetre-decimetre sized, rounded melanocratic regions (globules) set within a leucocratic matrix. The melanocratic globules vary in size and morphology through the stratigraphy. Preliminary geochemical data show that the globules are Fe-rich whereas the leucocratic matrix is Si-rich, analogous to the conjugate immiscible liquids which formed as the fractionating Skaergaard ferrobasaltic melt encountered a binode and unmixed.

Comparison of clinopyroxene-plagioclase-plagioclase dihedral angles in the sill with those of other sills show that it intruded as a single body, in contrast to previous work arguing for several sills separated by horizons of sedimentary rock. Our work shows that these horizons are discrete rafts dislodged and incorporated into the sill. This is supported by field observations which show the magma intruding along bedding planes, as well as significant anatexis and contamination of the proximal magma. We infer that the onset of immiscibility and the unmixing of conjugate Fe- and Si-rich liquids within the Portrush sill was a consequence of assimilation of pyrite-rich country rock. This represents the first documented example of macro-scale assimilation-induced liquid immiscibility, with major implications for our understanding of magmatic evolution globally.

Review of Standard Test Methods for Assessing Fines Quality of Aggregates

O'Neill, R.[1], Goodhue, R.[2]

1 Arup & Transport Infrastructure Ireland

2 Geology, Trinity College Dublin, Ireland

roneill1@tcd.ie

The goal of this project is to examine the methods for quality assessment of natural and recycled concrete aggregates (RCA) used in road and pavement construction in Ireland, focusing on the evaluation of fines using the Methylene Blue (MB) and Liquid Limit (LL) tests. Aggregate fines significantly influence the performance, durability, and sustainability of construction materials.

The project uses data derived from samples collected from 30 aggregate-producing sites across Ireland, covering diverse lithologies and geological ages. Key tests performed include the MB test, which measures the presence of reactive clay minerals, and the LL test, which assesses the water content at which fines transition to a liquid state. These methods help determine aggregate cleanliness and predict potential expansion or durability issues.

Key findings suggest that the LL test yields elevated results for RCA, due to the porous nature of residual cement and other fines in RCA. Conversely, the MB test demonstrates reliability in detecting reactive clays, making it a promising alternative to the LL test for assessing RCA fines quality. However, to date in Ireland no limit has been placed on the MB test and this project provides data which may enable the introduction of a limit.

Furthermore, the study highlights that the current LL specification for natural aggregates (NA) in Irish standards may be overly restrictive.

This project also investigates the correlation between MBV and the Thermal Maturation of bedrock. Thermal Maturation is known to alter physical properties of rock. The MB test is being used to examine the effect it has on the reactivity of the clay particles present.

Preliminary cosmogenic ^{10}Be surface-exposure dating of glacial deposits in the Gaddah Valley, McGillycuddy Reeks, Ireland: Implications for late glacial climate variability

Rodriguez, P., Bromley, G., Foreman, A., Roignot, A.

1. Palaeoenvironmental Research Unit, University of Galway, Galway, Ireland

2. Climate Change Institute, University of Maine, Orono, USA

p.rodriguezcaceres1@universityofgalway.ie

We present preliminary results from cosmogenic beryllium-10 (^{10}Be) dating of glacial deposits located adjacent to Coimin Mor lough, McGillycuddy Reeks, in south-west Ireland. The lough is bordered by a complex of 5 lateral-terminal moraines marking the former extents of a small cirque glacier during the Late Pleistocene. A previous study in the area dated two boulders on the complex; however, we aim to achieve a higher chronological and geomorphological resolution of glacier retreat along the valley. Three ages from the innermost moraine and moraine-proximal surfaces yield a mean age of ~12.7 ± 0.1 ka, while a fourth sample was rejected as an old outlier. Thus far, our data suggest (1) the last glacial advance in this valley occurred during the late glacial period and (2) that terminal deglaciation occurred under stadial conditions. This pattern aligns with similar studies utilizing cosmogenic ^{10}Be dating to reconstruct glacial retreat behavior in Scotland, south-western Norway, and Arctic Norway, all of which demonstrate shrinking of glaciers during the Younger Dryas stadial. Together, these data are intriguing, as they contribute to the flourishing discussion about summer temperatures during stadial intervals in the Northern Hemisphere. This ongoing work is part of a larger project involving the detailed geomorphological mapping and chronology of the Gaddagh valley's landforms and modelling of the valley's former glacier system, and will enhance our understanding of the climatic conditions that prevailed in Ireland during the last glacial maximum and the subsequent glacial-interglacial transition.

IGRM 2025 Abstracts - Oral Presentations Sunday

Arranged in order of presentation

Massive carbon input and hydrothermal vent complexes: present-day observations suggest the link lies through an accelerated hydrological cycle

Dickens G.R.[1], Somoza, L.[2]

1 Geology, Trinity College Dublin, Dublin 02, Ireland

2 GME Marine Geology Div., Geological Survey of Spain, 28005 Madrid, Spain

dickensg@tcd.ie

Massive injections of 13C depleted carbon to the ocean and atmosphere, as indicated by prominent global negative ï¤13C excursions (CIEs), coincided with extreme warmth and major environmental upheaval multiple times in the geological record. For several events, notably the Paleocene-Eocene Thermal Maximum (PETM) and Toarcian OAE (T-OAE), the source of carbon has been linked to explosive venting of thermogenic gas produced when magmatic sills intrude organic-rich sediment. Primary support for this process are ancient hydrothermal vent complex (HTVC) systems. An individual HTVC is a giant (1-2 km wide) pit crater on the seafloor connected to a saucer-shaped igneous sill via a vertical fluid pipe. Within strata of several marine sedimentary basins, pit craters of hundreds of HTVCs terminate very close in time to horizons that represent the seafloor during the PETM and T-OAE.

Recent oceanographic expeditions to Scan Basin offshore Antarctica have discovered at least 150 giant pit craters on the modern seafloor that are connected to saucer shaped sills via vertical fluid pipes. By all measures, Scan Basin represents a modern analogue to HTVC systems heretofore only described from the sedimentary record. Importantly, the craters (1) did not suddenly form in the Holocene, but represent long-lasting features, and (2) coincide in time with fossil fuel emissions, initiation of a major CIE, extreme warming and environmental change. We suggest that correlation of prominent CIEs and HTVC systems in the rock record are not linked through extraordinary production and release input of magmatic gases, but rather an accelerated hydrological cycle where warming and carbon emissions lead to greatly increased sedimentary inputs to the ocean and simultaneously filling pre-existing craters on the seafloor.

Using Distributed Fibre Optic Sensing to Monitor the Seismo-Acoustic Noisefield in Galway Bay

Berry-Walshe, L.; Tary, J.B.; Le Pape; F., Celli, N.; J. Bean, C.; Garcia Gomez, C.; Piana Agostenetti, N.; De Paolo, E.; MacCraith, E.;

Dublin Institute for Advanced Studies

University of Galway, Ifremer Brest

Universita' di Milano Biccoa, Geological Survey Ireland

berrywal@cp.dias.ie

The ocean environment is highly dynamic from both oceanographic and geophysical perspectives. The new exciting technology that is Distributed acoustic sensing (DAS) applied on submarine fibre optic cables offers an unprecedented spatial resolution within the ocean environment for detailed analysis of various oceanic signals and associated processes. Within this research project, a 10 day long DAS dataset was acquired in June 2023 to characterise the submarine noise field off the coast of Spiddal, Co. Galway, Ireland. The acquisition was performed on an optical fibre (5.56km length) connected to the Galway SmartBay offshore laboratory. In order to understand the cable sensitivity to seismic, acoustic and ocean wave signals potentially present in the bay, we compare the DAS data with data from other instruments such as seismometers (Irish National Seismic Network), hydrophones and wave buoys (both Galway SmartBay and Marine Institute Ireland). Using techniques that leverage the spatially dense nature of DAS data, we can target each signal based on various characteristics. The strongest of which is the ocean surface gravity waves (OSGW), within the frequency range of [0.1,0.3]Hz. These follow the theoretical dispersion relation for shallow waters. There are also two assumed seismic signals intermittently present, these include a narrowband signal that appears in the ranges of [0.5,1.2]Hz and a dispersive Scholte wave signal in the [3.5,5.5]Hz band. Both of these signals appear together throughout the acquisition and show a strong temporal correlation with significant wave height readings at the SmartBay wave buoy.

A combined cosmogenic-photogrammetric approach to quantifying and identifying drivers of rocky coastline erosion

Rink, G. M.[1,2], Bromley, G. M.[1,2]

1 Palaeoenvironmental Research Unit, Geography, University of Galway, Ireland

2 SFI Research Centre in Applied Geosciences, Ireland

g.rink1@universityofgalway.ie

The Irish coastline exhibits an extensive array of hard-rock structures (e.g., cliffs, shore platforms). In the face of climate and sea-level change, coastal erosion introduces distinct geohazards to hard-rock coastal zones and surrounding communities, including rockfall, landslides, cliff retreat. To capture the diversity of Ireland's coastline, we sampled bedrock for 10Be analysis from four sites along the island's west coast that together display contrasting environmental, lithological, and morphological settings. The sites vary from inner bay settings to high-energy sites open to the North Atlantic, and from hard rock material to softer, semi-lithified Late Pleistocene glacial sediments. Cosmogenic beryllium-10 (10Be) has been applied to coastal research since the 2010s, and workflows for processing and analysing have been refined in recent years. Arising from that prior work, 10Be concentrations are now used regularly to model maximum likelihoods of possible exposure histories of shore platforms and coastline changes on millennial scales. Coastal erosion is not steady, however, but exhibits periods of higher and lower intensity; investigations on shorter timescales are thus needed to evaluate possible drivers of coastal erosion. Therefore, recent Structure-from-Motion (SfM) data and historical orthophotos and maps afford a viable approach to reconstructing erosion rates on monthly and annual-centennial timescales. Such investigations are especially valuable for sites that are likely to show high, or highly variable, erosion rates, such as soft rock cliffs and semi-lithified glacial landforms. The latter are a dominant feature of the Irish coastlines and erosion rates of such features vary on annual to monthly scales, reflecting changes in storm and wave intensity. For a coastal drumlin at Silverstrand, Co Galway, shorter term erosion rates vary between 0.8 m*year-1 (SfM on yearly to monthly time scales) and 0.14 m*year-1 (historical maps, orthophotos and DSM on a decennial to centennial time scales). Using 10Be measurements, we were now able to calculate an average Holocene erosion rate of 0.8 m*year-1. By studying four coastal sites with our 10Be, SfM, and historical mapping methodology, we are quantifying and comparing long-term and short-term erosion rates with the goal of establishing drivers of erosion in multiple coastal environments.

Use of UAVs in the Geosciences

Crowley, Q.[1,2,3,4], Aghdam, M.M.[1], Casey, P.[1], Mulpeter, D.[1], Mitchell, L.[1]

1 Geology, School of Natural Sciences, Trinity College, Dublin, Ireland

2 Trinity Centre for the Environment, Trinity College, Dublin, Ireland

3 iCRAG, the Research Ireland Research Centre in Applied Geosciences

4 Geochron Ltd

crowleyq@tcd.ie, qcrowley@geochronconsulting.com

Recent advances in uncrewed aerial systems (UAVs) have revolutionised geoscientific surveying, offering unprecedented capabilities for rapid, high-resolution data acquisition across challenging terrains. Modern drone-based platforms now integrate advanced sensors including gamma-ray spectrometers, lidar, and multispectral cameras to deliver centimeter-accurate 3D models, radiometric maps, and geospatial analytics while reducing fieldwork costs by up to 80% compared to traditional methods. A key innovation lies in drone-mounted gamma-ray detection systems, which enable non-invasive radiometric mapping critical for several emerging applications, including: (1) creating digital twins for teaching in the geosciences, (2) monitoring coastal erosion, (3) characterising building material in quarries through natural radioactivity signatures, (4) assessing radon gas risks in greenfield developments, and (5) estimating peat thickness in wetland ecosystems via gamma attenuation measurements. These systems leverage real-time kinematic (RTK) positioning and post-processed kinematic (PPK) corrections to achieve sub-decimeter geolocation accuracy without the necessity for ground control points. The integration of automated photogrammetry pipelines with machine learning algorithms has further enhanced data processing efficiency, allowing near-real-time generation of digital elevation models (DEMs) and orthomosaics with 1-5 cm resolution. Here we present cutting-edge workflows employing drone platforms to address critical challenges in the applied geosciences.

Subsurface temperature models of Ireland from joint geophysical-petrological-lithological inversion

Chambers, E.L., Fullea, J., Owusu, B., Kiyan, D., Bean, C.

Chambers, Fullea, Owusu, Kiyan, Bean - School of Cosmic Physics, Dublin Institute for Advanced Studies, Dublin, Ireland

Fullea - Department of Physics of the Earth and Astrophysics, Universidad Complutense de Madrid, Madrid, Spain

Kiyan, Bean - iCRAG, SFI Research Centre In Applied Geosciences, Dublin, Ireland

echambers@cp.dias.ie

High-quality maps of subsurface temperature and the geothermal gradient are useful when assessing the geothermal potential of a region. However, determining geothermal potential is a challenge in regions where direct measurements of in situ temperature and thermal property information are sparse (e.g. Ireland). Significant risk reduction is required to understand the heat resources before they can be fully exploited. Furthermore, individual geophysical methods are sensitive to a range of parameters, not solely temperature.

We determine the subsurface temperature by inverting seismic, in addition to other geophysical, lithological and petrophysical input datasets, directly for temperature. The temperature maps obtained for Ireland so far are within error of direct borehole temperature measurements, providing confidence in the results (Chambers et al EarthArXiv 2024 and in review). We further develop the joint geophysical-petrological thermochemical workflow by introducing lithology from 3D subsurface models and transient thermal effects to the inversion. Additionally, gravity data will be integrated into the island scale model to refine the 3D crustal structure, and hence the subsurface temperatures.

In this presentation we initially focus on new subsurface temperature models of Ireland with associated uncertainty, where the multi-parameter output models fit the input data and reveal the thermal structure within the crust and mantle. We will then look at new applications of the methodology at the local scale, in particular at Krafla, Iceland, for a local geothermal power plant application and the integration of melt to the inversion. The new workflows will potentially be used as a resource to investigate geothermal regions worldwide.

Tellus: New regional topsoil geochemical data released for the southeast of Ireland

Scanlon, R., Lowe, V., Hodgson, J., and Leavy T.

Geological Survey Ireland

ray.scanlon@gsi.ie

Geological Survey Ireland's Tellus Programme has just released a new suite of 55 soil geochemical maps, data, and reports for the southeast of Ireland. This release brings the topsoil data coverage to nearly 70% of national coverage, with full national coverage due to be published during 2026.

Samples were taken close to the centres of a 2 km by 2 km grid, resulting in 2,820 samples, not including field duplicates. Topsoil samples were taken at a depth of 5-20cm depth and analysed by ICP Mass Spectrometry following an Aqua Regia digestion as well as being analysed for pH (in a CaCl2 solution) and for weight Loss on Ignition at 450°C (a proxy for organic matter and soil Carbon).

Contour maps (using Inverse Distance Weighting) along with the point data, metadata and extensive QA/QC reports are now available to download freely under Open Data Licences from the GSI website (www.gsi.ie/tellus), and web viewers will be updated to include these new data shortly.

The sampled area stretches right across the Leinster granites and the Lower Palaeozoic of Leinster in southeast Ireland. The data covers the western margin of the granites as far as the Rathdowney trend. The general distribution of most trace metals shows a strong geogenic signature, with patterns following known geological boundaries. Some metal anomalies are noted.

The data will play a significant role in defining national background or threshold values of Potentially Harmful Elements in soils under the incoming EU Soil Health and Monitoring Directive. These will be used to understand the environmental impact of anthropogenic activities. The data will feed our understanding of soil Carbon and peaty soil distribution and will also be of particular use to the farming sector where knowledge of trace metal excesses or deficiencies can reduce the usage, costs, and environmental impacts of fertiliser application for crops and animals.

The data is of course of keen interest for mineral exploration and will feed into the Geological Survey's National Exploration Programme in this region. This programme, an obligation under the EU Critical Raw Materials Act, will focus initially on Lithium deposits and on Volcanic Hosted Massive Sulphide Copper deposits in this area.

Multi-Stage Inflation and Mineralisation within the Carlingford Complex Layered Intrusion, Ireland

Beckwith, J.[1], Stock, M.J.[1], Cooper, M.R.[2], Holness, M.B.[3], Andersen, J.C.[4], Huber, C.[5], Chew, D.M.[1], Higgins, O.[1,6], Carter, E.J.[1,7], Broom-Fendley, S.[4]

1 Department of Geology, Trinity College Dublin, Dublin, Ireland
2 Geological Survey of Northern Ireland, Belfast, United Kingdom
3 Department of Earth Sciences, University of Cambridge, Cambridge, United Kingdom
4 Camborne School of Mines, University of Exeter, Penryn, United Kingdom
5 Department of Earth, Environmental, and Planetary Sciences, Brown University, Providence, United States
6 School of Earth and Environmental Sciences, University of St. Andrews, St. Andrews, United Kingdom
7 Department of Geography, Geology, and the Environment, Keele University, Keele, United Kingdom

beckwitj@tcd.ie

The classical model of large, long-lived molten magma chambers has been increasingly challenged in recent decades, with growing support for transcrustal mush systems characterised by complex networks of chaotically stacked sills as a more widely applicable model for magma emplacement. The Carlingford Complex (Co. Louth) serves as an excellent case study for evaluating the emplacement dynamics of layered mafic intrusions. Formed during plume-related rifting of the North Atlantic in the Palaeogene, its excellent exposure has allowed detailed petrological characterisation of key units throughout the early to mid-20th Century [1], with evidence of sulphide mineralisation attracting historical interest from exploration companies [2]. Despite this, the Carlingford gabbros have received little academic attention since the 1960s and lack robust geochemical data. Here, we present new field, petrographic and geochemical data to develop a new model for the emplacement of the Carlingford Complex. The discovery of sulphide-rich layers allows us to tie magmatic processes to economically important platinum group element (PGE) mineralisation.

High-resolution sampling of both outcrop and drill-core material reveals cryptic fractionating layers in the Carlingford gabbros. Our analyses record an initial inflationary phase where new recharging magmas entering the system encountered a large liquid-rich body which facilitated mechanical separation of mineral phases. After the system cooled sufficiently, subsequent recharge events were intruded as comparably small sills at the top of the magma pile, each with its own discrete cooling/crystallisation history. Sulphide-rich horizons hosting PGE mineralisation are intimately linked to cumulate layers associated with the liquid-rich magma body; they are absent in the later small-scale chaotic sills. Hence, our findings provide key insights into the interplay between the assembly of upper-crustal magma systems and the formation of key PGE-mineralised horizons, with further process-based study in progress to deepen our understanding of this relationship.

[1] Le Bas M.J. (1960) Earth Env Sci T R So 64:169-200.

[2] Buchanan D.L. (2012) Platinum-group element exploration. Elsevier.

Rare Earth Element Indicators of Assimilation in Magmas of the British and Irish Paleogene Igneous Province

Geifman E,[1] Stock M.J.[1], Cooper M.R.[2], Carter E.[1,3], Higgins O.[1,4], Chew D.M.[1], Holness M.B.[5], Andersen J.C.[6], and Huber C.[7]

1 Trinity College Dublin

2 Geological Survey of Northern Ireland

3 Keele University

4 University of St. Andrews

5 University of Cambridge

6 University of Exeter

7 Brown University

geifmane@tcd.ie

Assimilation can have significant effects on the composition of magmas and is integral to the formation of many mafic/ultramafic sulphide deposits. During the Paleogene, the north of Ireland was subject to extensive magmatism and volcanic activity driven by mantle melting where the proto-Icelandic plume impacted on the base of the lithosphere. This included the emplacement of numerous dykes, which are associated with the North Atlantic Igneous Province (NAIP). The dykes have been mapped using Tellus aero-magnetic data, and six major swarms have been identified, with relative age constraints provided by their cross-cutting relationships. We have sampled and geochemically characterised 71 of these dykes.

Our data show that the dykes exhibit a spectrum of rare earth element (REE) trends, with two distinct extremes characterised by light REE enrichment or depletion. This is prevalent in magmas across the entire Eastern NAIP. Heterogeneity in the plume-mantle source contributed to the range of LREE patterns, however geochemical evidence points to an increased enrichment in LREEs caused by the assimilation of country rock at shallow depths. These findings show potential for REE data to be applied as a geochemical indicator of assimilation and thus a tool in future exploration for Irish sulphide mineralisation.

Geometry, nature and timing of inversion structures at the Rapla Prospect, Rathdowney Trend, SE Ireland

Fredericks, L.[1,2], Walsh, J.J.[1,2], Torremans, K.[1,2], Monchal, V.[2,3], Othen, H[1,2], Güven, J.[1,4], Chew. D.[2,3]

1. School of Earth Sciences, University College Dublin, Belfield Dublin 4, Ireland

2. Research Ireland Centre in Applied Geoscience (iCRAG)

3. Department of Geology, Trinity College Dublin, Dublin, Ireland

4. Shanoon Resources.

la.fredericks@ucdconnect.ie

This contribution aims to constrain the geometry, nature and timing of inversion-related deformation from regional to borehole scales at the Rapla Zn-Pb prospect, located on the mineral-endowed Rathdowney fault trend in SE Ireland. Economic sulphides are hosted in Mississippian dolomitized limestones in the normal faults hanging wall. We present results from detailed borehole structural analysis, aeromagnetic data, optical and cathodoluminescence microscopy, SEM-EDS mapping and U-Pb LA-ICP-MS calcite dating.

At Rapla, ENE trending, N and S dipping syn-sedimentary normal faults form segmented fault systems, with coherent displacement transfer across relay ramps. Diagenetic calcite cements in the host rock dated to 332 ± 16 Ma. A detailed analysis of the normal faults reveals displacements > 100 m on individual N dipping faults and clear across-fault thickening, with an aggregated 250 m displacement across the full fault system. Normal faults have 5 - 10 m thick zones characterised by monomictic breccias, associated en-echelon syntaxial blocky fibrous, white - grey polyphase calcite tension veins (Va and Vb) showing light brown - orange luminescence. Vein frequency increases near the fault zones.

Basin inversion during the Variscan Orogeny created roll-over anticlines, monoclines, reactivated the normal faults and duplicated mineralisation during N-S compression. A complex set of NE - SW trending, north dipping dextral reverse faults offset earlier normal faults by 200 - 400 m. Dextral-dominant reverse faults localise on pre-existing normal fault segments, complicating the fault and transfer zones. Other larger, more continuous reverse faults are unaffected by the normal fault architecture. The reverse fault zones consist of polymictic breccias, containing clasts of calcite veins, pyrite, galena marked by host rocks, showing communition and recementation. Associated grey-white hybrid extensional-shear calcite veins (Vc, Vd) occur at low angles to bedding with grey - dull orange luminescence dated to 302.4 ± 3.1 Ma.

Cretaceous deformation is indicated by blocky calcite veins (Ve) which crosscut Mississippian and Variscan veins dated to 142 - 92 Ma. Paleogene deformation is indicated by NNW -SSE strike slip faults and fold tightening associated with inversion during the Alpine Orogeny. Associated veins are rhombohedral pink dolomite veins (Vf) and near vertical calcite veins with bright orange -brown luminescence (Vg), dated to 67 - 28 Ma.

A national survey of the Platinum Group Element abundance in the Irish lithospheric mantle

Morrison, A.[1], Stock, M.J.[1], Andersen, J.C.Ã.[2], Cooper, M.R.[3], Carter, E.J.[1], Hughes, H.S.R.[2], McGrath, E.[4]

1 Discipline of Geology, School of Natural Sciences, Trinity College Dublin, Dublin, Ireland

2 Camborne School of Mines, University of Exeter, Redruth, Cornwall, United Kingdom

3 Geological Survey of Northern Ireland, Belfast, Northern Ireland, United Kingdom

4 Geological Survey of Ireland, Blackrock, Co Dublin, Ireland

amorris7@tcd.ie

Platinum Group Elements (PGEs) play an essential role in new and emerging technologies which are vital to achieving the green transition. They are classed as 'Critical Raw Materials' (CRMs) due to their rapidly increasing demand but concerns over supply security, with rare and geographically restricted deposits controlled by only a small number of nation states. This criticality urgently necessitates innovative research to identify new deposits and fertile areas, securing the European supply of PGEs.

Palaeogene-aged mafic intrusions in Ireland and Northern Ireland have been identified as some of the most prospective European targets for Ni-Cu-PGE-(Au) exploration, and have been subject to PGE exploration since the ~1960s. However, while deposit-formation necessitates PGE-enriched mantle primary melts which are predisposed to mineralisation, the fertility of the lithospheric mantle feeding Irish intrusions has largely been extrapolated from temporally- and genetically-related intrusions in Scotland and has never been verified directly.

This project is conducting a national survey of PGE abundances in mafic/ultramafic Palaeogene intrusions in Ireland and Northern Ireland, placing the first direct constraints on PGE enrichment in their mantle source. The results will help to de-risk future Ni-Cu-PGE-(Au) exploration by placing spatial and temporal constraints on potential mineralisation. Integrating this dataset with equivalent results from the wider region will also assist in constraining mantle dynamics during the earliest stage of North Atlantic rifting.

Critical Raw Material Prospectivity Mapping in the north of Ireland

Koch, H.[1], Stock, M. J.[1], Milinevsky, A.[1] and Cooper, M. R.[2]

1 Trinity College Dublin, College Green, Dublin 2, Ireland

2 Geological Survey of Northern Ireland, Adelaide House, Belfast, United Kingdom

kochhi@tcd.ie

The EU Commission has defined Platinum Group Elements (PGEs: Pt, Pd, Rh, Ru, Os, Ir), as well as Cu and Ni, as high-priority CRMs due to their importance in new green and digital transition technologies [1]. Mineral prospectivity mapping is an important technique in delineating future mineral exploration targets by combining geological, geochemical and geophysical datasets to spatially constrain the mineral potential of a previously underexplored or unexplored region [2]. This project aims to create a mineral prospectivity map for several target layers within the Palaeogene-aged mafic/ultramafic sulphide Ni-Cu-(Au)-PGE mineralisation in the north of Ireland. Geochemical and geophysical datasets from the Geological Survey of Ireland and the Geological Survey of Northern Ireland have been combined with industry data and academic/grey literature to generate the prospectivity map. Preliminary data will be presented from our high-density soil survey (1 sample/500m^2), which includes top- and bottom-soil Cu and Ni concentrations. Our dataset will be compared with Ag, Pt and Pd values from the Tellus Stream Sediment survey as well as with openly available industry data. Furthermore, the potential of Ni and Cu concentrations in both soil layers as a vectoring tool for PGE exploration will be discussed.

[1] Ragonnaud, G. (2023). EPRS, European Parliament

[2] Zuo, R. (2020). Nat Resour Res, 29(6), 3415-3424

Developing matrix-matched reference materials for in situ Rb-Sr geochronology: twists, turns and new candidates

Corella Santa Cruz, C.R.[1], Belgrano, T.M.[1], Drost, K.[2], van Acken, D.[1], Brodbeck, M.[1], Menuge, J.F.[1], Chew, D.M.[2], Slezak, P.[3], McCaffrey, D.[4], Martin, A.J.[5], Daly, J.S.[1] and McDermott, F.[1]

1 School of Earth Sciences, University College Dublin, Dublin 4, Ireland

2 Department of Geology, Trinity College Dublin, Dublin 2, Ireland

3 Idaho National Laboratory, Idaho Falls, Idaho, USA

4 U.S. Geological Survey, Las Vegas, Nevada, USA

5 University of Nevada, Las Vegas, Nevada, USA

carlos.corellasantacruz@ucd.ie

Project ElRbSr seeks to develop an in situ Rb-Sr dating protocol using the recently commissioned Thermo Fischer Scientific NeomaTM MC-ICP-MS/MS at the National Centre for Isotope Geochemistry (NCIG) at UCD. The enhanced analytical precision of this method can only be fully realised using matrix-matched reference materials with commensurately precise Rb-Sr age determinations. Internationally available reference materials are currently limited to Cretaceous biotites, with uncertainty on their reference ages dominating error propagation for samples calibrated by them. Here we update the community on the development of in situ Rb-Sr dating in Ireland and on the long search for new K-feldspar, biotite, and muscovite reference materials. After several failed attempts, promising candidates originating from the 1.4 Ga Kingman pegmatite, Cerbat Range, Arizona (Bt, Ms); the Itrongay pegmatite, Madagascar (Kfs); and the Mourne Mountains, N. Ireland (Kfs) have now been identified. Dating by QQQ-ICP-MS/MS at Trinity College Dublin using N2O reaction gas indicates these materials have Rb-Sr systematics suitable for further isotope dilution characterisation at the National Centre for Isotope Geochemistry at UCD. The revival and refinement of this method is also underway. A notable result of this work so far is that the Itrongay K-feldspar Rb-Sr age is >100 Myr older than the currently accepted K-Ca and Ar-Ar ages, but consistent with U-Pb ages of apatite inclusions. The biotite age for the Kingman pegmatite (1420 ± 35 Ma) is consistent with the model age for international K-feldspar standard NIST SRM607A, but younger than a monazite microprobe age. Future monazite and allanite U-Pb dating should resolve the emplacement age of this LREE pegmatite.

Advancements in epidote U-Pb geochronology by LA-ICP-MS

Peverelli, V., Chew, D.

Trinity College Dublin

peverelv@tcd.ie

Epidote U-(Th)-Pb geochronology can be applied to a variety of rocks in diverse environments, as the occurrence of epidote spans the entire Ca-/Al-/Fe-rich lithosphere. Th-/REE-rich epidote (allanite) is a magmatic mineral that can date pluton emplacement. Epidote-clinozoisite is common in hydrothermal and skarn environments, and in regional greenschist-facies metamorphism, and can constrain the timing of fluid circulation, mineralization, and low-grade metamorphism. Orthorhombic epidote (zoisite) is typical of higher metamorphic grades, and its V-rich endmember ("tanzanite") is prized when found as gem-quality grains. Detrital epidote can be employed in provenance studies. Finally, epidote trace element and isotopic (e.g., Pb, Sr, Nd, O, H) systematics can be employed as tracers. Hence, epidote is a powerful tool for investigating crustal processes, and it has provided unprecedented information on pre- and syn-orogenic fluid circulation events in several localities (e.g., central and eastern Swiss Alps, Colombian Andes), with far-reaching petrological implications.

Epidote U-(Th)-Pb geochronology is notoriously challenging. Similar to apatite (another Ca-bearing mineral), initial Pb contents (i.e., incorporated during crystallization) can overwhelm those of radiogenic Pb (i.e., U-/Th-derived), whose ingrowth forms the basis of U-(Th)-Pb dating. While the contribution of initial Pb can be corrected for in magmatic epidote by analyzing U-poor cogenetic phases or by employing terrestrial Pb evolution models, this is not the case for epidote in other settings, where it typically has higher initial Pb/radiogenic Pb ratios and initial Pb isotopic ratios not conforming to Pb evolution models. Therefore, geochronology of non-magmatic epidote requires different analytical and age calculation approaches.

We discuss previously published and new protocols by laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) that have enabled accurate U-Pb geochronology of epidote with unknown initial Pb isotopic compositions. We present the technical and geochemical challenges related to these types of measurements, and how they can be proactively tackled to ensure the optimal success of epidote geochronology. We compare LA-ICP-MS raster vs. static analysis modes, and the use of allanite as a closely matrix-matched reference material in both modes. Finally, we evaluate major and trace element characteristics contributing to making epidote dateable, presenting a strategy to screen epidote samples without compromising them for U-Pb isotope analyses.

A 3D bed-resolution model of the Ross Sandstone Formation around Loop Head

Manzocchi, T.[1,2], Walsh, D. A.[1,2,3], Pierce, C.S.[1,4], Haughton, P.W.D.[1,2]

1 School of Earth Sciences, University College Dublin

2 Research Ireland Centre for Applied Geosciences (iCRAG)

3 Now at RSK Ireland

4 Now at CASP

Tom.Manzocchi@ucd.ie

A newly-developed geostatistical modelling approach able to reproduce the lateral continuity of fine-grained sedimentary units has been used to build a formation-scale, bed-resolution 3D model of the Ross Sandstone Formation around Loop Head (County Clare). The 8 km x 5 km x 400 m thick model has been built in seven separate zones defined individually based on pervious detailed quantitative outcrop and borehole logging. The vertical resolution of the model is ca. 20cm for turbidite and hybrid event beds, and much thinner for interbed deposits. The model includes zone-appropriate definitions of lobate and channelised deposits over three hierarchical levels, with up to nine types of depositional element per zone. The zone models were created using compression-based geostatistical simulation constrained to observed dimensional (thicknesses, widths, shapes) and stacking (volumetric proportions, amalgamation ratios) characteristics for each type of deposition element, and are tied to the beds logged in three research boreholes present in the model area. The purpose of the model was to validate the new modelling approach, done by ground-truthing the model using outcrop photos and model cross-sections at the same position and scale. These indicate that the target resolution has been achieved, and the outcrop-scale stacking characteristics reproduced.

Magma mingling and platy pyroxene in an ancient andesitic meteorite, Erg Chech 002

Sanders, I.S.[1], Simms, M.J.[2], Guyett, P.[1]

1 Trinity College Dublin,

2 National Museum Northern Ireland

isanders@tcd.ie

Found in 2020 in Algeria, Erg Chech 002 is a rare kind of meteorite made from andesite. It crystallized close to 4565.5 Myr ago, just 1.8 Myr after the Solar System began, making it the oldest known igneous rock. We recently studied pieces of the meteorite which, unusually, contain a little-known and essentially new kind of andesite alongside the normal kind. The new kind is our focus here. It is finer grained and is richer in MgO than the normal andesite, it has spectacular dendritic plates of pyroxene with interstitial sodic plagioclase, and it has beautiful, embayed, gem-like, green orthopyroxene xenocrysts. Its contact with the normal andesite is convoluted, implying that the two magmas mingled like immiscible melts before they froze in tandem as separate kinds of andesite.

Experimentally based thermometry suggests that growth of the dendritic pyroxene happened at about 1270°C, and that the normal magma was cooler, crystallizing at a published estimate of 1224 ± 20°C. Since dendritic growth requires substantial undercooling, we imagine that the new magma started out well above 1270°C and a batch of it cooled quickly after being injected into the normal magma at 1224°C. When its high temperature had fallen to 1270°C, we suggest that it was sufficiently undercooled for the pyroxene dendrites to nucleate and grow rapidly.

The embayed orthopyroxene xenocrysts were clearly dissolving in the hot magma before it began to cool. This again suggests a temperature well over 1270°C. The xenocrysts appear to have been sinking (under gravity?) onto the interface with the normal magma, indenting it and even dropping through it, before the dendrites crystallized.

The high initial temperature inferred for the new magma is puzzling. We suggest that it resulted from internal self-heating while the magma was stored in a large, well-insulated reservoir where heat input from the radioactive decay of aluminium-26 exceeded heat losses by conduction to the surroundings.

We believe that this is the first time that the process of radiogenic heating of segregated magma, and the process of undercooling of magma by mingling, have been invoked in the interpretation of an igneous meteorite.

IGRM 2025 Abstracts - Posters

Arranged in alphabetical order by surname of first author

Northeast Atlantic Ocean Wave Heights Monitoring Using Land-Based Seismic data

Baranbooei, Samaneh[1, 2] Bean, Christopher J.[1]

1 Geophysics Section, School of Cosmic Physics, Dublin Institute of Advanced Studies (DIAS), Dublin, Ireland

2 Department of Earth and Ocean Sciences, University of Galway, Ireland

samane@cp.dias.ie

Traditional methods for monitoring the spatiotemporal evolution of ocean waves include in-situ buoys, numerical wave modeling, and satellite altimetry, each with distinct advantages and limitations in spatial and temporal resolution. Buoys excel in temporal resolution but lack spatial coverage compared to satellite and model-based approaches.

This study explores an alternative, cost-effective method for monitoring ocean wave states by utilizing land-based seismic amplitudes. Secondary microseisms persistent earth vibrations generated by the interaction of opposing ocean waves, form the basis of this approach. The nonlinear relationship between seismic microseism amplitudes and standing wave heights was modeled using an Artificial Neural Network (ANN).

The ANN was trained on seismic data alongside buoy or numerically simulated wave height data, then applied to estimate Significant Wave Height (SWH) at specific locations in the Northeast Atlantic. Seismic data from stations across Ireland enabled accurate SWH predictions, demonstrating a statistical distribution closely aligned with in-situ measurements, with normally distributed deviations.

This data-driven method shows great potential as a straightforward and scalable solution for ocean wave monitoring, leveraging existing seismic networks to provide reliable, low-cost insights into ocean dynamics.

Seismic Identification of Subsurface Karst Conduits Using Reflection Data: Defining Signature Features Through Synthetic Seismic Simulations & Examining the Impact of Cave Geometry on Resonant Seismic Signals

Bayat, S., Henry, T., Bean, C.J.

1 Geophysics Section, School of Cosmic Physics, Dublin Institute of Advanced Studies (DIAS), Dublin, Ireland

2 Earth and Ocean Science, School of Natural Sciences, University of Galway, Ireland

3 iCRAG Research Ireland Centre for Applied Geosciences

bayats@cp.dias.ie ; sbayat1@universityofgalway.ie

Karst landscapes present significant challenges for subsurface exploration due to their complex and irregular geological structures. In many regions, including Ireland, karstified limestone formations can serve as crucial groundwater reservoirs. Data from boreholes, mining operations, and geophysical surveys confirm the presence of karst conduits at depths exceeding 100 meters. Accurately mapping these deep features has practical implications for optimizing water resource management and identifying geothermal energy opportunities. Previous studies of shallow karst environments have demonstrated that high-contrast geological features, such as water-filled cavities, can trap seismic energy and produce sustained resonant vibrations. Expanding on this concept, this research explores the potential for detecting deep, water-filled caves within limestone karst systems by analyzing their characteristic seismic frequency responses through synthetic modeling. The objective is to define the distinct "seismic fingerprint" of these waterfilled caves within simulated seismic reflection data. Additionally, the study examines how variations in cave shape influence seismic signatures. This study seeks to enhance the use of seismic techniques for investigating deep karst systems and assessing their significance in groundwater resource management.

Thinning and retreat of the temperate Connemara ice centre, Ireland, during Heinrich Stadial 1 constrained with cosmogenic ^{10}Be dating

Foreman, Adrienne C., Bromley, Gordon R. M., Hall, Brenda L., Rodriguez, Paulo C.

Palaeoenvironmental Research Unit, University of Galway

Climate Change Institute, University of Maine

a.foreman1@universityofgalway.ie

Within the North Atlantic region, climatic perturbations such as Heinrich Stadial 1 (HS1) and the Younger Dryas stadial (YD) have traditionally been viewed as anomalous periods of extreme cooling linked to abrupt changes in the poleward oceanic transport of heat. While there is considerable geologic data to support strong cooling during stadial winters, recent work in mid- and high-latitude regions fringing the North Atlantic suggests that this thermal signal did not extend to stadial summers, contrary to previously inferred palaeoecological and ice core proxies. Some directly dated glacial records from Britain, Ireland, and Scandinavia, for instance, document the large-scale retreat of terrestrial ice masses during both HS1 and the YD, coincident with meltwater pulses from the European continent and consequent weakening of Atlantic meridional overturning circulation. Similar patterns of stadial deglaciation have been reported from Greenland and north-east North America. Together, these datasets support the emerging model of stadials as periods of anomalous seasonality imposed on the strongly maritime North Atlantic climate. In this study, we present a geologic record of ice sheet behaviour from the Maumturk Mountains in western Ireland during the last glacial termination, constrained with cosmogenic ^{10}Be surface-exposure dating. Coupled with glacio-geomorphologic and sedimentologic characterisation of moraine landforms, our record describes a temperate ice mass undergoing sustained active retreat during the first half of HS1, synchronous with increased European meltwater discharge into the North Atlantic.

Seismic facies and geometries of Tropic Seamount: Where are the sediments?

Recouvreur, Audrey, Wheeler, Andrew, Commissario, Lucrezi, Batista, Luis

1 School of Biological, Earth & Environmental Sciences / Environmental Research Institute, University College Cork, Cork, Ireland

2 SFI Centre for Research in Applied Geosciences, University College Cork, Cork, Ireland

3 Instituto Portugues do Mar e da Atmosfera, Lisboa, Portugal

arecouvreur@ucc.ie

Tropic Seamount is a guyot, rising from 4300 m to 970 m water depth, located in the Southern Canary Island Seamount Province (also referred as the Western Sahara Seamount Province). Bottom currents and internal tidal-generated currents are strong enough on the summit of Tropic Seamount to ensure near constant exposure of the seabed to seawater and consequently Fe-Mn crusts have formed. As such, Tropic Seamount summit is covered by areas of pavements, nodules and sand. However, the characterization of the substrate at the Tropic Seamount summit and its sediment dynamics are not well-defined.

As part of the EU-funded TRIDENT project, newly acquired sub bottom-profiler TOPAS seismic data were acquired during the TRIDENT-1 cruise on the RV Mario Ruivo (2024) and cover Tropic Seamount flat summit with over 450km of seismic lines. It reveals a large diversity of seismic facies associated with sedimentary processes and deposits. Especially, a high amplitude blind reflector can be followed all over the summit, which could be interpreted as a hardground. This surface is either outcropping, corresponding to pavement mapped over the summit, or buried over sequences of sediment filling.

Lenticular-shaped seismic geometries show up to 0.1 TWTTs thick of accumulation over the high amplitude continuous reflector, depicting long sequences of sediment deposition in the centre-west part of Tropic Seamount and its centre-north part. Other sediment sequences can be observed over Tropic Seamount, differing with the apparent sediment-starved summit of Tropic Seamount. This contrast shows a change of dynamic from accumulation to the present-day low sedimentation rates and erosion processes occurring over Tropic Seamount.

The study of seismic data over this seamount increases our understanding of its surface, as well as its sedimentary dynamics. It helps better understanding the geological baseline of Tropic Seamount and could improve knowledge of the summit environment of seamounts that are unique isolated systems.

Enhanced Angular Range Analysis: A Novel Object-based Image Analysis Approach for Seafloor Characterisation

Brennan, C., Summers, G., de Oliveira, L.M.C., and Lim, A.

Earth and Ocean Lab, Department of Geography, University College Cork, Cork

cara.brennan@ucc.ie

Multibeam echosounder backscatter has proven to be a useful tool in deciphering seabed sediments. While traditional image-based backscatter processing methods are commonly used, signal-based approaches such as Angular Range Analysis (ARA) offer a robust sediment characterisation, albeit with a relatively low spatial resolution. Thus, this research aims to improve the spatial accuracy of ARA; and investigate influences (geophysical; sediment geotechnical and sampling parameters) on eARA's accuracy. This research utilises open-source data from the Irish National Seabed Survey and its successor the Integrated Mapping for the Sustainable Development of Ireland's Marine Resource programme, which spans >20 years. Our framework applies object-based image analysis to backscatter data and incorporates ARA characterisation to create a more spatially robust sediment classification workflow without the need for reprocessing large volumes of MBES data. Here, the developed workflow is applied to four sites offshore Ireland, with ranging water depths (59-2000 m), operating frequencies (12-300 kHz), and multibeam sonars. Statistical analyses focus on: 1) correlation between observed and estimated grain size; 2) thematic accuracy; 3) spatial accuracy; 4) relationship between residuals (Î¦) (observed - estimated mean grain size) with sediment geotechnical properties and 5) sediment sampling parameters. Accuracy assessment yielded a Spearman's rank correlation up to 0.75 ($p<0.01$) with overall accuracies up to 96.15% ($k=0.84$) and improved spatial accuracies across almost all standard metrics compared to traditional ARA. Overall, these results showcase the capacity of the workflow as a robust sediment estimator, while improving spatial accuracy. Therefore, providing a scalable approach for seafloor characterisation applicable to large governmental programmes.

Measuring Thermal Conductivity with Multiple Methods for Rocks on the Island of Ireland

Chambers, E.L.[1], Kiyan, D.[1,2], Fuchs, S.[3], Raine, R.[4], Rodriguez Salgado, P.[2], Unitt, R.[2,5], O'Reilly, B.M.[1,2]

1 School of Cosmic Physics, Dublin Institute for Advanced Studies, Dublin, Ireland

2 iCRAG, SFI Research Centre In Applied Geosciences, Dublin, Ireland

3 Helmholtz Centre Potsdam, German Research Centre for Geosciences GFZ, Potsdam, Germany

4 Geological Survey of Northern Ireland, British Geological Survey, Belfast, UK

5 University College Cork

echambers@cp.dias.ie

New measurements of thermal conductivity (TC) have been taken on core samples across Ireland and Northern Ireland. The measurements were taken on samples from under sampled lithologies and locations across the island with a focus on the Mallow area, a location with known warm springs. Three methods were used to take multiple measurements: 627 using a Thermal Conductivity Scanner (TCS, Optical scanner), 180 on a Heated Transient Plane Source and 86 using the Divided Bar Analysis. The TC measurements varied between the methods and for different rock types. Results for the optical scanning ranged from 2 to 5.7 W/m/K and from 1.2 to 3.7 for the Divided Bar. The Transient Plane Source obtained results at room temperature similar to the TCS with most samples having decreasing TC with increasing temperature (a reduction of ~0.5 W/m/K with a 225 °C increase in temperature for most samples). Most of Ireland's bedrock geology is limestone where mean TC varied from 3.1 to 5.05 W/m/K for saturated samples using the TCS. Limestones had the most variability due to the variation in composition. This is in contrast to the Antrim basalts which produced stable values across the methods and did not vary with increasing temperature using the Transient Plane Source (1.7 to 2.1 W/m/K). The results for each method are compared to see the variation between methods as well as rock types. Raman spectroscopy was also performed on the samples to determine if composition within cores has a quantifiable effect on the samples. The new measurements provide information on the thermal state of Ireland's rocks which can be used for future geothermal projects in Ireland and for modelling Ireland's subsurface.

The Evolution of Shipwreck Imagery from the Irish National Seabed Survey to INFOMAR

Chan-Kinsella, A., McKeon, C.

Geological Survey Ireland

annamei.chan-kinsella@decc.gov.ie

INFOMAR (Integrated Mapping for the Sustainable Development of Ireland's Marine Resource) is a 20 year programme co-delivered by Geological Survey Ireland, and the Marine Institute, to map the physical, chemical and biological features of Ireland's seabed. Before INFOMAR, the Irish National Seabed Survey (INSS) mapped Ireland's offshore waters. INFOMAR primarily uses multibeam echosounder technology to map the seafloor in 3D.

The RMS Lusitania, built in 1906, was the largest ship built at the time. The vessel was attacked on May 7th, 1915, by U-20 and sank in 18 minutes. The wreck lies 22km south of the Old Head of Kinsale in a general water depth of 93m. The wreck was first surveyed in 2002, under the INSS, and has been resurveyed a number of times since this initial survey. With ever evolving technologies, images produced of the RMS Lusitania become more detailed, and also produces evolutionary time-series data of the state of the shipwreck. New imagery, from repeat surveying provides more detail of the shipwreck and its features, which allows for new research and analyses to be conducted. Shipwreck imagery can be used to monitor the impacts of wreckages on the wreck environment. This project details the evolving technologies used on INFOMAR surveys.

The Identification and Delineation of Candidate Turloughs with Very Small Plan Areas from High Resolution Remote Sensing Data

Chan-Kinsella, A.[1], Tedd, K.[1], Meehan, R.[2], Von Beaumont, R.[3], Duncan, N.[3], McCormack, T.[1]

1 Geological Survey Ireland

2 Talamhireland

3 TOBIN

annamei.chan-kinsella@decc.gov.ie

The GWFlood Project was initiated in 2016 following the floods of winter 2015/2016, to address the gaps in karst groundwater flooding data available across Ireland, and to further understand groundwater flooding. Karst feature mapping conducted in the field at field scale as part of Geological Survey Ireland's GW3D project during Summer 2024 identified a number of potential turloughs of small plan area which had not yet been recorded.

This project investigated the best methodology to map these features remotely. High resolution Sentinel-2 imagery, and Vivid Standard remotely sensed data were both used, as well as local groundwater level data, and further field mapping in the Winter season to verify and better characterise the features. The features were then manually digitised from the remotely sensed data.

The inclusion of these smaller features, not previously recognised from previous mapping, is significant at local scale, and provides improved information for Planning decision makers, ecologists, engineers, farmers, and local heritage groups. Further future work will investigate the potential to automate this methodology using high-resolution LIDAR data.

Secondary Alteration in Calcium and Aluminium-rich Inclusions from Enstatite Chondrites

Farrelly, D.[1,2], Anzures, B.A.[3], Mane, P.[2,4], McCubbin, F.M.[5], Dunham, E.T.[3], Gorce, J.S.[3], Le, L.

1 Trinity College Dublin

2 Lunar and Planetary Institute (USRA), Houston, Texas

3 Amentum, NASA Johnson Space Center

4 ARES, NASA Johnson Space Center

5 Lawrence Livermore National Laboratory

dvdfarrelly@gmail.com

Calcium and Aluminium-rich Inclusions (CAIs) are some of the first condensates in the Solar System, recording characteristics of the environments where they formed. Spinel, corundum and melilite are some of the primary minerals that make up CAIs [1]. The term 'inclusion' references their presence in chondrites; stony meteorites formed from the condensation of gas and dust during the protoplanetary stage of the early Solar System [2]. Two distinct chondrite reservoirs were identified through stable isotopes, carbonaceous (CC) and non-carbonaceous (NC) [3]. Within the NC reservoir, enstatite chondrites (EC) are thought to have formed closest to the Sun due to their highly reduced minerals and isotopic similarities to Earth [4]. The reduced mineralogy, extremely low in-situ H2O measurements, and low matrix abundances, are inconsistent with the presence of a powerful oxidizing agent such as water. However, some recent bulk H2O measurements suggest ECs may have contributed to Earth's volatile budget [5], although terrestrial weathering of ECs occurs rapidly. Some ECs do contain rare secondary minerals including magnetite, sodalite, roedderite, hydrated Cr-Fe sulfide, and Cl-bearing sulfide djerfisherite in their matrix [e.g. 6], which necessitate caution when distinguishing between hydrothermal activity on their parent bodies or alteration on Earth. Dunham et al. (2023) [7] reported new data on the mineralogy of EC CAIs, providing a list of minerals present and their abundances. Among these minerals were nepheline and sodalite, minerals formed through hydrothermal alteration. As CAIs are nebular condensates, it is unclear if their volatile-related alterations extend to the chondrite parent body. Thus, our study aims to answer the question "Did alteration of EC CAIs occur in the nebula, chondrite parent body, or on Earth?".

[1] MacPherson G. J. (2014) Treatise on Geochemistry, 2, 139-179. [2] Scott E. R. D. and Krot A. N. (2014) Treatise on Geochemistry, 1, 65-137. [3] Warren P. H. (2011) EPSL, 311.1-2, 93-100. [4] Javoy M. (1995) GRL, 22.16, 2219-2222. [5] Piani L. (2022) Science, 369.6507, 1110-1113. [6] Weisberg M. K. (2023) MAPS, 58, 1693-1706. [7] Dunham E. T. et al. (2023) MAPS, 58, 643-671. [8] Wilbur Z. E. et al. (2024) MAPS, 1, 1-15.

Assimilation-Induced Outcrop Scale Liquid Immiscibility in the Portrush Sill, Northern Ireland

Geifman, E.[1], Stock, M.J.[1], Holness M.B.[2], Cooper M.R.[3], Andersen J.C.Ã[4]., Huber C.[5], Carter E.[1,6], Chew D.M.[1]

1 Trinity College Dublin,

2 University of Cambridge,

3 Geological Survey of Northern Ireland,

4 University of Exeter,

5 Brown University,

6 Keele University

geifmane@tcd.ie

The Portrush Sill in Northern Ireland is a bowl-shaped, Paleogene (c. 58.5 Ma) intrusion, exposed on the north coast of Co. Antrim. The sill intruded Jurassic sediments containing abundant pyritised macrofossils and disseminated pyrite.

We have undertaken a remapping of the intrusion, together with stratigraphically constrained microstructural and geochemical analysis. The centre of the sill is characterised by a striking magmatic texture comprising centimetre-decimetre sized, rounded melanocratic regions (globules) set within a leucocratic matrix. The melanocratic globules vary in size and morphology through the stratigraphy. Preliminary geochemical data show that the globules are Fe-rich whereas the leucocratic matrix is Si-rich, analogous to the conjugate immiscible liquids which formed as the fractionating Skaergaard ferrobasaltic melt encountered a binode and unmixed.

Comparison of clinopyroxene-plagioclase-plagioclase dihedral angles in the sill with those of other sills show that it intruded as a single body, in contrast to previous work arguing for several sills separated by horizons of sedimentary rock. Our work shows that these horizons are discrete rafts dislodged and incorporated into the sill. This is supported by field observations which show the magma intruding along bedding planes, as well as significant anatexis and contamination of the proximal magma. We infer that the onset of immiscibility and the unmixing of conjugate Fe- and Si-rich liquids within the Portrush sill was a consequence of assimilation of pyrite-rich country rock. This represents the first documented example of macro-scale assimilation-induced liquid immiscibility, with major implications for our understanding of magmatic evolution globally.

ProtoSigns: Exploring Protocell Formation and Fossilisation on the early Earth, and Implications for Microfossil Interpretation

Gillet de Chalonge, Louise[1]; Coutant, Maxime[1] ; Brun-Usan, Miguel[2]; Jordan, Seán F.[1]

1 Life Sciences Institute, School of Chemical Sciences, Dublin City University, Dublin, Ireland

2 Genetic Regulation and Morphogenesis Group, CABD (Andalusian Center for Developmental Biology), CSIC, Seville, Spain

louise.gilletdechalonge3@mail.dcu.ie

Understanding the emergence of life is one of the most fundamental questions in science. Although different approaches have been proposed to tackle it, the traces that early life left in the geological record remain the most essential source of evidence. However, the interpretation of the oldest fossils on Earth has been met with many controversies in the past few decades, even more so with the discovery of abiotic (and prebiotic) chemical reactions that produce structures remarkably similar to microfossils – biomorphs. It is imperative to redefine biogenicity criteria for a more accurate analysis of microstructures from the early Earth, but also to facilitate the interpretation of potential biosignatures in forthcoming extraterrestrial samples, such as those from Mars. However, data on the formation and preservation of biomorphs is still scarce.

The ProtoSigns project aims to fill this gap in knowledge by combining cutting-edge experimental, computational and analytical approaches. The first step involves the development of a state-of-the-art microfluidic system, allowing for the standardised and reproducible formation of protocells (abiotic precursors to living cells), in a range of environmental conditions plausible for the early Earth. Concurrently, a 3D computational model, based on the EmbryoMaker framework, is being constructed to link protocell formation parameters to their morphology and guide the experimental work. The third phase involves the controlled silicification and diagenesis of produced protocells, as well as of various microorganisms relevant to the putative first microbes and to the oldest known microfossils, such as methanogens, acetogens, and cyanobacteria . The resultant biomorphs and microfossils will be characterised with advanced analytical techniques to identify correlations and extract robust biogenicity criteria for ancient silicified microstructures.

This integrative research aims to advance our knowledge of protocell evolution on the early Earth, link fossilised microstructures to the environmental context of their formation, and allow for a clearer interpretation and detection of biosignatures from Earth and beyond.

GenesisLinks: From the origin of life on Earth to the search for life on Mars

Jordan S., Foresta V., Jambhule D.

Dublin City University

devyani.jambhule2@mail.dcu.ie

The GenesisLinks project focuses on using our knowledge of the emergence of life on Earth for the development of novel biosignatures to investigate geological samples from Mars. The project is investigating the chemical processes leading to the emergence of life and how their remnants could be preserved in the rock record. These traces may mislead our interpretation of biosignatures by appearing as biomorphs' abiotic microstructures morphologically similar to traces of life. To fully understand the origin and evolution of life on Earth, and potentially elsewhere in our Solar System, we must develop techniques to distinguish between abiological and biological microstructures in geological samples.

A microfluidic device will be used for both prebiotic chemistry and growth of microorganisms and entombment of both in clays and carbonates to create abiotic biomorphs and biological controls, respectively. Artificial diagenesis of biomorphs and microbial controls will be induced in autoclaves under high temperatures and pressures to mimic fossilisation. The characterisation of prebiotic biomorphs, fossilised microorganisms, and relatively recent (Phanerozoic) geological samples containing confirmed microfossils will be conducted using analytical techniques including optical and electron microscopy, FTIR and Raman spectroscopy, and mass spectrometry. The final phase will involve data interrogation and classification to identify novel biosignatures. These novel biosignatures will then be applied to ancient (Archean) geological samples containing putative microfossils to determine their biogenicity.

Eventually we will have a robust approach to biogenicity determination that will help us characterise biosignatures from the early Earth and Mars, increasing our understanding of the emergence and evolution of life on these planetary bodies.

Assessing the impact of 10 years of the GSI Research Programme

Lavado, Ana Luisa[1,2], Braiden, Aoife[1], Verbruggen, Koen[2]

1 RML

2 Geological Survey Ireland

analuisa.lavado@gsi.ie

Geological Survey Ireland established its new Research Programme in 2015 which was designed to promote and fund excellent geoscience research and build capacity across Ireland. Since then, the geoscience research landscape has seen significant change with increased funding and numerous national research policies and strategies.

In 2024, the GSI Research Programme team conducted a review of the impact of the overall programme. In the past decade, the GSI Research Programme had funded projects, research infrastructure and collaborations to develop new knowledge and fill research gaps in geoscience and related areas such as environmental and climate research. Since 2015, GSI has supported 226 research projects with a total value of over €65million and direct investment from GSI of almost €17million.

Here we summarise the impact of the overall GSI Research Programme in a changing research funding landscape. Quantitative and qualitative data was collected from funded researchers, along with information about outputs and outcomes of funded projects, and the collaborative links between the GSI technical teams from GSI, the Research Programme and the geoscience research community.

Geochemical Observations of New Tellus G8 Dublin Soil Data

Leavy, T., Lowe, V.

Geological Survey Ireland

Thomas.leavy@gsi.ie

Geological Survey Ireland has completed geochemical mapping of Dublin city as part of the Tellus programme, Ireland's national mapping project. The city was part of the 'G8' block, with samples collected in 2021, and analysed in 2023-2024. In total, 877 sites were sampled, at a density of 0.25km2, with two samples taken at each site, the first at a depth of between 0.05-0.20 m, designated 'A' samples, and the second between 0.35m – 0.5m depth, designated 'S' samples. These were then analysed for over 50 elements, pH, and Loss-on-Ignition (LOI). In general, the 'A' samples showed a stronger influence from anthropogenic activities, while the 'S' samples showed a stronger geogenic signature. This poster gives a brief overview of the study area and the geochemical anomalies identified. Anomalies attributed to geological factors are seen at Howth Head and Bull Island in the northern half of the mapped area, along with the Leinster Granite in the south. Anomalies attributed to anthropogenic factors are prominent in the city centre, the docklands, and historic industrial areas.

MSc in Subsurface Characterisation and Geomodelling

Manzocchi, T., English, K.

University College Dublin

kara.english@ucd.ie

MSc in Subsurface Characterisation and Geomodelling. This one-year, full time MSc aims to provide geoscience graduates with skills and knowledge for a career in the broad range of industries and organisations requiring digital subsurface characterisation and geological modelling. The course is taught by experts from diverse geoscience disciplines including geology, geophysics, geomodelling, geoengineering and computational geoscience, with experience of the minerals and several geoenergy sectors. It focuses on theoretical and applied aspects of data interpretation, analysis and computer modelling of the deep and shallow subsurface using real-world data and industry-standard software.

Deep Geothermal Research in Tullamore, Co. Offaly

Martin, T., Bourke, P., Rogers, R., Hunter Williams, T., Blake, S.,

Geological Survey Ireland

Tristan.Martin@DECC.gov.ie

This poster presents a preliminary report on the research Geological Survey Ireland has carried out on the Clonminch borehole in Tullamore, Co. Offaly with a view to advancing our knowledge of deep geothermal resources in the area.

The main outputs for this project included: 1) a core log, 2) a fracture count, 3) x-ray fluorescence analysis, and 4) downhole geophysics carried out by Robertson Geo.

This interim report examines selected sections of interest of the core, presents initial results and preliminary interpretations, and investigates the methods of data acquisition used by the Geological Survey Ireland graduate geologists during the project and details how this process was reformed and refined with an aim to make the process as efficient and effective as possible.

1001 metres of core were analysed using 2 handheld S1 Titan Bruker XRF units. The core was analysed every 50cm, with a duplicate measurement taken after five measurements to act as a method of quality control. The results of this analysis have been compared to the core log of the borehole carried out by Markus Pracht.

A total of 7006 fractures were logged in the core. The fractures were counted and classified in an effort to identify prevalent fracture sets. The fractures were grouped into coring induced, mode 1 and mode 2, and further grouped based on angle with respect to bedding (either sub horizontal to horizontal, or sub vertical to vertical). The most prevalent fracture sets have been selected and examined.

Towards an Early Warning Groundwater Drought Modelling Ensemble: Understanding Aquifer Responses to Climate Extremes Across Irish Catchments

Mohamed, T., Nasr, A., Hynds, P.

Technological University Dublin

d23125166@mytudublin.ie

Predicting groundwater drought is challenging, particularly in Ireland's temperate climate and complex (hydro)geology. To date, groundwater drought in Ireland has yet to be empirically defined despite considerable potential impacts on drinking water supply, ecosystem health, and agricultural productivity. Groundwater catchments are unique in terms of their recharge mechanism(s), influenced by diverse geology, subsurface soil profiles, and surface water-groundwater interactions. Accordingly, “surface to aquifer” ensemble-based modelling likely represents the best approach for groundwater drought across Irish hydrogeology.

The current study aims to characterise and subsequently predict groundwater behaviour to climate extremes (droughts) within the Irish groundwater network by integrating drought indicators with antecedent climate and local hydrogeological setting using machine learning (ML) approaches. Groundwater level (GWL) time series from 100 stations covering the period 2010 to 2023 were used for drought investigation using the Standardised Groundwater Index (SGI), which normalises GWLs to classify drought severity. The method was validated using the 1-in-100-year 2018 drought event, identifying SGI < -1.5 as a suitable drought threshold.

Groundwater droughts were identified using eXtreme Gradient Boosting (XGB) algorithms which were trained using meteorological factors. These models exhibited a wide range of accuracy and precision therefore, top-performing models with an area under the receiver operation characterise curves (AUC) of > 0.8 were delineated and hydrologically profiled to understand the influence of catchment parameters on groundwater drought propagation. Individual models were subsequently aggregated into a drought prediction ensemble based on their performance in relating hydrogeological response to i) climate variability and ii) local hydrogeological setting.

Results indicate that the first ensemble learner effectively predicts drought in areas characterised by short groundwater memory (71 days) and low mean elevation. A series of non-parametric bivariate tests confirmed this learner profile for groundwater memory ($p=0.005$), soil drainage ($p=0.008$), subsoil type, ($p=0.03$) and bedrock type ($p=0.03$). Further model training showed that topographical features (i.e., Elevation, Slope) significantly enhanced model performance. As might be expected, sensitivity analysis highlighted precipitation as a key precursor to drought propagation, with the top learner identifying antecedent rainfall over 60 days as being particularly significant.

Study of the Leinster Granite by 3-D multi-physics joint inversion

Molodtsov, D., Kiyan, D., O'Reilly, B.

Dublin Institute for Advanced Studies

mitya@cp.dias.ie

The Leinster Granite is one of the largest batholiths in Ireland. It is one of the target localities for Enhanced Geothermal Systems investigation and a potentially economically important source of critical elements (e.g., spodumene pegmatite occurrences at Stranakelly Prospect). 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. This was the main aim of the LEGS (Leinster Granite Seismics) wide-angle controlled-source seismic experiment conducted in 1999. We have reprocessed these legacy data to allow for the first 3-D tomographic inversion of the first arrivals. Although the first-arrival traveltime tomography is able to resolve the bottom of the granite plutons, the velocity contrast between the granite and the surrounding formations is relatively low and the ray coverage between the three seismic profiles is rather limited, which complicates the interpretation of the results. The study area is well covered by land gravity observations which provide good constraints on the lateral extent of the granite. Within the framework of the IRETHERM project, magnetotelluric (MT) data were acquired along two profiles transecting the Leinster Granite between the two tranverse seismic profiles. The MT data are able to image the electrically resistive granite and are particularly sensitive to the relatively conductive middle-lower crust and metasediments surrounding the granite bodies, but the sensitivity is limited to the vicinity of the profiles. In order to reduce the uncertainties inherent to the individual inversions, we perform 3-D joint inversion of the gravity, seismic and magnetotelluric datasets. The resulting models will provide new constraints for the 3-D structural geological modelling of the study area.

LA-ICP-MS U-Pb dating applied to calcite unravels post-Variscan shallow crustal deformation histories in Ireland

Monchal, V.[1], Drost, K.[1,4], Murray, J.[2,4], Walsh, J.J.[3,4], Chew, D.[1,4]

[1] Department of Geology, School of Natural Sciences, Trinity College Dublin, Ireland

[2] Earth and Ocean Sciences, School of Natural Sciences, University of Galway, Ireland

[3] School of Earth Sciences, University College Dublin, Belfield, Dublin 4

[4] SFI Research Centre in Applied Geosciences (iCRAG), Ireland

monchalv@tcd.ie

The low Variscan metamorphic grade in Ireland means that syn-kinematic minerals amenable to geochronology are typically absent. So are post-Variscan structural markers such as younger sedimentary rocks and igneous intrusions. This study employs direct U-Pb dating of calcite fracture fills, using an LA-ICP-MS mapping approach that incorporates complementary elemental and textural information. This method facilitates detailed mapping (at the tens of microns scale) of isotope and element distributions (Drost et al., 2018, G3) highlighting potentially different growth zones of calcite. This approach has been applied to calcite vein systems in two sampling regions (Fenit, on the North side of Tralee Bay and the Burren) in southwestern Ireland, The sampling sites are located c. 50 km and 100 km north, respectively, of the Variscan “front” which in Ireland is represented by the northern margin of a zone of enhanced Variscan deformation.

Multiple vein sets were sampled, with some appearing common to both regions. Variscan (c. 312-300 Ma) ages are documented in E-W trending vertical veins in the Burren, and in a structurally-early vein in the Kilfenora anticline (Fenit). A period of tectonic quiescence from end Permian to early Cretaceous times is observed, with no vein growth nor reactivation/age resetting detected. The Kilfenora anticline experienced Paleocene tightening with timing and kinematics consistent with early Pyrenean contraction, while slightly older ages (extending back onto the Maastrichtian) are obtained from “damage zones” in the Burren. Finally, a cluster of Miocene ages with kinematics compatible with N-S shortening (vertical, N-S trending Mode I fracture fills) are observed in both areas and can be attributed to the propagation of far-field Alpine shortening into NW Europe.

Shoreline Dynamics along Tramore Bay, County Waterford: A 24-Year Analysis of Coastal Change (2000–2024)

O’Brien, A., Monteys, X., Caloca, S.

Geological Survey Ireland

Xavier.Monetys@decc.gov.ie, Silvia.Caloca@gsi.ie

Coastal shorelines worldwide, including those in Ireland, are increasingly threatened by erosion due to climate change factors such as sea level rise and intensified storm events. Approximately 20% of Ireland's coastline is experiencing erosion, with unconsolidated (soft) coasts being especially vulnerable (EMODnet, 2021). Tramore Bay, located along the southeast coast of Ireland, faces ongoing erosion driven by natural processes such as wind and wave action, compounded by anthropogenic pressures, specifically recreational activity. As part of the National Shoreline Change Assessment, this study examines the erosional and accretional patterns in Tramore Bay over the past 24 years (2000-2024) and further forecasts future trends. An integrated methodological approach was employed, consisting of a time-series analysis of aerial imagery with manually digitised vegetation lines to quantify shoreline change. Additionally, wave and tidal data, alongside storm records, were analysed to identify key drivers of the coastal dynamics. Preliminary findings identified erosional hotspots where erosional rates exceeded the average of -1m/y, highlighting the dynamic nature of shorelines. While some areas remained relatively stable, instances of high accretion were substantially less frequent. These findings offer insights into the historical shoreline dynamics of Tramore Bay and support the advancement of the National Coastal Change Strategy of Ireland along with climate adaptation initiatives.

The Theology of Extraction

O'Neill, Joseph Nicholas

Trinity College Dublin

oneilj23@tcd.ie

The extractive industry is facing a moral dilemma with respect to sustainability and planetary boundaries. Religious traditions provide insights into understanding human relationship with the earth and creation that may influence future extractive industry strategy. This poster explores theological aspects of mineral extraction and tests our current sustainable resource management frameworks against practical reasoning in moral theory and promotes individual ecological conversion as a solution to sustainable mineral extraction.

Review of Standard Test Methods for Assessing Fines Quality of Aggregates

O'Neill, R.[1], Goodhue, R.[2]

1 Arup & Transport Infrastructure Ireland

2 Geology, Trinity College Dublin, Ireland

roneill1@tcd.ie

The goal of this project is to examine the methods for quality assessment of natural and recycled concrete aggregates (RCA) used in road and pavement construction in Ireland, focusing on the evaluation of fines using the Methylene Blue (MB) and Liquid Limit (LL) tests. Aggregate fines significantly influence the performance, durability, and sustainability of construction materials.

The project uses data derived from samples collected from 30 aggregate-producing sites across Ireland, covering diverse lithologies and geological ages. Key tests performed include the MB test, which measures the presence of reactive clay minerals, and the LL test, which assesses the water content at which fines transition to a liquid state. These methods help determine aggregate cleanliness and predict potential expansion or durability issues.

Key findings suggest that the LL test yields elevated results for RCA, due to the porous nature of residual cement and other fines in RCA. Conversely, the MB test demonstrates reliability in detecting reactive clays, making it a promising alternative to the LL test for assessing RCA fines quality. However, to date in Ireland no limit has been placed on the MB test and this project provides data which may enable the introduction of a limit.

Furthermore, the study highlights that the current LL specification for natural aggregates (NA) in Irish standards may be overly restrictive.

This project also investigates the correlation between MBV and the Thermal Maturation of bedrock. Thermal Maturation is known to alter physical properties of rock. The MB test is being used to examine the effect it has on the reactivity of the clay particles present.

Determining the subsurface temperature at Krafla, Northern Iceland through joint inversion of seismic, elevation, heat flow, and thermal data

Owusu, B. A.[1], Chambers, E. L.[1], Bean C. J.[1,2]

1 Geophysics Section, School of Cosmic Physics, Dublin Institute for Advanced Studies

2 iCRAG, SFI Research Centre In Applied Geosciences, Dublin, Ireland

baowusu@cp.dias.ie

The scarcity of downhole temperature measurements in many parts of the world means we have to rely on indirect geophysical measurements to find heat for geothermal exploration. However, individual geophysical methods are limited by parameter sensitivity and such indirect measurements may not match reality. Joint inversion schemes, such as geophysical-petrological inversion (WINTERC, Fullea et al. 2021), provide the opportunity to combine different geophysical datasets with petrophysical data to determine lithospheric structure and the geothermal potential of different regions (e.g., in Ireland, Chambers et al. 2023, 2024).

We are looking to improve the workflow by incorporating 3D lithospheric structure into the previous 1D geophysical-petrological inversion. The new geophysical-petrological-lithological inversion scheme will help to account for lateral heat flow effects as well as inverting for a multi-layered crust in contrast to the 3-layered crust used in Ireland. In addition, we are including melt in the inversion to model high-enthalpy geothermal systems. We are focusing on a high-enthalpy system at Krafla, Iceland, where geothermal heat has been extracted since 1977. This will provide us with the opportunity to test and refine our model against multiple temperature, petrophysical, and geophysical datasets available within the Krafla geothermal area. This new method will then be applied to model geothermal potential in both low and high enthalpy regions around the world.

Preliminary insights into potential application of random forest (RF) modelling to predict water-table (WT) in selected Irish peatlands

Premrov, A.[1,2], Yeluripati J. [3], Renou-Wilson, F.[4], Walz, K.[5], Byrne K. A.[5,6], Wilson, D.7, Hyde, B.[8], and Saunders, M.[1]

[1] Botany Discipline, School of Natural Sciences, Trinity College Dublin, Dublin, Ireland.

[2] Department of Environmental Science, Faculty of Science, Atlantic Technological University, Sligo, Ireland.

[3] Information and Computational Sciences Department, The James Hutton Institute, Aberdeen, Scotland, UK.

[4] School of Biology & Environmental Sciences, University College Dublin, Ireland.

[5] Department of Biological Sciences, University of Limerick, Limerick, Ireland.

[6] Earthy Matters Environmental Consultants, Donegal, Ireland.

[7] Bernal Institute, University of Limerick, Limerick, Ireland.

[8] Environmental Protection Agency, Regional Inspectorate, The Glen, Monaghan Town, Ireland.

apremrov@tcd.ie ; alina.premrov@atu.ie

Recent Irish peatland restoration activities highlight the need to understand key drivers affecting carbon dioxide (CO_2) fluxes, and to improve methodologies for reporting and verifying terrestrial CO_2 removals/emissions from drained and restored peatlands. The dependency of CO_2 fluxes on the position of the water-table (WT) in these ecosystems, under different land-uses (LU), has been recognised in existing literature (1), and indicates the importance of incorporating the WT variable in predictive models. This study focuses on the potential random forest (RF) application to model WT from selected blanket-bog and raised-bog sites in Ireland under different LU. Provided will be preliminary insights of RF application using on-site measurements (2) and selected geospatial data from E-OBS daily gridded meteorological dataset (3).

Acknowledgements: The authors are grateful to the Irish Environmental Protection Agency (EPA) for funding the projects CO2PEAT (2022-CE-1100) and AUGER (2015-CCRP-MS.30) [EPA Research Programmes 2021-2030 and 2014-2020], as well as to the University of Limerick funding.

(1) Tiemeyer, B., et al., 2020. A new methodology Ecological Indicators 109 105838. https://doi.org/10.1016/j.ecolind.2019.105838.

(2) Renou-Wilson, F., et. al, 2022. Peatland Properties https://www.epa.ie/publications/research/climate-change/Research_Report_401.pdf.

(3) Copernicus Climate Change Service, Climate Data Store, 2020 E-OBS. https://doi.org/10.24381/cds.151d3ec6.

Preliminary cosmogenic ^{10}Be surface-exposure dating of glacial deposits in the Gaddah Valley, McGillycuddy Reeks, Ireland: Implications for late glacial climate variability

Rodriguez, P., Bromley, G., Foreman, A., Roignot, A.

1. Palaeoenvironmental Research Unit, University of Galway, Galway, Ireland

2. Climate Change Institute, University of Maine, Orono, USA

p.rodriguezcaceres1@universityofgalway.ie

We present preliminary results from cosmogenic beryllium-10 (^{10}Be) dating of glacial deposits located adjacent to Coimin Mor lough, McGillycuddy Reeks, in south-west Ireland. The lough is bordered by a complex of 5 lateral-terminal moraines marking the former extents of a small cirque glacier during the Late Pleistocene. A previous study in the area dated two boulders on the complex; however, we aim to achieve a higher chronological and geomorphological resolution of glacier retreat along the valley. Three ages from the innermost moraine and moraine-proximal surfaces yield a mean age of ~12.7 ± 0.1 ka, while a fourth sample was rejected as an old outlier. Thus far, our data suggest (1) the last glacial advance in this valley occurred during the late glacial period and (2) that terminal deglaciation occurred under stadial conditions. This pattern aligns with similar studies utilizing cosmogenic 10Be dating to reconstruct glacial retreat behavior in Scotland, south-western Norway, and Arctic Norway, all of which demonstrate shrinking of glaciers during the Younger Dryas stadial. Together, these data are intriguing, as they contribute to the flourishing discussion about summer temperatures during stadial intervals in the Northern Hemisphere. This ongoing work is part of a larger project involving the detailed geomorphological mapping and chronology of the Gaddagh valley's landforms and modelling of the valley's former glacier system, and will enhance our understanding of the climatic conditions that prevailed in Ireland during the last glacial maximum and the subsequent glacial-interglacial transition.

Expanding the Ireland's Fossil Heritage public engagement programme using a new activity kit loan scheme

Sianis, P. D.[1,2], Franklin, J.[1,2], McNamara, M.[1,2]

1 University College Cork, School of Biological, Earth and Environmental Sciences, University College Cork, Distillery Fields, North Mall, Cork T23 TK30, Ireland

2 Environmental Research Institute, Ellen Hutchins Building, University College Cork, Lee Road, Cork T23 XE10, Ireland

psianis@ucc.ie

Ireland's Fossil Heritage is a science engagement programme funded by Research Ireland and the European Research Council since 2019. The programme aims to foster interest in Science, Technology, Engineering and Mathematics (STEM subjects), the natural world, palaeontology, and Irish fossils, by providing free resources to the public. The delivery of hands-on, curriculum-led workshops in schools has been a major focus of the project, but the reach of this programme has been limited by resources, especially staff time. To address this issue and greatly expand the reach of our project, we have developed a series of standalone activity kits that can be used independently in the classroom by other stakeholders, such as teachers and Geopark staff. The kits include modified versions of activities used in our fossil workshops and were selected as they are intuitive, easy to understand and provide opportunities for pupils to practise the scientific process. The kits are fully self-contained: there are seven sets of all physical materials for the classroom activities to allow students to work in small groups. The kits also contain supporting materials for facilitators, including a manual with detailed instructions, video guides for each activity, printed handouts and brochures. The loan scheme is open to schools across the country and is free of charge; the project team manage all associated logistics. With these kits, many different stakeholders can deliver our fossil workshops independently, with minimal future input from the project team, thus greatly expanding the reach and sustainability of the programme. Feedback from ongoing evaluation of the facilitator experience will inform our understanding of the effectiveness of the loan scheme and future modification of the kit to better serve facilitator needs.

Irish National Seismic Network: Recent observations, new local network in northern Donegal and network upgrades

Smith, P. J.[1*], Grannell, J.R.[1], Möllhoff, M.[1], Craig, D.[1], Collins, L.[1], Grange, P.[1], Hogg, C.[1], Bean, C. J.[1], Verbruggen, K.[2], Mohamed, H.[1]

1 Dublin Institute for Advanced Studies, Geophysics Section, 5 Merrion Square, Dublin 2, Ireland

2 Geological Survey, Ireland (GSI), Booterstown, Blackrock, Co. Dublin

psmith@cp.dias.ie

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 2024 to present, the INSN detected 45 regional earthquakes and over 1900 quarry blasts.

The highest concentration of seismic activity over recent years has been observed in County Donegal. To enhance detection capabilities, a temporary network of 12 to 16 offline seismic stations is planned for Northern Donegal, with eight now installed since December 2024. This expansion aims to improve event localisation, analyze seismicity in greater detail, and identify geological features such as fault structures.

Additionally, recent upgrades to the seismic network include: 1) installation of a posthole seismometer at permanent station DGL2 in Western Donegal to improve performance, and 2) the forthcoming deployment of a posthole seismometer in a 14m deep borehole in County Leitrim for new permanent station, ILET.

The INSN continues to play a crucial role in monitoring seismic activity in Ireland, providing valuable insights into regional tectonics and supporting research on seismic hazards. Future developments will further refine earthquake detection and contribute to a more comprehensive understanding of the geophysical landscape of Ireland.

Can individual Bryde's whales be identified using ocean bottom instrument data and machine learning?

Tary, J. B., Peirce, C., Hobbs, R. W.

Geophysics section, School of Cosmic Physics, Dublin Institute for Advanced Studies, Dublin, Ireland

Department of Earth Sciences, Durham University, Lower Mountjoy, South Road, Durham, DH13LE, UK

tary@cp.dias.ie

When whales vocalize, their calls might include information that depend on each individual whale. The attribution of vocalizations to specific individuals is however generally difficult, time-consuming and requiring dedicated instrumentations such as animal tags. On the other hand, using passive acoustic monitoring may hold promise for this task as it can monitor large areas for long periods of time.

In the present study, we focus on well-located calls of five Bryde's whale tracks recorded by ocean-bottom arrays of hydrophones in the Panama basin. The calls under investigation are ~3-5 s long, and consists of two frequency components at ~20 and ~36 Hz. We use their time-frequency content to characterize the information contained in each call. This information is extracted using the 4th-order Fourier synchrosqueezing transform (FSST4), which is a high-resolution time-frequency transform based on the short-time Fourier transform.

Based on this information, we aim to cluster a subset of high-quality calls into different classes, corresponding to the five different whale tracks, using both unsupervised and supervised clustering techniques, namely the t-SNE and Support Vector Machines (SVM), respectively. The t-SNE clustering shows that the whale calls can be separated into different clusters corresponding to the different whale tracks. The SVM results corroborate those obtained by t-SNE clustering, with models reaching classification balanced accuracies of ~86±5%, their statistical significance corresponding to chance classification associated with 25% balanced accuracy at $p < 0.001$. Being able to classify these calls according to their respective tracks indicate that these Bryde's whale calls could include information about individual whales, and that this information can be derived from ocean bottom data.

Towards Machine Learning Assisted Prediction of Subsurface Seismic Velocity Structure in Highly Scattering Environments

Totten, E., Bean, C. J., O'Brien, G. S.

Dublin Institute for Advanced Studies

etotten@cp.dias.ie

Seismic imaging in volcanic settings is challenging due to wavefield scattering effects from strong impedance changes in the subsurface. This is exacerbated by along-path effects from highly rugous surface topography as well as environmental noise, volcanic tremor and complex earthquake source mechanisms, all of which result in significant codas observed in recorded seismograms. A main challenge of seismic inversion is harnessing these information-rich codas to resolve seismic velocity models on length scales of the smallest significant heterogeneities.

Fourier Neural Operator (FNO) machine learning models can make predictions of physical system states but there are only a few examples of their use in seismology. Previous studies have demonstrated that geologically feasible velocity models can be recovered by FNOs from forward-modelled seismograms when trained on large populations of seismograms and seismic models. FNOs and their variants have also been used for 3D forward-modelling of the seismic wavefield in heterogeneous earth models, resulting in strong waveform fits. However, an outstanding challenge for FNO research is to progress the successful performance of sim-to-sim FNOs to make robust velocity model predictions from field-gathered seismic data.

Here we create a large population of velocity models with statistically-generated perturbations designed to represent heterogeneity on length scales observed for volcanic rocks as informed by field measurements such as petrophysical logs. Full waveform modelling is used to produce a seismogram set for each velocity model. Each forward-modelled wavefield accounts for viscoelastic attenuation with appropriate Q factors for volcanic environments. We train an FNO neural network to predict a velocity model from input seismic records and present in-progress model performance for several seismogram-to-model sets with different population sizes. We address the resolution limits of the FNO-predicted velocity models for each dataset and discuss future applications of the pending, optimally-trained model in full.

Characterizing Geothermal Resource Potential at the Interface Between Buried Granites and Overlying Carbonate Geothermal Reservoirs

Watson, E.L., Torremans, K., Melo, A., Chakraborti, P., Roche, V., Rodriguez-Salgado, P., Kelly, P., Keohane, J.

UCD,

SETU,

ICRAG

elizabeth.andres@ucd.ie

Buried granites are a valuable geothermal resource especially where radiogenic heat production locally raises the geothermal gradient in overlying reservoirs. This study seeks to assess the geothermal potential of the partially buried Leinster Batholith and its interaction with overlying Carboniferous limestone reservoirs in the Ireland's Carlow-Castlecomer area. While significant geothermal heat production has been identified based on granite outcrop work, uncertainty remains regarding subsurface geometry, fault networks, and heat production. This work improves subsurface characterisation, especially of the granite-limestone interface, advancing understanding of fluid pathways and regional heat flow in limestone-granite reservoirs. It introduces an integrated method for subsurface modelling in a geothermal context, refining geothermal assessments for the region and analogous systems globally. A regional 3D subsurface model of the area integrates 500km of 2D seismic, magnetotelluric data, 100+ boreholes, and outcrop data to constrain the geometry and depth of the granite, limestone reservoir units, and fault networks. This data also constrained a gravity inversion through L1-L2 norm regularisation resulting in a detailed model of the granite bodies under the Carboniferous units. This revealed relationships between the buoyant granite batholiths and Mississippian facies development, major fault pattern deflection during Mississippian rifting, and regional dolomitization, and hence, palaeofluid migration. A link is also clear between the buried granites and low thermal conductivity Namurian deposits, acting as thermal "Caps". Preliminary work is being done to analyze heat production from the buried granite from radiogenic element decay in outcrop and core. Future work also aims to take thermal conductivity measurements from limestones and granites to inform a 3D subsurface property model at reservoir scale. Preliminary work is ongoing on the porosity and permeability framework of the mixed limestone-granite reservoirs, examining the complex secondary porosity patterns key to understanding fluid flow.

Helium isotopes: Lifting the veil on the source of fluids for sedimentary rock-hosted Cu, Zn, Ni deposits and iron oxide-apatite (IOA) prospects

Yining Li[a], Finlay M. Stuart[b], Simon Jones[a], Koen Torremans[a], Murray Hitzman[a]

[a] *SFI Research Ireland Centre for Applied Geosciences (iCRAG), School of Earth Sciences, University College Dublin, Belfield, Dublin 4, Ireland*

[b] *Scottish Universities Environmental Research Centre (SUERC), East Kilbride G75 0QF, United Kingdom*

yining.li@icrag-centre.org

Measurement of helium isotope (^{3}He and ^{4}He) ratios from fluid inclusions within sulfide minerals provide powerful tracers of hydrothermal fluid origins in ore deposits, particularly in mantle-derived and hydrothermal systems. However, the application of this technique to sedimentary rock-hosted copper (Cu, Zn, Ni) deposits has been limited due to challenges in extracting helium from low-concentration disseminated sulfides and the complexity of multiple helium sources in sedimentary environments. This study analyzes helium isotopes in coarse grained sulfide minerals from carbonate-hosted Cu, Zn, and Ni deposits in the Central African Copperbelt (CACB) and the Michigan White Pine deposit, as well as Iron Oxide-Apatite (IOA) deposits from Central Zambia, to constrain fluid sources and ore-forming processes. Our results reveal distinct helium isotopic signatures across these deposit types. Sulfides from sedimentary rock-hosted Cu, Cu-Co, Cu-Zn, Cu-Au and Ni deposits in the CACB exhibit low R/R_a values ranging from 0.004 to 0.058 (averaging 0.020), while samples from the White Pine deposit display a narrow R/R_a range of 0.01 to 0.02 (averaging 0.015). These crustal values suggest minimal magmatic influence in both regions. In contrast, IOA deposits from Central Zambia within similar age host rocks to those of the CACB show elevated ^{3}He/^{4}He ratios with maximum R/R_a values of 0.346, indicating significant mantle-derived fluid input. These findings validate that helium isotopes effectively discriminate between major mineral deposit classes and provide crucial insights into the role of magmatic fluids in upper crustal hydrothermal systems.

Characterisation of the White Bridge boulder deposit in central Scotland

Youngeagle, D.D.[1,2], Kelley, S.E.[1,3], Crowell, C.[1,3], Moucheron, M.[1,2]

1 School of Earth Sciences, University College Dublin, Dublin, Ireland

2 Research Ireland

3 SFI Research Centre in Applied Geosciences (iCRAG)

dakota.youngeagle@ucdconnect.ie

The White Bridge Boulder Deposit (WBBD) in the Cairngorm Mountains, Scotland is a 4.4 km2 accumulation of sediment topped by granite boulders. It is deposited at the present-day confluence of the River Dee and Geldie Burn and sits above Neoproterozoic metasedimentary bedrock on the south-eastern margin of the Cairngorm massif, itself comprised of granite. The contact between granite and metasedimentary rocks lies 1.6 km north-west from the deposit up Glen Dee, implicating downstream movement of the granite boulders. This, combined with geomorphic features in upper Glen Dee, leads us to believe the boulders were emplaced by a Glacial-lake-outburst-flood (GLOF). The goal of this investigation is to test this interpretation by characterising the deposit and source area, as well as the timing of deposition.

To characterise the WBBD, we

- measured boulder roundness from boulders in the WBBD and from prominent moraines 5 km up-stream along the River Dee to identify trends within and between both deposits. Preliminary roundness calculations show the WBBD contains smaller and rounder boulders than found at the moraine located up-valley. Within the WBBD, a trend towards larger boulders in the centre of the deposit can be seen, however no spatial trend for roundness exists. A comparison of the roundness data with other Kirkbride datasets puts the deposit into context between coastal boulder deposits and more angular moraine deposits.

- implemented drone-supported photogrammetric survey to create a digital surface model (DSM) for morphometric mapping, in order to examine surface morphology and assess the depositional evolution.

- and collected samples for ^{10}Be exposure dating to determine the timing of deposition. Five samples from boulders in the WBBD were collected for ^{10}Be exposure dating analysis, which are currently being prepared at University College Dublin for cosmogenic isotope extraction.

In total this work will allow us to characterise the deposit and gain an understanding of the process and timing of deposition, therefore advancing our knowledge of the formation of the existing geomorphic features.