Geochemistry Group
Research in Progress 2026

Mineralogical Society

The Geological Society

University of BRISTOL

Programme and abstract booklet

UNIVERSITY OF BRISTOL
School of Chemistry, Cantock's Close

Dear Delegates,

Welcome to the 2026 Geochemistry Group's Research in Progress Meeting! We hope you enjoy your time here in the wonderful City of Bristol. GGRiP aims to provide a showcase for new geochemical talent in Great Britain and Ireland across the many areas of Geochemistry. The Geochemistry Group's ethos is about creating a welcoming and inspiring environment at GGRiP. Therefore, please ensure you are following our Code of Conduct (https://www.minersoc.org/code-of-conduct.html). If you have any questions or queries, please ask the local committee members marked by star on their badges.

The main conference will be held in the School of Chemistry, University of Bristol, Cantock's Close, BS8 1TS. This will be signposted from Woodland Road. The conference dinner will be held from 7pm–9pm at The Stable, Canon's Road, Bristol, BS1 5UH. Directions can be found on the website ggrip2026.co.uk.

We would very much like to thank our amazing sponsors for their generosity! We encourage delegates to engage with our sponsors throughout the meeting.

We hope you enjoy GGRiP 2026!

-The Bristol Committee ☺

Contents

Meet the Bristol Committee!

- Dr. Kathryn Shaw (Lead Organiser)
- Dr. Jamie Lewis (Workshop Organiser)
- Dr. Chris Coath
- Dr. Nidha Eriyattukuzhiyil
- Dr. Emmeline Gray
- Mr. Bernát Heszler
- Mr. Gowtham Sekar

We also thank Prof. Ian Bull and Dr. Tim Knowles for their help with the workshop.

We thank our amazing sponsors!

Anton Paar

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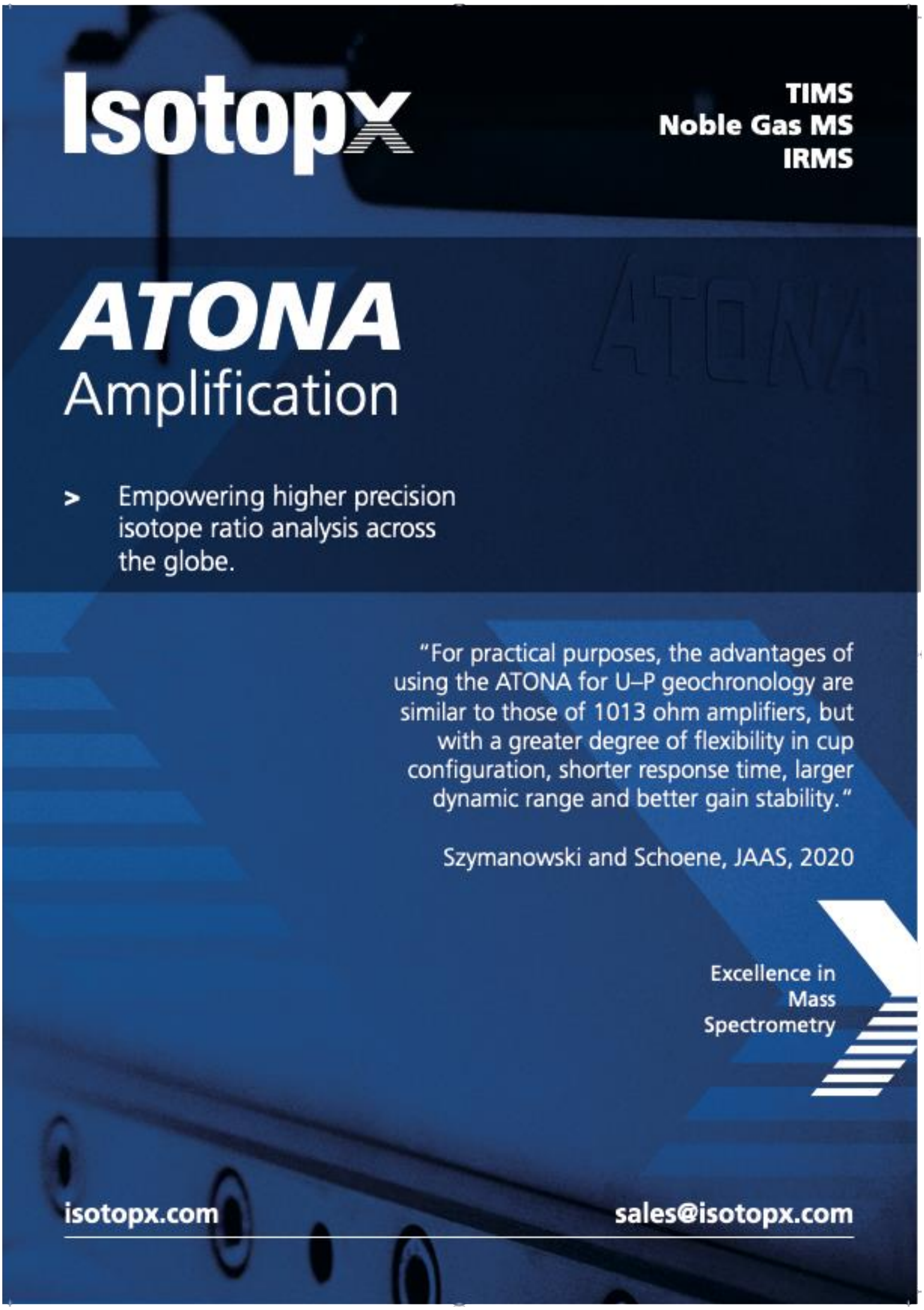

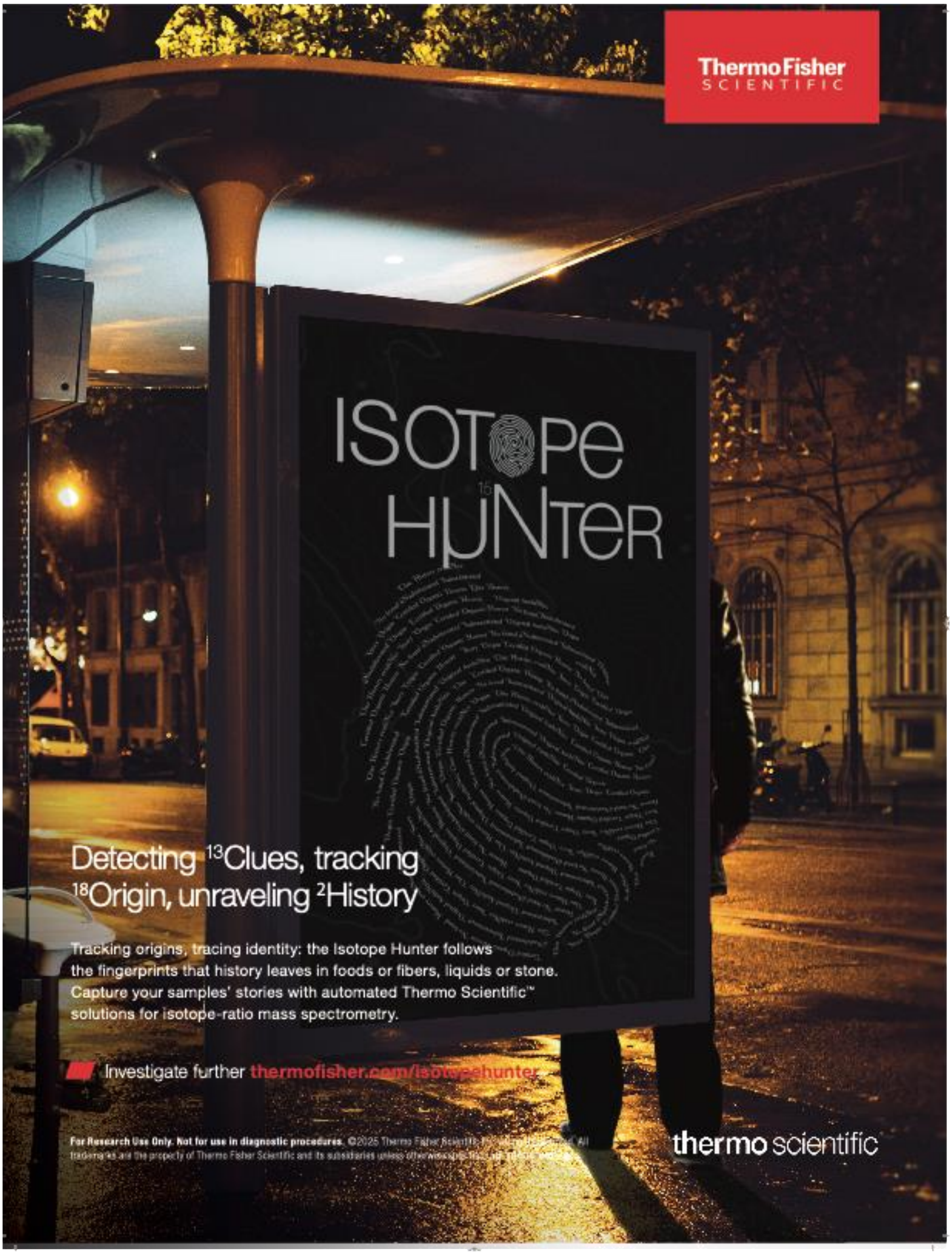
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Key Information

Icebreaker Sponsored by MK

The icebreaker will take place in the chemistry foyer, surrounded by our sponsors and poster presenters. Drinks will be available from 5pm. Please leave the building at 7pm promptly for security reasons.

Conference Dinner Sponsored by Isotopx, Sercon, and Edinburgh Instruments

The dinner will take place at **The Stable** on Bristol's waterfront in the city centre (https://stablepizza.com/bristol/). Pizza will be included with your conference registration! Those with allergies please let the staff at the restaurant know when you arrive and they will cater for you.

Cleanroom Tours

As part of GGRiP 2026 partnered with MK we are offering 20-minute lab tours to visit our start of the art metal-free cleanroom during coffee and lunch breaks. Please either sign up for this at the **registration desk** or visit **MK's booth** during the conference. Spaces on each tour are limited due to room size so it will be on a first come basis.

Please note, to reach our cleanroom you must pass through an active nuclear laboratory and as such you will be given a lab coat to wear and may be asked to undergo a quick hand and foot contamination monitor before we leave

Day	Session Time	Title	Presenter	Information
Tuesday 24th March	**12:00 – 13:00**	***Registration* in Chemistry Building**		
Session 1	13:00 – 13:05	***Welcome and Information***	Kathryn Shaw	Bristol Lead Organiser
13:00 – 14:50	13:05 – 13:20	Introduction to the MK metal-free clean laboratory at Bristol Isotope Group	Florian Kuhl	MK Versuchsanlagen GmbH & Co, Sponsor
	13:20 – 13:35	Boron isotopes of planktic Orbulina universa under decoupled carbon chemistry	Wei-Ning Fang	University of Cambridge
	13:35 – 13:50	Understanding the trigger mechanisms for OAE1d using boron isotopes	Gowtham Sekar	University of Bristol
	13:50 – 14:20	Small amounts of nitrogen tell us big stories about past climates and ecosystems	Alexandra Auderset	Keynote, University of Southampton
	14:20 – 14:35	Nitrogen in strongly peraluminous granites reveals a significant increase in biomass burial and O_2 production prior to the Neoproterozoic Oxygenation Event.	Fawn S. M. Holland	University of St Andrews
	14:35 – 14:50	Carbon dioxide release from Arctic mountain rivers driven by sulfide oxidation	Sabina Sulikova	University of Oxford
	14:50 – 15:15	**Coffee Break**		
Session 2	15:15 – 15:30	Interference removal strategies quadrupole ICP MS for the accurate analysis of geological samples	Matthew Cassap	Agilent Technologies, Sponsor
15:15 – 17:00	15:30 – 15:45	Lithium mobilisation during metapelite melting: insights and open questions	Elisa Oliveira da Costa	University of St Andrews
	15:45 – 16:00	B, Sr, and O Isotopic Records of Alteration in the Basement of the Lost City Hydrothermal System.	Will Osborne	University of Leeds
	16:00 – 16:30	The double-edged sword of trace element mobility during high-temperature metamorphism	Barbara E. Kunz	Keynote, The Open University
	16:30 – 16:45	Zoned Triple Oxygen Isotope Record in UHP Garnet from Dora-Maira	Kyra L. Schroeder	Boston College, USA
	16:45 – 17:00	Reductive leaching experiments quantify Pb isotope and element release during silicate weathering	Katie Brown	University College London
	17:00 – 19:00	**Ice Breaker, Chemistry Foyer**		

Day	Session Time	Title	Presenter	Information
Wednesday 25th March	**09:00 – 9:30**	**Morning Tea, Coffee and Pastries**		
Session 3	09:30 – 09:45	Extreme Fe Isotope Variability in 3-Billion-Year-Old Greenland Carbonatites.	Ségolène Rabin	University of Cambridge
09:30 – 11:00	09:45 – 10:00	Variations in Hawaiian Plume Flux Controlled by Ancient Mantle Depletion	Paul Béguelin	Invited Talk, Cardiff University
	10:00 – 10:30	Return of the Layered Mantle?	Tim Elliott	Keynote, University of Bristol
	10:30 – 10:45	Stable Cerium Isotopes as a Tracer of Crustal Recycling	Jane E. Macdonald	University of Cambridge
	10:45 – 11:00	Progress on in situ Rb-Sr dating using the Neoma multi-collector tandem mass spectrometer (LA-MC-ICP -MS/MS)	Alex Simpson	British Geological Survey
	11:00 – 11:30	**Coffee Break, Lab Tours**		
Session 4	11:30 – 11:45	Comparing seasonal assimilation of inorganic ^{15}N and organic ^{13}C^{15}N nutrients by freshwater biota in a stream mesocosm	Ana T. Castro-Castellon	University of Bristol
11:30 – 13:00	11:45 – 12:00	Investigating the impact of environmental character on dissolved organic nutrient uptake by freshwater biota using mesocosm experiments	Charlotte L. Briddon	University of Bristol
	12:00 – 12:30	Bridging the gap between isotope geochemistry and plant sciences	Rebekah E. T. Moore	ECR Lecturer Awardee 2025/26, Imperial College London
	12:30 – 12:45	Mediterranean basins responses to connectivity changes during the Messinian Salinity Crisis: Evidence from Strontium Isotopes	Caroline Aparecida Pereira Dias	University of Bristol
	12:45 – 13:00	pH-driven compositional variability in amorphous calcium-magnesium carbonate	Peter Methley	University of Cambridge

Day	Session Time	Title	Presenter	Information
Wednesday 25th March	**13:00 – 14:00**	**Lunch and Coffee, Lab Tours**		
Session 5	14:00 – 14:15	Streamlined Workflows for Geochemical Laser Ablation and a New IRMS chamber for Carbon and Oxygen Isotope Measurement	David N. Douglas	Elemental Scientific
14:00 – 15:30	14:15 – 14:30	Contemporaneous formation of chondrules and CAIs recorded by Al–Mg dating of individual chondrules	Judy Wang	University of Bristol
	14:30 – 14:45	Halogen abundances in chondrule mesostasis of ordinary and carbonaceous chondrites	Julia Neukampf	University of Manchester
	14:45 – 15:00	Identification of a chondritic mantle reservoir in Mars from the 1.27-billion-year-old olivine-phyric shergottite Northwest Africa 13441	Dylan M. Seal	Boston College, USA
	15:00 – 15:15	Tellurium Isotope Fractionation During High-Temperature Volatilisation on Achondritic Parent Bodies	Joshua Hollowood	Imperial College London
	15:15 – 15:30	The effect on core formation of the extreme thermal and rotational states of planets after giant impacts	Simon J. Lock	University of Bristol
	15:30 – 17:30	**Poster Session: Tea, Coffee, cake**		
	19:00 – 21:00	**Group Dinner: The Stable, Bristol**		

Day	Session Time	Title	Presenter	Information
Thursday 26th March	**09:00 – 9:30**	**Morning Tea, Coffee and Pastries**		
Session 6	09:30 – 09:45	Monitoring Mobile Metals: A Pb-Zn Isotopic Approach to Trace Metal Pollutant Sources in Rivers	Luke Franks	Durham University
09:30 – 11:00	09:45 – 10:15	Novel Phosphate-Oxygen Stable Isotope Analysis of Sediments: Reconstructing the Impact of Sewage Management on Algal Blooms	Savannah Worne	ECR Lecturer Awardee 2025/26, Loughborough University
	10:15 – 10:30	Tracking Volcanic Unrest through Mercury: Insights from Santorini and Kolumbo during the 2025 Seismic Crisis	Sofia Della Sala	University of Oxford
	10:30 – 10:45	Early Evolution of the Palaeogene Mull volcano: An integrated volcanological, Geochemical and Geochronological approach	Fiona J. Goddard	Cardiff University
	10:45 – 11:00	Determining the season of past volcanic eruptions from glacio-chemical records in Greenland ice cores	Mengwen Yang	University of St Andrews
	11:00 – 11:30	**Coffee Break, Lab Tours**		
Session 7	11:30 – 11:45	Unmixing sources of organic carbon: an approach integrating bulk and distributional data	Jotis Baronas	Durham University
11:30 – 13:00	11:45 – 12:00	Optimising laser ablation-based methods for long sea surface temperature proxy reconstructions from coral skeletons	Thomas Arney	University of Southampton
	12:00 – 12:30	Mineralogical Controls of the Oceanic Nickel Cycle	Lena Chen	ECR Medal Awardee 2026, University of Bristol
	12:30 – 12:45	An osmium isotope record of continental weathering from the northern Tethys	Naomi J. Saunders	Royal Holloway
	12:45 – 13:00	Tracing sources of serpentinization fluids in the Mariana Forearc using stable and radiogenic strontium isotopes	Kristijan Rajič	Durham University
	13:00 – 14:00	**Lunch and Coffee**		
	14:00 – 15:30	**AGM and Awards**		

Poster No.	Lead Author	Title and link to abstract
1	Markus Adloff	Influences of seawater composition and paleogeography on the stability of Cretaceous marine carbon and oxygen cycling
2	Emily Baker	Revealing Hidden Magmatic Processes in Subduction Zone Plumbing Systems Using Plutonic Xenoliths
3	Lewis Banks	Combining femtosecond laser ablation and ultra-fast washout sample chambers; an evaluation of ablation craters and the application to multi-element mapping
4	Elliot Carter	What can iodine in altered seafloor rocks tell us about the long-term carbon cycle?
5	Alma Chavez	Using geochemical techniques to trace the origin of human remains
6	Elisa Oliveira da Costa	Quantifying changes in biomass burial over geological time: the effect of melt-back reactions to N mobilisation
7	Victoria Dutch	Targeting key unknowns in terrestrial Arctic CO_2 fluxes
8	Hannah Elms	Stable cadmium isotopes track the evolution of carbon burial and basin redox during the Toarcian Ocean Anoxic Event
9	Julian Fuchs	Why less stable doesn't mean less important: looking at vaterite as an underestimated calcium carbonate precursor phase
10	Kate Greenaway	The stable hafnium isotope composition of ocean island basalts
11	Daniel Gaskell	Correcting for pH and temperature effects on $\delta^{13}C$ and $\delta^{18}O$ in foraminifera
12	Elise Harrington	Nitrogen isotope variation as a proxy for pH in the Eocene Green River Formation, USA
13	Bernat Heszler	Spatially Resolved Boron Isotope Records Support a Strong CO_2–Temperature Coupling During the Late Cretaceous Hothouse
14	Satya Ilindra	Decoupling Carbonate Chemistry Controls on Coral Calcification Using Boron Isotopes in *Acropora millepora* and *Acropora spathulate*
15	Eleanor John	Microscopic elemental banding in *Morozovella*: Evolutionary insights and implications for Paleogene SST proxies
16	Emma Johnson	Mineralogy, Biogeography, and Proxy Potential of New Zealand/Southwest Pacific
17	Alexander Krause	The impact of spatial weathering on atmospheric O_2 and CO_2 predictions in isotope mass balance driven models
18	Frederick Lacey	Differential retention of Rb-Sr and U-Pb in subducted oceanic crust, evidence from the Zermatt–Saas Ophiolite
19	Pratyusha Madhnure	Environmental Controls on Trace Element Incorporation in Coccolithophore Calcite

20	Isabel Marshall	Temporal and Structural Constraints of Magmatism and Hosted Mo Mineralisation: The Inner Starav Granite, Etive Pluton, Scotland
21	Guy Morley	Diffusion-reaction modelling to predict the boron isotope composition of photosymbiont species *O. universa* from observed physiological fluxes
22	Meherun Nesha	Investigation of Zinc Accumulation in Cacao (*Theobroma cacao*) Trees via Natural Stable Isotope Analysis
23	Shardul Pandit	Plio–Pleistocene Indian Summer Monsoon evolution: new insights from the Bay of Bengal
24	Daniel Roberts	10–100 pg Nd Isotope Analysis via NdO and TE-Stabilised Emission on NuTIMS
25	Jose Sebastian Nava de la Pena	Tracing the Source of Archaean Rare-metal Pegmatites using Silicon Isotopes ($\delta^{30}Si$)
26	Joe Stewart	A millennium of cold-water coral habitat loss in the East Pacific during low ENSO variability in the mid- to late-Holocene
27	Lucy Stott	Characterisation of ochreous mining waste in the UK to optimise sustainable bioprocessing of iron oxyhydroxides
28	Patrick Sugden	Automating column chemistry for sulfur isotope analysis by solution-based mass spectrometry using a prepFAST-MC
29	Oscar Terry	Closed-System Behaviour of Subducted Serpentinites Revealed by Sr-Pb Isotopes in the Zermatt-Saas Ophiolite
30	Helen Underwood	Interglacial changes to the Greenland ice sheet and impacts on weathering
31	Stephanie Walker	New isotope and geochemical facilities at the University of Exeter, Camborne School of Mines
32	Lulu Wang	Reconstruction of marine redox landscape during the Cryogenian interglacial oceans using thallium isotopes
33	Bridget Warren	Greenland Sea Surface Temperatures during the mid-Piacenzian Warm Period
34	Ross Whiteford	Using Cadmium Isotopes To Quantify Marine Organic Carbon Burial during the Paleocene–Eocene Thermal Maximum
35	Kai Wen	Slab window processes in the final stage of an ancient convergent margin: Insights from the eastern Central Asian Orogenic Belt
36	Sophie Westacott	Simultaneous boron and silicon measurements on single biogenic silica samples
37	Lucy Wright	Constraining the Temperature Sensitivity of Microbial Rock Organic Carbon Oxidation
38	Kirsten Wong	Quantifying changes in biomass burial over geological time
39	Jia Yin	Application of FT-ICR MS in Shale Oil Evaluation: A Case Study from the Saline Lacustrine Shales of the Qaidam Basin, China

Session 1

Chairs: David Wilson and Savannah Worne

Introduction to the MK metal-free clean laboratory at Bristol Isotope Group

Kuhl, F.*

*florian.kuhl@mk-versuchsanlagen.de

[1] MK Versuchsanlagen GmbH & Co. KG, Muecke, Germany
[2] MK METALFREE IRELAND Ltd., Dublin, Ireland
[3] MK METALFREE Corp., Surprise, AZ, USA

Metal-free clean labs are of great interest for geochemical and cosmochemical research. Especially for chemical and isotopic analyses of trace elements, it is critical to protect samples against airborne contaminants and metal particles, while simultaneously ensuring the safety of the operator. Our company has more than 35 years of experience in metal-free cleanrooms and workstations with laminar airflow and is a trusted partner in the scientific community.

At the University of Bristol, in collaboration with the Bristol Isotope Group, we present an introduction with a lab tour to the metal-free clean laboratory, which was planned, designed and built in close cooperation with Prof. Tim Elliott's group.

In our talk, we will briefly discuss the project itself, the timeline and the outcome. Afterwards I want to catch up my last years talk and give a deeper insight into human dust generation and how to avoid bringing particulate matter into a cleanroom itself. These considerations are also intended to ensure that subsequent laboratory visits in small groups can be carried out with as little disruption as possible to the atmosphere of the cleanroom and to the researchers working there.

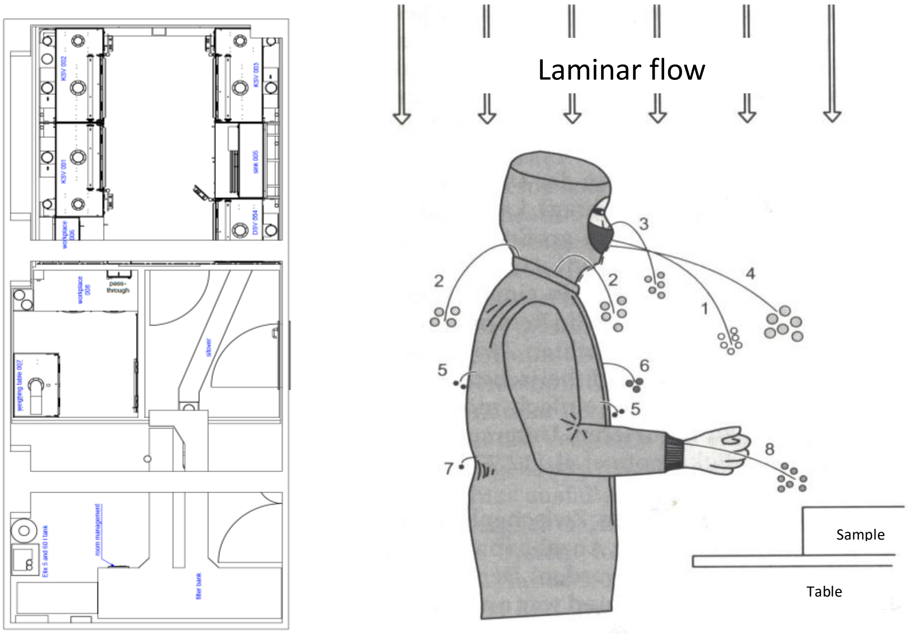

Figure 1: Left: Layout of the MK metal-free cleanroom at Bristol University, right: Schematic of particulate matter generated by a person wearing cleanroom clothes.

Boron isotopes of planktic *Orbulina universa* under decoupled carbon chemistry

Wei-Ning Fang[1], Hana Jurikova[2], James Rae[2], and Oscar Branson[1]

[1]Department of Earth Sciences, University of Cambridge, CB2 3EQ, UK
[2] School of Earth and Environmental Sciences, University of St Andrews, KY16 9TS, UK

Boron isotopes ($\delta^{11}B$) in foraminifera are commonly used as a proxy for seawater pH. This application relies on the widely accepted mechanism that marine carbonates incorporate charged borate ions (BOH_4^-) from seawater into the calcite lattice, with the $\delta^{11}B$-BOH_4^- varying as a function of pH. However, observations show that (1) the pH in foraminiferal microenvironment is strongly influenced by photosynthesis and respiration, and (2) foraminifera actively create a pH gradient via proton pumping during calcification. These observations raise a key question: how can foraminiferal $\delta^{11}B$ reflect ambient seawater pH when the pH at the site of calcification is heavily modified?

To better understand the mechanisms of boron incorporation, we present new $\delta^{11}B$ data of planktic *Orbulina universa* cultured under decoupled carbonate chemistry conditions, where pH, dissolved inorganic carbon (DIC), and carbonate ion concentration ($[CO_3^{2-}]$) were varied independently. This design allows us to isolate the influence of each parameter on foraminiferal $\delta^{11}B$.

Our results show that foraminiferal $\delta^{11}B$ values are generally positively offset from the theoretical $\delta^{11}B$-BOH_4^-. However, the magnitude of this offset (up to +5‰) varies under different carbonate system conditions, without a dominant control exerted by any single parameter. These results are interpreted to shed light on the complex boron incorporation pathway in foraminifera, and offer a potential explanation for species-specific offsets from $\delta^{11}B$-BOH_4^-.

Understanding the trigger mechanisms for OAE1d using boron Isotopes

Gowtham Sekar[1]*, Markus Adloff[1], Brian T. Huber[3], Rich Pancost[1], Fanny Monteiro[2], Michael J. Henehan[1]

[1] School of Earth Sciences, University of Bristol, Bristol, UK
[2] School of Geographical Sciences, University of Bristol, Bristol, UK
[3] Department of Paleobiology, MRC-121, Smithsonian Institution, Washington DC, USA
** Presenting Author, gowtham.sekar@bristol.ac.uk*

The need to understand the trigger mechanisms behind the Cretaceous Oceanic Anoxic Events (OAEs) has become increasingly important with the ongoing expansion of oxygen minimum zones (OMZs). Increased nutrient input – particularly phosphorous (P) – due to volcanic CO_2 emissions has been suggested as a key driver [1], with P regeneration from anoxic sediments sustaining them [2]. Studies have shown that the strength and the efficiency of the biological pump play a major role in controlling the intensity and position of the OMZ [3]. Intriguingly, several Cretaceous OAEs are associated with a decline in the abundance of pelagic marine calcifiers [4], which could decrease the efficiency of the biological pump via a reduction in $CaCO_3$ mineral ballast [5]. Conversely, elevated nutrient concentrations during the Cretaceous OAEs would increase the strength of the biological pump. Therefore, understanding the changes in the biological pump might provide better insights into the trigger mechanisms behind the OAEs.

Here, we present new boron isotope-derived via MC-ICP-MS analysis of planktic and benthic foraminifera across OAE 1d, a relatively poorly-studied event, whose cause is unclear. Our new multispecies timeslices provide insights into surface pH and vertical water column pH gradients across OAE 1d, helping detangle changes in atmospheric CO2 and biological pump efficiency across this enigmatic event.

[1] Monteiro et al (2012) *Paleoceanography*, 27(4).
[2] Beil et al (2020) *Clim. Past*, 16(2), 757-782.
[3] Meyer et al (2016) *Geobiology*, 14(3), 207-219.
[4] Jones et al (2023) *Nature Geoscience*, 16(2), 169-174.
[5] Henehan et al (2019) *Proceedings of the National Academy of Sciences*, 116(45), 22500-22504.

KEYNOTE:

Small amounts of nitrogen tell us big stories about past climates and ecosystems

Alexandra Auderset[1]

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SO14 3ZH, UK

Fossil-bound nitrogen isotopes are emerging as a powerful yet complex proxy in paleoceanography, capable of capturing signals that span from global-scale nutrient cycling to organism-level metabolic processes. This proxy targets organic matter locked within biomineral crystal lattices, offering exceptional preservation over large geological timescales. In this talk, I will introduce this new proxy and the denitrifier method, a bacterial conversion technique that allows high-precision $\delta^{15}N$ measurements from nanomolar quantities of nitrogen preserved within million-year-old fossils. With two case studies on foraminifera-bound $\delta^{15}N$ (FB-$\delta^{15}N$) I will demonstrate how this approach opens new windows into the past ocean system.

First, I examine the large-scale biogeochemical evolution of marine oxygen-deficient zones (ODZs) across the Cenozoic using FB-$\delta^{15}N$. In contrast to future projections, we find evidence that the eastern equatorial Pacific ODZ contracted during Cenozoic climate optima, including the PETM, whilst the Arabian Sea and eastern tropical Atlantic display a more complex, regionally variable response.

Second, I assess FB-$\delta^{15}N$ as a tool for identifying symbiotic relationships and microscale nutrient cycling. Using a new global compilation of core-top and Holocene data, along with glacial/interglacial records from the South Atlantic, we observe consistent $\delta^{15}N$ differences between symbiont-bearing and symbiont-barren species. Symbiont-bearing species appear to retain low-$\delta^{15}N$ foraminiferal ammonium waste, reducing their trophic enrichment signature. Building on this finding, I use FB-$\delta^{15}N$ to reconstruct species-specific symbiosis in extinct foraminifera, a key information for the evolution of life (not just foraminifera) and in the application of many geochemical proxies.

Nitrogen in strongly peraluminous granites reveals a significant increase in biomass burial and O_2 production prior to the Neoproterozoic Oxygenation Event.

Fawn S. M. Holland[a], Eva E. Stüeken[a], Wei Dan[b], Wenxiang Zhang[c,d], Yu Zhu[e], Sami Mikhail[a]

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[b] State Key Laboratory of Deep Earth Processes and Resources, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China.
[c] School of Earth and Planetary Sciences, China University of Geosciences, Wuhan, 430074, China.
[d] School of Earth Sciences and Engineering, Xi'an Shiyou University, Shaanxi, 710065, China.
[e] Hubei Key Laboratory of Petroleum Geochemistry and Environment, College of Resources and Environment, Yangtze University, Wuhan 430100, China.

Strongly Peraluminous Granites (SPGs) are mostly formed by the partial melting of metasedimentary rocks and can reflect the chemical properties of their sedimentary protoliths. Recent work (Mikhail et al., 2024) suggests that unaltered SPGs with elevated [N] reflect the elevated [N] of their sedimentary protolith, and this additional nitrogen comes from sediment-hosted biomass. Therefore, the nitrogen content ([N]) of SPGs preserves changes in biomass burial over time. This archive reveals an increase in biomass burial by a factor of 5- to 8-fold between 1.4 – 0.5 Ga (Mikhail et al., 2024)

In our recent study (Holland et al., 2026) we analysed the nitrogen abundances and isotopic values of SPG samples from 1.0 to 0.7 Ga to better resolve the period when biomass burial increased. We find that SPG [N] increases 2.4-fold across the Mesoproterozoic-Neoproterozoic boundary at 1.0 Ga and 2.8-fold across the Neoproterozoic-Phanerozoic boundary at 0.5 Ga. Therefore, with consideration of the time lag from biomass burial to SPG formation, we suggest that biomass burial first began to increase in the late Mesoproterozoic.

Biomass burial removes organic carbon, a reductant, from Earth's surface, causing a net production of O_2. Therefore, these data permit us to calculate an increase in O_2 production from biomass burial starting in the Mesoproterozoic, yielding an additional 6.3×10^{20} to 30×10^{20} moles of O_2 throughout the Neoproterozoic, possibly contributing to the Neoproterozoic Oxygenation Event and the chain of events which resulted in an environment capable of supporting animal life in the Cambrian.

References

Holland, F.S.M., Stüeken, E.E., Dan, W., Zhang, W., Zhu, Y., Mikhail, S., 2026. Nitrogen in strongly peraluminous granites reveals a significant increase in biomass burial and O2 production prior to the Neoproterozoic Oxygenation Event. Earth Planet. Sci. Lett. 679, 119890. https://doi.org/10.1016/j.epsl.2026.119890

Mikhail, S., Stüeken, E.E., Boocock, T.J., Athey, M., Mappin, N., Boyce, A.J., Liebmann, J., Spencer, C.J., Bucholz, C.E., 2024. Strongly peraluminous granites provide independent evidence for an increase in biomass burial across the Precambrian–Phanerozoic boundary. Geology 52, 87–91. https://doi.org/10.1130/G51800.1

Carbon dioxide release from Arctic mountain rivers driven by sulfide oxidation

***Sabina Sulikova**[1*], Joshua Dean[2], Mark H Garnett[3], Jordon Hemimgway[4], Leonardo Mena Rivera[1], Catherine Baldwin[1], Zheyu Tian[1], Hilde Cronwright[1], Christopher Day[1], Suzanne Tank[5] and Robert Hilton[1]*

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[2]School of Earth Sciences, University of Bristol, Wills Memorial Building Queens Road, Bristol BS8 1RJ, UK
[3]NEIF Radiocarbon Laboratory, Scottish Universities Environmental Research Centre (SUERC), Rankine Avenue, East Kilbride, Glasgow G75 0QF, UK
[4]Department of Earth and Planetary Sciences, ETH Zurich, Sonneggstrasse 5, 8092 Zurich, Switzerland
[5]Department of Biological Sciences, University of Alberta, CCIS 2-281, Edmonton, AB, T6G 2E9, Canada

Rivers play an important role in the global carbon cycle, acting as dynamic pathways that transport and emit carbon dioxide (CO_2) from terrestrial environments to the atmosphere. Mountain rivers contribute importantly to this flux and are undergoing rapid hydrological and climatic change, particularly in Arctic regions underlain by permafrost. Understanding the controls on river CO_2 release is essential for predicting how these fluxes may respond to future warming. We investigated the drivers and sources of CO_2 emissions from mountain rivers in the Canadian Arctic, where permafrost thaw and ongoing warming are accelerating chemical weathering rates. Across 42 sites spanning lithology, slope, and climate gradients, we measured dissolved gases and CO_2 fluxes alongside major ion chemistry, pH, alkalinity, and isotopic tracers ($\delta^{13}C_{CO2}$ and $F^{14}C_{CO2}$). This multi-proxy approach reveals strong spatial variability in CO_2 release across the Mackenzie basin, with negligible emissions from catchments draining igneous and metamorphic units. Highest CO_2 emissions were found in catchments with high rates of sulfide mineral oxidation and carbonate weathering. We propose that sulfuric acid production can lower river pH and drive CO_2 outgassing with radiocarbon evidence indicating widespread geological carbon inputs. Young CO_2 release from hotspots of sulfide weathering points toward oxidative weathering driving greenhouse gas release even when carbonate minerals are not weathered. Our findings reveal a previously unrecognised pathway for carbon transfer from the lithosphere to the atmosphere via mountain streams, controlled by oxidative weathering processes which may increase with ongoing warming and permafrost thaw in sedimentary rock dominated basins.

Session 2

Chairs: Jane Barling and Elliot Carter

Interference removal strategies quadrupole ICP-MS for the accurate analysis of geological samples

Matthew Cassap, Sonia North.

Agilent Technologies LDA UK Ltd

Accurate quantification and isotope ratio measurements using ICP-MS are frequently limited by spectral interferences, including polyatomic species, isobaric overlaps, and matrix-induced background signals. These challenges are addressed differently in single-quadrupole (SQ) and triple-quadrupole (TQ/QQQ) ICP-MS systems, each offering unique strengths in interference removal.

In SQ ICP-MS, helium collision mode with Kinetic Energy Discrimination (He-KED) provides an effective universal approach for removing polyatomic ions. The Agilent 7850 ICP-MS demonstrates robust suppression of common interferences such as ArO^+, $ArCl^+$, and BaO^+, enabling accurate multi-element analysis of complex geological matrices, including REE-rich basalt. The ORS cell exploits cross-section differences to selectively remove interference, allowing analyte ions to pass while eliminating spectral overlaps. This approach supports high-throughput routine analysis and stable long-term performance.

In contrast, TQ ICP-MS introduces MS/MS control to selectively remove severe isobaric interference. The Agilent 8900 uses oxygen reaction gas to convert Sr isotopes to mass-shifted oxide ions (e.g., $^{86}SrO^+$, $^{87}SrO^+$), thereby separating them from unreactive $^{87}Rb^+$ and enabling high-precision isotopic ratio measurements. Optimized cell reaction conditions and timing adjustments further suppress plasma-derived flicker noise and enhance measurement precision to levels approaching MC-ICP-MS performance.

Together, these instrumental strategies provide a comprehensive solution for laboratories requiring both routine multi-element quantification and high-accuracy isotopic analysis, offering complementary pathways to achieve interference-free results.

Lithium mobilisation during metapelite melting: insights and open questions

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The growing demand for Li – essential to modern economies and green energy – is prompting closer examination of all geological processes related to the genesis of Li deposits. While studies on the genesis of enriched peraluminous granitoids has traditionally focused on the magmatic-hydrothermal stages of enrichment, recent works have also been focusing on the preceding metapelite melting stage. However, these studies employed different partition coefficients, which predict contrasting behaviour. Melting models based on experimental partition coefficients predict that biotite-dehydration melting generates more enriched melts (Koopmans et al., 2024), while melting models based on natural partition coefficients produce more enriched melts during muscovite-melting (Ballouard et al., 2024). To bridge that gap, we compared novel and published in-situ mineral Li concentrations with equilibrium melting models. Our results corroborate with recently observed mica trends (Kunz et al., 2022). and show that cordierite concentrations decrease with increasing temperature. The comparison between mineral/mineral Li concentrations indicates natural partition coefficients better reproduce nature, which indicates biotite-dehydration with peritectic garnet – at intermediate to lower crustal depths – enhances Li mobilisation to the melt. However, neither model perfectly reproduces nature. Future studies are still needed for us to understand how Li concentrations are affected by diffusion during cooling, as well as how these coefficients vary with temperature. Similarly, clear differences between the physicochemical parameters associated with experiments and natural examples – protolith and mineral major element compositions, particularly water and fluorine – need to be investigated. Our work highlights biotite dehydration melting at higher pressures more efficiently mobilises Li. Nevertheless, more studies are necessary before we can accurately constrain how Li behaves during melting.

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B, Sr, and O Isotopic Records of Alteration in the Basement of the Lost City Hydrothermal System.

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Serpentinization of mantle rocks exposed at the seafloor along slow spreading mid ocean ridges facilitates transfer of key volatile elements (C, S, H, B, Li etc.) between seawater and the oceanic lithosphere and fuels unique hydrothermal systems which vent alkaline fluids rich in organic molecules. Despite extensive dredging, shallow drilling and vent fluid sampling in several peridotite hosted hydrothermal systems the metamorphic conditions, fluid pathways and reaction sequences which control vent fluid chemistries are not well understood.

IODP Expedition 399 (Spring 2023) drilled a deep (1268m) hole in serpentinized mantle peridotite and subordinate gabbroic rocks at the Atlantis Massif (AM) oceanic core complex (30°N; Mid Atlantic Ridge), only 800m from the famous Lost City Hydrothermal System (LCHF). The exceptional recovery rate and depth of Hole U1601C, along with the unprecedented recovery of CH_4-H_2-rich borehole fluids (Lang et al., 2025) allows for a rigorous assessment of the processes which sustain peridotite-hosted hydrothermal systems such as the LCHF.

Here we present bulk rock B and Sr isotopic profiles from Hole U1601C. The isotopic composition of serpentinites indicates that serpentinization was accomplished by evolved fluids that had undergone modification from primary seawater composition due to interaction with both mafic and ultramafic rocks. We also present preliminary mineral separate O isotope analyses and plans for in situ Fe speciation measurements. Together these data will allow us to quantify variations in the temperature and redox conditions through the serpentinization process and their effect on rates of H_2 production and organic synthesis.

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KEYNOTE:

The double-edged sword of trace element mobility during high-temperature metamorphism

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Geochemical signatures are an integral part to unlock metamorphic histories. Interweaving with petrography and geochronology, they allow us to trace processes through time and space, creating the discipline of petrochronology.
Over the last ten years many studies have demonstrated successful applications of petrochronology. Other studies have shown that extended high-temperature metamorphism can be detrimental to petrochronological investigation, erasing records of past events, which makes reconstruction of P-T-t paths flawed or impossible. Improvements in analytical spatial resolution, accuracy and precision have not only allowed researchers to identify such problematic cases, but also sometimes unravel the underlying cause. In other cases, the mechanism for the breakdown of the petrochronological record isn't fully understood.

On the other hand, trace element mobility during high-temperature metamorphism and specifically partial melting is critical for transporting elements from the lower crust to the upper crust during crustal differentiation. This cycling of elements is of particular importance considering the interest in green energy and technology, which drives the demand for critical elements. Studies on metamorphic systems show that critical element release into melts is controlled by complex interplays between the consumption and crystallisation of different minerals under the various melting reactions and conditions. Therefore, melting reactions and mineral stability may either help or hinder the enrichment of critical elements in the melt, with consequences for later mineralisation potential.

Zoned Triple Oxygen Isotope Record in UHP Garnet from Dora-Maira

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Fluids in continental subduction zones mediate metasomatism and mass transfer at depth, yet constraints on fluid involvement during ultrahigh-pressure (UHP) metamorphism remain limited. We present triple oxygen isotope measurements (δ^{18}O, δ^{17}O, Δ'^{17}O) from micromilled, compositionally distinct growth domains in a Dora-Maira whiteschist garnet megablast. Across a ~5 cm transect, δ^{18}O increases from 3.6‰ in the inner mantle to 6.2‰ near the rim whereas Δ'^{17}O shows no systematic variation between −0.03‰ and −0.08‰. The rim δ^{18}O values are similar to those reported from smaller Dora-Maira garnet that formed at the same time and P-T conditions[1]. The ~2.5‰ increase from garnet interior to rim suggests infiltration of a fluid with heavier δ^{18}O during garnet growth.

In δ'^{17}O - δ'^{18}O space, mass-dependent fractionation of oxygen isotopes plots with a positive slope of ~0.528. Garnet zonal groupings define linear arrays with slopes of 0.5130 ± 0.0033 (mantle, 12 zones, n=22), 0.5415 ± 0.0070 (inner rim, 7 zones, n=10), and 0.562 ± 0.015 (outer rim, 5 zones, n=7), documenting systematic steepening in δ'^{17}O - δ'^{18}O space toward the rim. In δ'^{18}O - Δ'^{17}O reference space, the dataset forms a V-shaped geometry with rimward compositions extending to higher δ'^{18}O and less negative Δ'^{17}O. These changes suggest a progressive shift to a different equilibrium or kinetic fractionation process during garnet growth and fluid infiltration.

These results demonstrate resolvable, spatially structured triple oxygen isotope variability within a single UHP garnet megablast and provide constraints on oxygen isotope systematics relevant to fluid-rock exchange in the Dora-Maira continental UHP massif.

[1] Gauthiez-Putallaz et al. 2016

Reductive leaching experiments quantify Pb isotope and element release during silicate weathering

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Authigenic lead (Pb) isotopes derived from Fe-Mn crusts or sediment grain coatings in marine sediment cores are expected to reflect the Pb isotope composition of seawater at the time of precipitation. As the seawater composition is influenced by the dissolved flux of Pb from the continents, such Pb isotope records could potentially reveal past changes in regional silicate weathering fluxes over glacial cycle timescales. However, authigenic Pb isotope records are difficult to interpret. Compositions can be affected by the preferential dissolution or retention of different minerals during weathering, provenance changes, or water mass mixing. To aid in identifying these controls, we conducted laboratory experiments investigating major and minor element release and Pb isotope systematics during the progressive chemical weathering of silicate rocks, including fresh granite and Greenland glacial rock flours, over a range of grain sizes.

We found that progressive radiogenic Pb enrichment in the leaching solutions dominates the isotopic behaviour for ^{206}Pb/^{204}Pb and ^{207}Pb/^{204}Pb ratios, with thorogenic retention affecting ^{208}Pb/^{204}Pb ratios under more enhanced weathering. A grain-size dependence is observed in early weathering, where larger grain sizes (>350 μm) preferentially release more radiogenic Pb compared to smaller grain sizes (<100 μm). This behaviour reverses under enhanced weathering conditions, with smaller grains releasing more radiogenic Pb and increasing fluid ^{208}Pb/^{204}Pb ratios compared to larger grains.

These findings provide insight into the rock dissolution processes occurring during chemical weathering, and have implications for the application of authigenic Pb isotopes as a chemical weathering tracer.

Session 3

Chairs: Helen Williams and Hugo Moreira

Extreme Fe Isotope Variability in 3-Billion-Year-Old Greenland Carbonatites.

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Carbonatites are of great interest as these carbonate-rich igneous rocks host the largest resources of REE. However, processes related to carbonatite formation are still controversially discussed between:1) the direct melting of carbonate-bearing peridotites, 2) liquid immiscibility of carbonated silicate melts, and 3) fractional crystallization of carbonated silicate melts [1]. Iron stable isotopes represent a promising tool to trace magma interaction because of their high sensitivity to redox and compositional changes [2].

We present a new stable Fe isotope dataset generated from two of the oldest carbonatites complex known on Earth, namely Tupertalik (3 By) and Singertat complex (2.7 By). We observe a large range in magmatic δ^{57}Fe values in agreement with the substantial variability in Fe isotope compositions observed in carbonatites from locations worldwide [3]. For the first time, we show that large Fe isotope variations, from light to heavy δ^{57}Fe values, are recorded within a single carbonatite complex. While most of the carbonatites investigated display δ^{18}O and $\delta 1^{3}$C compositions within the range of primitive mantle values [4], the negative covariations of δ18O and δ^{13}C values in our samples are interpreted to be related to CO_2 degassing [5].

From these results, we discuss the relationship between the evolution of carbonatite melt CO_2 content and oxygen fugacity as well as the influence of these parameters on melt Fe isotopes composition signatures. This work represents an important step towards our further understanding of Fe isotope behaviour during carbonatite formation and evolution, including ascension and emplacement in the crust and post-magmatic processes.

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[2] Rabin et al., 2021. **GCA** 304:101–118
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Invited:

Variations in Hawaiian Plume Flux Controlled by Ancient Mantle Depletion

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Geophysical observations reveal the size of volcanoes along the Hawai‘i–Emperor chain, and thus magma flux out of the plume, has varied over the past 85 Ma with bursts in magma production at ~15 and 2 Ma. These observations go against the model of a strong early and later waning plume activity and have so far remained enigmatic.

We[1] pioneer a quantitative, processes-based approach to geochemical data interpretation to quantify the composition and proportion of different plume constituents over time from new and existing radiogenic Ce–Sr–Nd–Hf isotope data for Hawaiian shield lavas.

Our results show plume peridotite has experienced variable degrees of melt depletion before being incorporated into the plume. The upwelling of more melt-depleted, and thus less dense, more buoyant plume peridotite occurred synchronously to a burst of magma production at 2 Ma. Our plume upwelling and melting calculations yield a good match with independent geophysical observations of magma volume flux through time and suggest excess buoyancy from depleted peridotite may be an underrated driving force for convective mantle flow worldwide.

Our work highlights a counter-intuitive relation between peridotite depletion and radiogenic isotope systematics, with isotopically enriched compositions arising from the aggregation of melts from more depleted, trace element-starved peridotite, causing the over-visibility of melts from recycled crust in the mixture.

Geochemistry – geophysics inter-disciplinary approaches are powerful strategies to investigate deep Earth processes[2,3]. They however require quantitative, processes-based approaches to geochemical data interpretation rather than models confined by first-order considerations of geochemical data structure.

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KEYNOTE:
Return of the Layered Mantle?

Tim Elliott[1], Yan Song[1], Danny Stubbs[1], Chris Coath[1], Nils Messling[2], Matthias Willbold[2], Jiacheng Tian[3], Paul Tackley[3], Tony Kemp[4], Anders Scherstén[5], Andreas Petersson[6]

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Subtle, mass independent variations in $^{182}W/^{184}W$ (expressed here as $\Delta'^{182}W$), ultimately the result of the decay of short-lived ^{182}Hf (half life ~9Ma), have been a gift that has kept giving in understanding the formation and evolution of planets.

An observation that remains to be compellingly explained is the temporal decrease in $\Delta'^{182}W$ of terrestrial samples, from typical values of +10ppm in the Archean to zero at present day. The magnitude of this difference is compatible with the effect predicted for the Late Veneer, as determined by the highly siderophile abundances of the Earth's mantle. Yet the main decrease in $\Delta'^{182}W$ does not occur until the middle of Earth history. A Late Veneer explanation therefore requires that unradiogenic (low $\Delta'^{182}W$) chondritic material survived mixing with the accessible mantle for several billion years. This represents either a major geodynamic constraint or reflects that a different process is at work.

Thus other, more obviously deep mantle sources of unradiogenic W have been invoked. These include the dregs of a basal magma ocean, which may be sufficiently unradiogenic if the magma ocean occurred within the half-life of ^{182}Hf. However, this model would predict coupled ^{182}W and ^{142}Nd anomalies, which are not observed. More recently, there has been considerable interest in a flux of unradiogenic W from the core to the lower mantle. This leaky bottom model can explain the unradiogenic compositions of some modern ocean island basalts and could potentially account for the longer term decrease in $\Delta'^{182}W$ of the mantle.

We have assessed this puzzle in two ways. Firstly we have tried to determine better the timing of change in $\Delta'^{182}W$. We focussed on new measurements of the previously, sparsely analysed period of the late Archean and early Proterozoic. This allows us to show that the decrease in $\Delta'^{182}W$ was rapid and not a gradual decrease as might be expected from gradual leakage from the core. Secondly, we use another isotope system. We show that the ~20ppm decrease in the mass independent $^{100}Ru/^{99}Ru$ ratio between Archean and modern samples cannot be explained by core leakage. As a result, we argue for a model in which the Late Veneer dominantly accumulates in a dynamically stratified lower mantle, before mantle overturn ~2.2Ga that establishes the W isotopic compositions dominantly sampled in modern crust and mantle.

Stable Cerium Isotopes as a Tracer of Crustal Recycling

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The redox-dependent behaviour of cerium (Ce) is a powerful tool for reconstructing paleoredox conditions. While elemental Ce anomalies are an established proxy, advances with a ^{136}Ce-^{138}Ce double spike have enabled high precision Ce isotope measurements ($\delta^{142}Ce(‰) = [(^{142}Ce/^{140}Ce)_{Sample}/(^{142}Ce/^{140}Ce)_{STD} - 1] \times 1000$) using MC-ICP-MS [1]. Experimental and isotopic studies have shown that Ce isotopes are fractionated under varying redox conditions [2,3], supporting their application as tracers of crustal recycling into mantle reservoirs, like the stable uranium isotope system for identifying recycled oceanic crust in mantle source regions [4]. The stable U isotope compositions of MORB suggest that their depleted mantle source was contaminated by the addition of oceanic crust that had experienced alteration under oxidising conditions <600Ma [4]. To determine if the Ce stable isotope composition of the depleted mantle reservoir has varied through time, we measured the Ce isotope composition of 12 ophiolite samples (~1998Ma-~400Ma) spanning multiple basins. Pillow basalt samples show minimal variation relative to the basaltic geostandard while samples from the sheeted dyke sections show more notable variations ($\delta^{142}Ce$=0.07 and -0.05‰). Limited variability in the pillow basalts may suggest the depleted mantle Ce isotope composition has remained constant. Alternatively, restricted variation could also indicate limited mobility of Ce during oceanic crust alteration in contrast to U [4]. Additionally, for $^{142}Ce/^{140}Ce$, the mass dependent and nuclear field shift effects act in opposite directions, potentially complicating the condition [5]. Further sheeted dyke samples will be measured to assess if observed variation is consistent as this may indicate later alteration effects.

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Progress on in situ Rb-Sr dating using the Neoma multi-collector tandem mass spectrometer (LA-MC-ICP -MS/MS)

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Laser ablation Rb-Sr geochronology is a technique that can provide age constraints on a variety of minerals that are useful for geoscientists (such as micas and K-feldspars). This technique utilises a reaction cell sandwiched between two mass separation devices. The first mass separation device is used to control what enters the reaction cell (e.g, only ^{87}Rb and ^{87}Sr), the reaction cell is used to react only the analyte of interest (e.g, Sr^+ reacts with SF_6 gas to form SrF^+ but Rb^+ does not form RbF^+) and the second mass separation device is used to separate the ions exiting the reaction cell (e.g., so that $^{87}SrF^+$ can be measured separately to $^{87}Rb^+$). Previous work has largely used quadrupole-based mass spectrometers, which are limited in precision and sensitivity compared to magnetic sector-based instruments such as the Neoma (and Proteus) MC-ICP- MS/MS. We will show recent progress in developing in-situ Rb-Sr and Sr-Sr isotope analysis using a Neoma MC-ICP-MS/MS at the British Geological Survey. This includes investigation of the formation of reaction cell-based interferences (such as $^{32}S^{19}F_3{}^{16}O^+$ on $^{86}SrF^+$) and demonstration of the increased precision obtainable for Rb-Sr dates using the Neoma, particularly for low to medium Rb/Sr minerals ($^{87}Rb/^{86}Sr$ ratios of < 20), as well as young samples with limited radiogenic ingrowth of ^{87}Sr (< 100 Ma). We present case studies of Rb-Sr geochronological data for K-feldspar and mica samples from both LA-QQQ-ICP-MS and LA-MC-ICP-MS/MS instruments, highlighting potential advantages and complexities of Neoma Rb-Sr dating.

Session 4

Chairs: Marie-Laure Bagard and Jamie Lewis

Comparing seasonal assimilation of inorganic ^{15}N and organic ^{13}C^{15}N nutrients by freshwater biota in a stream mesocosm

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Eutrophication of inland waters is a defined feature of the Anthropocene, driven largely by agricultural nutrient inputs. While management typically targets dissolved inorganic nutrients, livestock-derived dissolved organic matter (LDOM) is widespread in agricultural catchments and provides highly bioavailable nitrogen and carbon, with implications for food-web dynamics and greenhouse-gas emissions(a,b).

We quantified the uptake and assimilation of inorganic versus organic nitrogen by biofilms, the bryophyte *Fontinalis antipyretica*, and grazing snails (*Lymnaea stagnalis*)(c), in a mesotrophic UK stream using in-stream mesocosms deployed in spring and autumn. Treatments included one inorganic ^{15}N tracer and six dual-labelled (^{13}C^{15}N) organic substrates(c,d), applied at equivalent nitrogen doses, with tracer incorporation and CO_2 and N_2O isotopic signatures measured over eight days.

Across biota, organic nutrient uptake matched or exceeded ammonium uptake, demonstrating substantial dissolved organic nitrogen utilisation even under mesotrophic conditions. Assimilation showed strong seasonality, with higher incorporation in autumn. Snail nitrogen was primarily routed through biofilms, while carbon was mainly derived from bryophytes. Although low, gas isotopic patterns followed biotic tracer incorporation, indicating rapid coupling between organic substrate processing, respiration, and nitrogen transformations.
These findings show that LDOM functions as a major, selectively used nutrient source that shapes biota metabolism and contributes to stream greenhouse-gas emissions, linking catchment inputs to metabolic-scale biogeochemical processes.

Keywords*: Livestock-derived organic matter, dual-labelled organic compounds, inorganic nitrogen, freshwater biota, preferential uptake, field mesocosm*

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Investigating the impact of environmental character on dissolved organic nutrient uptake by freshwater biota using mesocosm experiments

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Multiple anthropogenic stressors are causing rapid freshwater ecosystem decline, driving increased nutrient fluxes to freshwaters (particularly carbon, nitrogen and phosphorus), promoting harmful algal blooms, excessive macrophyte growth and decline in biodiversity. Organic nutrient fractions can be the dominant fraction in oligotrophic freshwaters (>80% of the total nutrient load), comprise at least 20% of the total nutrient load in eutrophic freshwaters, and are highly bioavailable to microbial and primary producer groups. Whilst the impacts of inorganic nutrient enrichment on freshwater biota have been widely researched, there is a less focus on how organic nutrient fraction composition and environment interact to influence the rates and pathways of dissolved organic matter (DOM) uptake in freshwater ecosystems. Here, we conducted three stable isotope dosing experiments in replicate mesocosms in streams with differing underlying chemistries (chalk, clay and peat) under ambient conditions, and under experimentally altered streamflow and warming conditions (+2.3^{o}C, based on RCP 6.0). Results suggest different patterns of ^{13}C and ^{15}N uptake according to DOM chemistry, similarities in bulk $^{13}C^{15}N$ nutrient uptake rates regardless of environmental character, changes in uptake rates under climate change, and organic nutrient uptake at rates equal to or in excess of inorganic nutrient uptake rates. Further work currently underway will determine gene x environment interactions controlling relative nutrient use efficiency and metabolic responses to these differing DOM chemistries.

Early Career Researcher Prominent Lecturer 2025/26:
Bridging the gap between isotope geochemistry and plant sciences

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This keynote presentation will briefly cover the principles behind and methodologies necessary for investigation of metal uptake, sequestration and transport by terrestrial plants using non-traditional stable isotope analyses. It will cover what natural stable isotope analyses of different metals, such as zinc and iron, have already taught us about biological and physicochemical processes in plant-soil/solution systems, and present ideas for future collaborative work. This will draw from information collated for a recent review, which brought together a team of isotope geochemists and plant scientists from across six institutions, to bridge the gap between the fields.[1]

After highlighting best practices for data acquisition and interpretation, the second half of the talk will present the results of a recent pilot study which investigated a biological process not yet considered in natural stable isotope experiments: symbiotic plant-fungi associations. Rice was grown under controlled environmental conditions with and without inoculation with an arbuscular mycorrhizal fungus (AMF, *Rhizophagus irregularis*). Zinc concentration measurements and isotope analyses were conducted to determine whether inoculation with the AMF i) improved the phytoavailability of zinc, and (ii) altered the mechanisms by which the zinc was taken up by the rice. Extraction experiments on growth substrates were also conducted to inform how best to design and control such systems to enable unbiased and precise natural stable isotope mass balance modelling.

This pilot experiment sets the foundation for a new area of multidisciplinary research with enormous potential to inform and influence environmental and agricultural strategies and policies, e.g. related to depleted or contaminated land, plant and human nutrition, and food security.

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Mediterranean basins responses to connectivity changes during the Messinian Salinity Crisis: Evidence from Strontium Isotopes

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During the Messinian Salinity Crisis (MSC; 5.97–5.33 Ma), tectonic forcing, eustatic sea-level fluctuations, and climatic variability drove the progressive restriction and eventual closure of the Mediterranean–Atlantic gateways, promoting extreme environmental changes and the formation of a Mediterranean salt giant. The strontium isotope composition (^{87}Sr/^{86}Sr) of seawater is globally homogeneous at any given time; however, in restricted environments, such as marginal seas, it can deviate from open-ocean values in response to changes in the relative contributions of Sr inputs (e.g., riverine and hydrothermal sources). Consequently, the Sr isotope system has been widely used to reconstruct and quantify past connectivity during phases of reduced exchange between the Atlantic and the Mediterranean, when ^{87}Sr/^{86}Sr ratios gradually deviated from the global seawater curve, commonly shifting toward more unradiogenic compositions. Despite its extensive application at the Mediterranean-wide scale, comparatively little attention has been paid to basin-specific ^{87}Sr/^{86}Sr variability during the MSC. In this study, ^{87}Sr/^{86}Sr analysis was conducted on evaporite (anhydrite and gypsum) and foraminifera samples from the Alboran Sea (IODP Exp 401), Tyrrhenian Sea (IODP Exp 402) and Aegean Sea (IODP Exp 398). We aim to evaluate changes in the ^{87}Sr/^{86}Sr record across these different Mediterranean basins, assessing how restriction of Mediterranean–Atlantic connectivity during the MSC was expressed regionally and identifying potential basin-specific Sr sources contributing to the observed ^{87}Sr/^{86}Sr signatures.

Keywords: Strontium isotopes; Atlantic–Mediterranean exchange; Strontium inputs.

pH-driven compositional variability in amorphous calcium-magnesium carbonate

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As a metastable precursor to crystalline carbonate minerals, amorphous calcium-magnesium carbonate (ACMC) is commonly involved in biomineralisation, and may have formed some enigmatic fabrics in Precambrian carbonate rocks[1]. The magnesium content of ACMC influences its stability and eventual crystallisation products[2], yet the precise mechanisms controlling magnesium incorporation remain unclear. Additionally, increasing evidence suggests that ACMC may be compositionally heterogeneous[3] or incorporate species such as OH^-[4].

To investigate these controls, we synthesised ACMC by mixing $CaCl_2$ + $MgCl_2$ solutions with pH-adjusted $NaHCO_3$ solutions, either in batches or using a mixed-flow reactor[5]. Products were characterised using XRD, SEM and Raman spectroscopy, and magnesium contents were determined by ion chromatography following dissolution. Combined with a literature compilation, our results show that $(Mg/Ca)_{ACMC}$ increases linearly with both solution [Mg]/[Ca] and pH, exerting a stronger control than carbonate saturation state or other parameters.

To explain this behaviour, we numerically modelled solution chemistry during ACMC precipitation, assuming a constant magnesium distribution coefficient, but this approach failed to reproduce the observed pH dependence. However, a model allowing co-incorporation of OH^- with Mg^{2+} at high pH closely matched the data. The optimised reaction order for ACMC precipitation was near 1, consistent with a diffusion-limited process.

Incorporation of a pH-sensitive species aligns with previous interpretations of thermogravimetric analysis and infra-red spectra[4]. This implies that ACMC varies in composition depending on the pH during precipitation – even when $(Mg/Ca)_{ACMC}$ remains constant. Such differences likely influence ACMC stability and crystallisation, and should be considered when interpreting experiments using synthetic ACMC.

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Session 5

Chairs: Paul Savage and Kathryn Shaw

Streamlined Workflows for Geochemical Laser Ablation and a New IRMS chamber for Carbon and Oxygen Isotope Measurement

David N. Douglas, Joe Ready, Sam Schultz and Ciaran O'Connor

Characterisation of geochemical materials often requires a multi-instrumental approach for identification and characterisation of materials. As these systems are supplied by different vendors it can often be tedious and difficult to combine datasets or utilise data for LA-ICPMS experiment planning. ESL's new Targeting software (powered by Iolite) provides automatic and offline integration of upstream datasets e.g. BSE images for isotope spot analysis, mineral zoning for targeted mapping, etc. into ESL laser ablation workflows, improving efficiency.

ESL has developed a novel chamber for in-situ carbon and oxygen isotope measurement by coupling laser ablation and laser heating with IRMS. Example applications include in-situ analysis of carbonates, providing high-resolution temporal reconstruction of paleoenvironmental and paleoclimatic events, improving models for past and future climates. The low-flow IRMS chamber reduces sample preparation time, reduces the amount of samples required for analysis and enables the reanalyze of samples due to the minimally destructive nature of laser techniques.

Contemporaneous formation of chondrules and CAIs recorded by Al–Mg dating of individual chondrules

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Chondrules are quenched ferromagnesian silicate melt droplets that are the defining component of chondritic meteorites. Establishing their formation age is central to understanding early protoplanetary disk evolution. Two key chronometers have been used to date chondrules. The extinct Al–Mg chronometer relies on the decay of $^{26}Al \rightarrow ^{26}Mg$ ($t_{1/2} \approx 0.73$ Myr), and the Pb–Pb chronometer uses the decay of $^{238}U \rightarrow ^{206}Pb$ and $^{235}U \rightarrow ^{207}Pb$. These chronometers yield conflicting timelines: internal Al–Mg isochrons suggest most chondrules formed ~2 Myr after calcium–aluminium–rich inclusions (CAIs), taken as t = 0 of Solar System formation[1,2], whereas high-precision Pb–Pb dating indicates that chondrule formation began contemporaneously with CAIs[3]. Crucially, the Al–Mg chronometer assumes a homogeneous “canonical” initial $^{26}Al/^{27}Al_0$ ratio defined by CAIs throughout the protoplanetary disk, although this assumption remains debated[4].

Independent constraints from refractory forsterite grains show unradiogenic $\Delta'^{26}Mg$ signatures consistent with formation in a reservoir with canonical $^{26}Al/^{27}Al_0$, indicating that early chondrule silicates formed contemporaneously with CAIs and that nebular reservoirs shared similar initial ^{26}Al abundances[5].

Here we extend this approach by measuring $\Delta'^{26}Mg$ in typical chondrule forsterites using a new laser-ablation micro-collection technique coupled with solution MC-ICP-MS. Physically separated olivine and bulk chondrule fractions are analysed to construct internal chondrule isochrons that minimise the influence of Al-rich phases susceptible to diffusive resetting or inheritance.

The resulting initial $^{26}Al/^{27}Al$ ratios indicate that the onset of chondrule formation was coeval with CAIs, reconciling Al–Mg and Pb–Pb chronologies without requiring heterogeneous ^{26}Al in the protoplanetary disk.

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Halogen abundances in chondrule mesostasis of ordinary and carbonaceous chondrites

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Halogens (fluorine [F], chlorine [Cl], bromine [Br], iodine [I]) are key volatile tracers that link processes in the protoplanetary disk to the accretion and early evolution of the terrestrial planets. Their distribution and mobility in chondritic materials provide important constraints on how volatile elements were incorporated into planetesimals and Earth. Chondrule mesostasis glass provides a sensitive record of halogen behaviour, as halogens are incompatible in silicate minerals and become concentrated in the residual melt during chondrule crystallisation, while remaining susceptible to exchange with a surrounding vapour during open-system melting and cooling.

To assess what halogen concentrations in chondrules reveal about protoplanetary disk processes, we investigated halogen systematics in chondrule mesostasis glass by measuring abundances of F, Cl, Br, and I, using secondary ion mass spectrometry (SIMS). Analyses were conducted on 46 chondrules from two Antarctic carbonaceous chondrites and four Antarctic ordinary chondrites, all showing limited secondary parent-body processing (petrologic type 3).

Mesostasis halogen concentrations in carbonaceous chondrites range from 0.37-12.2 ppm F, 0.22-290 ppm Cl, ≤0.006-0.83 ppm Br, and 30-432 ppb I, whereas ordinary chondrites show broader ranges of 0.2-118 ppm F, < 20-2255 ppm Cl, ≤0.006-2.5 ppm Br, and 2-273 ppb I. In L-group ordinary chondrites, Br concentrations increase and I concentrations decrease systematically with increasing metamorphic grade (3.05-3.6), producing a strong correlation between Br/I ratio and metamorphism. This trend suggests modification of halogen signatures by diffusion or dissolution. The low abundances of halogens in chondrule mesostasis from ordinary and carbonaceous chondrites relative to enstatite chondrites [1] points to differences in halogen carriers, redox conditions, or vapour-melt exchange during chondrule formation in different regions of the protoplanetary disk.

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Identification of a chondritic mantle reservoir in Mars from the 1.27-billion-year-old olivine-phyric shergottite Northwest Africa 13441

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Here we report on the petrology, mineralogy, geochemistry, and isotope compositions (including O isotopes and ^{147}Sm-^{143}Nd isotope systematics) for Northwest Africa (NWA) 13441, an olivine-phyric shergottite rich in melt glass that was recovered from Algeria in 2019. The meteorite NWA 13441 is a basalt containing abundant oriented olivine megacrysts set in a groundmass of pigeonite, olivine, and maskelynite with accessory chromite and merrillite. The Fe/Mn ratios of olivine and pyroxene (30.1 ± 2.1; 2σ, n=10), alongside bulk rock O isotope ratios confirm a martian origin. Pyroxene Ti/Al barometry indicates that crystallization began near the crust-mantle boundary of Mars. The bulk rock rare earth element (REE) pattern ($(La/Yb)_{CI}$ = 0.64) suggests an affinity to intermediate shergottites. Hand-picked mineral separates as well as leachates define a ^{147}Sm-^{143}Nd isochron age of 1273 ± 21 Ma (MSWD = 19; n = 9) that is distinct from other shergottites, which primarily cluster at <600 Ma. Notably, NWA 13441 also yields a chondritic εNd_i composition of +0.96 ± 1.04, indicating derivation from a long-term broadly chondritic reservoir. The relationship of the chondritic εNd_i and intermediate trace element composition requires at least two stages of melt extraction over a relatively short timescale. The ~1.27 Ga age and unique isotope-trace element composition provide the first direct evidence for a chondritic mantle source on early Amazonian Mars, likely representing a new ejection site and a previously unsampled martian mantle reservoir.

Tellurium Isotope Fractionation During High-Temperature Volatilisation on Achondritic Parent Bodies

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As a moderately volatile and chalcophile/siderophile element, tellurium (Te) is sensitive to both high-temperature evaporation and planetary differentiation and can therefore serve as a tracer of such processes. Using high-precision double-spike analyses [1], Te concentrations and mass-dependent isotope compositions were determined for achondrites, including howardites, eucrites, diogenites from the HED parent body, aubrites, ureilites, and lunar meteorites.

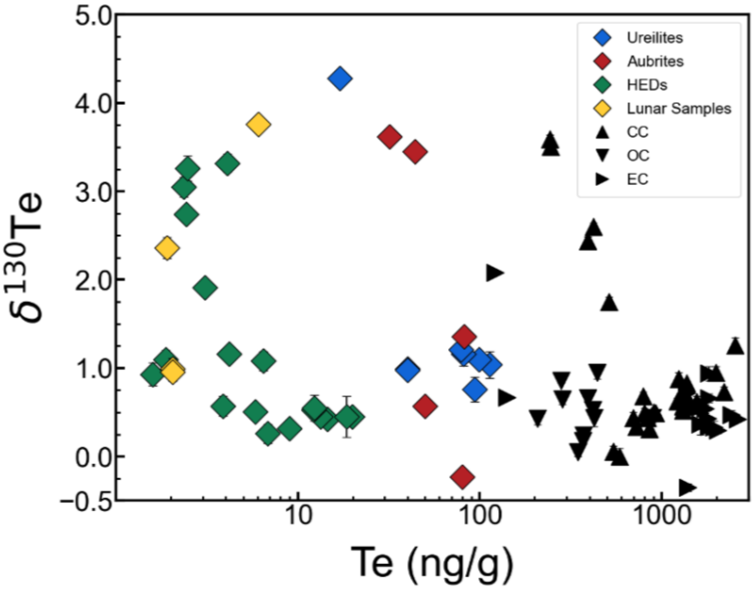

Figure 1. Plot of δ^{130}Te versus Te concentrations (log scale) for ureilites, aubrites, HED meteorites, and lunar meteorites, compared to carbonaceous (CC), ordinary (OC), and enstatite (EC) chondrites.

Across all achondrites, Te is depleted relative to chondrites (Fig. 1), indicating widespread Te loss during accretion by magma-ocean degassing, differentiation, and impacts. Eucrites, lunar meteorites, two aubrites, and the ureilites have especially high δ^{130}Te values coupled with lower Te concentrations. This is consistent with high-temperature evaporation from early magma oceans and during impacts. For the lunar meteorites and ureilites, this is likely associated with the Moon-forming impact and the catastrophic disruption of the ureilite parent body [2], respectively. In contrast, Te-rich diogenites preserve δ^{130}Te indistinguishable from average chondrite values, suggesting Te depletion occurred with minimal isotope fractionation. These systematics define a progression from an isotopically fractionated surface to less fractionated interior materials on the HED parent asteroid. Howardites are mixtures of eucrite and diogenite material, and also require the addition of ~1.5% chondritic material from impact gardening on the parent body. Finally, most aubrites retain enstatite-chondrite-like δ^{130}Te values, reflecting inheritance from an enstatite-chondrite-like precursor.

Together, these data show that Te isotopes record evaporation during magma-ocean degassing and impact processing, thereby helping to constrain the volatile budgets of differentiated planetary bodies and clarifying how planetary crusts were modified during early Solar System evolution.

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The effect on core formation of the extreme thermal and rotational states of planets after giant impacts

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During accretion, almost all terrestrial planets experience collisions with other planet-sized bodies, so-called giant impacts. Giant impacts are the most energetic events growing planets experience, driving large thermal and chemical perturbations and fundamentally shaping the properties of the final planets. In particular, it is the aftermath of such collisions that provides the setting for core formation. Giant impacts typically deposit large amounts of metal into the mantle of the largest remnant and melt a substantial fraction of that mantle, providing the opportunity for metal to segregate to the core. The thermodynamic and dynamic conditions in the aftermath of giant impacts therefore control how different elements partition between the core and mantle, affecting the long-term thermal and chemical evolution of planets, the potential for magnetic dynamos, and our interpretation of geochemical tracers of accretion.

In this work, we explored the thermal outcomes of a representative set of collisions between Moon- to super-Earth-mass bodies and their implications for core formation. We used updated ANEOS equations of state with the SWIFT hydrocode and HERCULES planetary structure code to more accurately describe the temperatures, pressures, and heat budgets of post-impact planets. We find that a substantial fraction of the mantle is heated above the Fe-MgO solvus for impacts with specific energies $>10^6$ J/kg, implying that a thermodynamically miscible layer should form at the core-mantle boundary (CMB) for many giant impacts. We present scaling laws for the efficiency of impact heating, mantle/core heat partitioning, and CMB pressures and temperatures. We find that post-impact pressures are generally lower than previously assumed for CMB conditions, due to both thermal and rotational effects, and such lower pressures can be sustained for millions of years. The comparatively low internal pressures after giant impacts have a significant effect on the conditions for metal-silicate equilibration, and our work strongly implies that Earth's core-mantle equilibration occurred close to the CMB, much deeper than previously inferred.

Session 6

Chairs: Catriona Menzies and Nidha Eriyattukuzhiyil

Monitoring Mobile Metals: A Pb-Zn Isotopic Approach to Trace Metal Pollutant Sources in Rivers

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Dissolved metal concentrations in rivers are influenced by a combination of natural processes and anthropogenic activities, with inputs that vary in time and space. Heavy metal concentrations respond strongly to changes in discharge, in both contaminated and pristine catchments.

Environmental legislation (such as the Water Framework Directive) establishes recommended limits on heavy metals in freshwater systems, yet these are frequently exceeded. Effective remediation requires accurate identification of the relative contributions from different pollutant sources. Concentration measurements alone cannot resolve sources when hydrological variability and within-catchment processes are considered.

We use a multi-tracer framework that combines major and trace element concentrations together with stable zinc (Zn) and radiogenic lead (Pb) isotope ratios, to identify and distinguish sources of dissolved heavy metal contamination. This approach is tested in the River Wear catchment, a historic mining region in northeast England. In this catchment, metal loads in the headwaters are dominated by legacy mine wastes, while downstream reaches inherit inputs from agriculture and urban activities.

Catchment-wide transect sampling was conducted under low, medium, and high flow conditions. We show clear and significant shifts in Zn isotope composition under changing flow. The combined use of Zn and Pb isotopes alongside complementary chemical tracers improves the resolution of source discrimination between historical mining and contemporary anthropogenic sources and provides insight into key catchment processes such as mixing, dilution, and hydrologically-mediated mobilisation. Overall, this integrated approach offers a robust tool for source apportionment and supports the design of targeted remediation strategies in rivers affected by legacy contamination.

Early Career Researcher Prominent Lecturer 2025/26:

Novel Phosphate-Oxygen Stable Isotope Analysis of Sediments: Reconstructing the Impact of Sewage Management on Algal Blooms

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Sewage effluent remains a major driver of nutrient enrichment (eutrophication) and algal blooms in aquatic ecosystems. While tertiary treatment technologies aim to reduce nutrient loading, their long-term ecological effectiveness, particularly in standing waters like lakes, remains unclear due to a lack of long-term biological monitoring. This issue is becoming increasingly urgent with the dual pressures of climate change and urbanization, which are intensifying the frequency and severity of harmful cyanobacterial blooms.

Here, we present a novel application of phosphate-oxygen stable isotope analysis to a lake sediment core, to directly reconstruct historic biological phosphorus cycling in response to waste water management, using a case study from Rutland Water Nature Reserve, UK. Complemented by stable nitrogen isotopes, photosynthetic pigment profiles and cyanotoxin concentration data, this multi-proxy approach identifies shifts in nutrient loading, primary productivity, nutrient availability and cycling, and ecological quality, in response to changes in sewage treatment practices over time.

Tracking Volcanic Unrest through Mercury: Insights from Santorini and Kolumbo during the 2025 Seismic Crisis

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Hydrothermal systems strongly influence ocean biogeochemical cycles, yet the links between volcanic unrest, hydrothermal fluid emissions, and the records of hydrothermally-derived species in sediments remain poorly constrained. In particular, the question of whether sedimentary metal enrichments can be used as reliable recorders of paleo-hydrothermal venting remains unresolved. Mercury (Hg) is considered a notable proxy for hydrothermal activity in volcanic settings due to its low background concentrations in seawater [1], but as yet Hg fluxes from submarine hydrothermal settings remain poorly quantified [2].

The Santorini and Kolumbo volcanoes in the South Aegean Volcanic Arc offer a unique environment to address these questions. Despite being only 7 km apart, they host contrasting hydrothermal systems: diffuse, low-temperature venting at Santorini (~300 meters below sea level) and focused, high-temperature chimney venting at Kolumbo (~500 meters below sea level). Between late 2024 and early 2025, both systems were affected by a seismic crisis with earthquakes of up to magnitude 5, interpreted to result from a dyke intrusion [3]. This unrest provided a rare opportunity to examine how crustal stresses influence shallow hydrothermal activity.

During the NERC DY190 offshore expedition (March 2025), we sampled hydrothermal fluids and their surrounding sediments across both volcanoes in the latter stages of the seismic crisis. We focus on Hg to evaluate: (1) whether anomalies can be linked to episodes of tectono-magmatic unrest; and (2) the contribution of shallow submarine hydrothermal systems to global Hg fluxes.

Our preliminary results indicate marked differences between Santorini and Kolumbo, reflecting the contrasting styles of venting and associated metal mobility. More broadly, they provide new insights into the role of hydrothermal systems in geochemical cycles and highlight the potential for hydrothermal systems to serve as long-term monitoring tools for volcanic unrest.

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Early Evolution of the Palaeogene Mull volcano: An integrated volcanological, Geochemical and Geochronological approach

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The British Palaeogene Igneous Province (BPIP) has long been a significant research area, for both British volcanology and understanding the evolution of the North Atlantic Igneous Province. However, since the Mull Memoir was published [1], little substantive research has investigated the early evolution of the Mull central complex, the focus of this study.

Volcanological fieldwork, combined with geochemical fingerprinting and petrological examination, has revealed new information on the post-collapse volcanic infill sequence of the early caldera on Mull. The range of volcanic units indicates that during this period, the Mull volcano had varied eruption styles and a trend towards higher silica magma compositions, with increasingly explosive eruptive episodes.

Major and trace element analysis investigated processes including magma mixing, crustal contamination and links between sub-surface magma conduits and erupted deposits. Isotopic and elemental fingerprinting has revealed most units associated with the early Mull central complex show a significant upper crustal contamination signature, consistent with contamination by Moine metasediments. These new models have been constrained temporally by U-Pb geochronology on the two earliest volcanic centres.

The significant new information from this study in understanding the early development of the central complex on the Isle of Mull, has resulted in an updated volcanological and petrological model. It has also expanded our understanding of the BPIP, allowing comparison of timescales and volcanic evolution to other centres, such as Arran [3],[4] and Skye (e.g. [2]). More widely, this study has implications for our understanding of explosive volcanism, particularly in young and evolving environments.

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Determining the season of past volcanic eruptions from glacio-chemical records in Greenland ice cores

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Volcanic eruptions occurring in different seasons can produce distinct climatic forcings and impacts due to seasonally varying insolation, atmospheric and environmental conditions. As volcanic eruptions are the major natural forcing of climate over the past 2000 years, accurate records of volcanism (including eruption season) are crucial for simulating the climate over this time period. Our best records of volcanism come from sulphur peaks in polar ice cores, and these can provide constraints on sulphur loading in the atmosphere. However, to date there has been no systematic constraints on the season of the eruption, with >95% of eruptions assigned an arbitrary date of January 1 for the most recent PMIP4 forcing dataset [1].Here, we build a quantitative framework to incorporate the detailed seasonality information of multiple chemical species (Na, Mg, Ca) from surface snow measurements into a Bayesian age-depth model (Bacon [2]) on ice cores. Ten years of surface snow samples collected at Summit Station, Greenland [3] with exact dates known were analysed their seasonal timing and applied as prior constraints into the age-depth model on Summit2023 Greenland ice core [4]. The derived chronologies allow us to pinpoint the start of volcanic eruptions represented by sulphate peaks with uncertainties ranging from 1 to 5 months. This first seasonally constrained volcanic chronology will be applied in the upcoming PMIP7 past2k volcanic forcing simulations.

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Session 7

Chairs: George Cooper and Chris Coath

Unmixing sources of organic carbon: an approach integrating bulk and distributional data

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The continental organic carbon (OC) cycle plays an important role in controlling atmospheric pCO_2 and pO_2. When exported from the continents and buried in marine sediments, biosphere-derived OC acts as a key sink of atmospheric CO_2, while the erosion and oxidation of rock-derived OC acts as a CO2 source. An effective way to quantify these OC fluxes at scale is to measure riverine fluxes, but this requires geochemical models to "unmix" biospheric- and rock-derived particulate OC (POC) carried by rivers.

Here, we present an effective approach to do this, which integrates bulk POC composition ($\delta^{13}C$, $Fm^{14}C$, and C/N ratios) with distributions of POC thermal reactivity in a Bayesian (un)mixing model, and probabilistically quantifies the proportions of biospheric-derived (OC_{bio}) vs. rock-derived (OC_{petro}) carbon. We apply this approach to the suspended sediments and bedloads of the Irrawaddy, Salween, and Mekong rivers in Southeast Asia, together responsible for >1% of the total global POC flux to the ocean. The results indicate they carry a larger than expected flux of rock-derived POC (10-30% of total), with important implications to our understanding of the global organic carbon cycle. These results are consistent with recent evidence of high rock-derived POC abundance in soils developed on sedimentary rocks (Grant et al., 2023), and in CO2 being degassed from global rivers (Dellinger et al., 2023; Dean et al., 2025).

Importantly, the Bayesian (un)mixing modeling approach developed here could be applied to different kinds of geochemical problems where both bulk and distributional data are available.

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Optimising laser ablation-based methods for long sea surface temperature proxy reconstructions from coral skeletons

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As reef-forming stony corals grow, they incorporate trace elements into their carbonate skeletons. The proportions of these trace elements to calcium or to each other (e.g. Sr/Ca, Li/Mg) vary in large part due to the ambient water temperature. Well-dated cores can therefore provide long records of sea surface temperature (SST), spanning tens to hundreds of years. After calibration with recent observation-based SST data, these proxies enable the extension of temperature records beyond the range of reliable instrumental data, potentially providing vital quantification of the preindustrial period and beyond. However, such long time-series require high-throughput yet precise measurement of the trace elemental composition of the coral skeleton. Here we show that laser ablation inductively-coupled plasma mass spectrometry (LA-ICPMS) is a viable alternative to established micro-milling and solution-based sampling and measurement techniques, but with higher resolution and much higher throughput. Accuracy and precision of LA-ICPMS data is improved by reporting the average of a small number of parallel, laterally-spaced laser transects, each scaled and/or offset to align uneven growth banding. To counter instrumental drift and improve accuracy and reproducibility within and between long measurement sessions, we implement a data reduction scheme using time-varying regressions of measured and reference element-to-calcium ratios in multiple matrix-matched reference materials. Using these LA-ICPMS methods, a 100-year SST reconstruction at sub-monthly resolution from over a metre of core could be generated in around 24 hours of instrument time and with minimal sample preparation. Given that replication using nearby coral cores is key for reliable reconstructions of SST[1], applying this workflow to long coral cores from suitable locations would enable significantly improved estimations of global temperatures in the pre- and early instrument era.

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Postdoctoral Medal Winner 2026

Mineralogical Controls of the Oceanic Nickel Cycle

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Transition metal isotopes are increasingly used as paleo-productivity proxies, yet their utility depends on understanding metal cycling between sediments and seawater. In this talk, I will examine how Mn mineral processes control Ni isotopes in oxic marine sediments.

By analysing synthetic and natural samples, and simulating sediment diagenesis, we show Ni isotope variability in modern Mn-rich sediments is driven by the relative contribution of two bonding mechanisms: surface adsorption to and structural incorporation into Mn oxides, which evolve during Mn mineral aging and transformation. These findings provide mechanistic insight into how Ni and its isotopes are preserved in marine sediments and exchanged with seawater. We propose a conceptual model in which Mn mineral aging and diagenetic transformation co-modify sedimentary and seawater Ni isotope signatures. This framework provides a mechanistic basis for interpreting sedimentary Ni isotope records.

More broadly, this work highlights Mn mineral formation and transformation as central, yet unconstrained controls on marine metal isotope proxies. Because the cycling of many trace metals is coupled to Mn oxides, these findings have implications that extend beyond Ni, offering a perspective on how Mn mineral processes may shape metal isotope records used to reconstruct Earth's ocean history.

An osmium isotope record of continental weathering from the northern Tethys

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Silicate weathering acts as a negative feedback on carbon emissions (C removal) and oxidative weathering can release carbon from C-rich rocks weathering on land (C emission). Therefore, quantifying the magnitude of the weathering process through time, as well as separating and constraining these two weathering effects on the C-cycle, is an important goal for understanding the drivers of the geological carbon cycle. The flux of osmium (Os) into the oceans is strongly affected by the weathering of organic-rich sedimentary rocks, and thus this proxy may be a useful tool to assess oxidative weathering processes.

We present new radiogenic osmium (Os) isotope datasets from the Sogno core, Lombardy Basin, N Italy, obtained by N-TIMS. This locality samples a deep pelagic sedimentary succession from the north-western Tethys, which includes the global carbon isotope excursion that defines the ‘Toarcian Oceanic Anoxic Event’ or the ‘Jenkyns Event’. We use the new data to identify how the Os isotopic composition of the ocean evolved across the T-OAE in response to continental weathering fluxes, focusing specifically on the onset of the negative carbon isotope excursion interval which has been interpreted variably in terms of oxidative weathering pulses and silicate weathering.

We will show results across the onset and duration of the Early Toarcian Oceanic Anoxic Event and discuss how these data have potential to constrain oxidative carbon weathering at this time.

Tracing sources of serpentinization fluids in the Mariana Forearc using stable and radiogenic strontium isotopes

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Fluids released from subducting slabs play fundamental role in mass transfer, redox evolution and mantle wedge serpentinization, yet their sources and pathways in the forearc remain poorly constrained. We combine radiogenic ($^{87}Sr/^{86}Sr$) and stable ($\delta^{88}Sr$) strontium isotope data to trace slab-derived fluids in the Mariana Forearc, using sample recovered during the IODP Expedition 366, including subducting sediments and basalts, mantle wedge serpentinites, and co-existing pore fluids from serpentinite mud volcanoes.

All samples display a narrow range of $^{87}Sr/^{86}Sr$ (0.705-0.706). In contrast, $\delta^{88}Sr$ values show variations linked to lithology, temperature, and mineralogy. Metabasalts exhibit $\delta^{88}Sr$ values that differ from incoming basalts, demonstrating substantial modification during subduction channel transport. Serpentinites show $\delta^{88}Sr$ values overlapping those of metabasalts from the same sites. Pore fluids are consistently heavier compared to solids, defining a fractionation of $\Delta^{88}Sr_{\text{fluid-solid}} \approx 0.06\text{-}0.11‰$. These relationships indicate that the same slab-derived fluids responsible for altering detached slab clasts in the channel also infiltrate and serpentinize the mantle wedge. Mineral-specific Sr isotope fractionation factors suggests that sulphates dominate Sr fractionation at shallow levels, while carbonate-controlled Sr budget prevails at greater depths. Geochemical and isotopic signatures indicate sediment-derived fluids dominate serpentinization at shallow depths, whereas altered oceanic crust becomes the principal fluid source at greater depths (~30 km). Thermodynamic modelling indicates major slab dehydration does not occur until the blueschist-eclogite transition (≥80 km). Fluids released at these depths may be transported over long distances along the subduction channel and represent the same fluid that infiltrates the mantle wedge, driving widespread forearc serpentinization.

Poster Session

POSTER 01

Influences of seawater composition and paleogeography on the stability of Cretaceous marine carbon and oxygen cycling

Markus Adloff and Michael J. Henehan

Repeated disruptions of climate and biogeochemical cycling occurred during the Cretaceous (145 – 65 Ma) but were absent during most of the Cenozoic. This difference between the Cretaceous and Cenozoic worlds was initially exclusively attributed to paleogeographic differences and more frequent large-scale volcanic activity in the Cretaceous, but it is unclear how much of this difference indicates state-dependence in Earth system feedbacks due to critical thresholds in seawater composition, which seems to have been markedly different and varied throughout the Cretaceous. Here, we present a systematic study of how chemical and physical boundary conditions shaped Cretaceous carbon and oxygen cycling and their response to external perturbation. Specifically, we show how differences in circulation, climate, biological carbon cycling and seawater composition (magnesium, calcium, sulphate, phosphate concentrations) might have altered the CO_2 buffering capacity of seawater and the ocean's susceptibility to wide-spread marine anoxia and thus conditioned the response to warming (orbitally or carbon-driven) in the Earth system model cGENIE.

POSTER 02

Revealing Hidden Magmatic Processes in Subduction Zone Plumbing Systems Using Plutonic Xenoliths

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The study of magmatic systems is often constrained to the geochemical analysis of erupted lavas. However, lavas represent the final erupted product, therefore early differentiation processes are subject to overprinting. Plutonic xenoliths (erupted with lavas) are directly from the vertically extensive mush-dominated reservoirs existing in the crust, likely representing deeper portions of the magmatic plumbing system. Pairing geochemical analysis of lavas with plutonic xenoliths therefore allows previously hidden magmatic processes to be revealed. Geochemistry at the crystal-scale adds another level of insight when interpreting magmatic processes, as the crystal cargo is diverse (phenocrysts, antecrysts and xenocryst) and often heterogeneous with varying chemical zonation. Focussing on whole rock analysis in isolation, therefore masks these variations.

My research focusses on two locations, 1) Statia, Lesser Antilles Arc and 2) Southern Volcanic Zone, Chile allowing for an oceanic and continental arc comparison. The abundance of zoned crystals and multiple generations of crystal phases in both sample sets is extensive, making them ideal target samples. Scanning Electron Microscopy-Energy Dispersive Spectroscopy (SEM-EDS) elemental maps of plutonic xenoliths have allowed crystal-scale samples to be identified. SEM Quantitative EDS and Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) analysis, for major and trace elements respectively, shows that crystal cores and rims display different geochemical signatures.

Now that target samples have been identified, a combination of non-traditional stable isotope (Fe, Cu, Zn, Ti) analysis, alongside estimates of magmatic water contents will be performed to potentially uncover redox conditions, sulphur saturation and fluid sources of the crystallising magma.

POSTER 03

Combining femtosecond laser ablation and ultra-fast washout sample chambers; an evaluation of ablation craters and the application to multi-element mapping

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Femtosecond (fs) laser ablation (LA) inductively coupled plasma mass spectrometry (ICP-MS), has been widely adopted as a powerful technique for high-precision elemental and isotopic analysis, offering advantages over traditional nanosecond (ns) lasers. Research has shown that the shorter pulse duration of fs lasers helps to mitigate common analytical challenges, such as matrix effects, particle size and distribution, and sample transport[1,2,3]. This results in more reliable isotopic data, which is spatially resolved. The combination of these benefits, explored with a fast-washout sample chamber, has, to our knowledge, never been explored. In this contribution, we highlight the use of high-frequency fs lasers for application to multi-elemental imaging applications.

This contribution also explores crater formation and shape over a range of sample materials. Detailed profilometry and scanning electron microscope (SEM) imaging of the resultant craters are evaluated and are shown to have steep crater sides, and minimal crater rims and ejecta.

This study utilises the IRIDIA femto, a next-generation femtosecond laser ablation system, fitted with a fast-transport sample chamber to allow washouts from the sub-millisecond range, to whole seconds (depending on the configuration). We explore how this system performs when applied to complex sample types, and how its imaging capabilities can be fine-tuned for a range of analytical requirements.

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POSTER 04

What can iodine in altered seafloor rocks tell us about the long-term carbon cycle?

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Low temperature hydrothermal flow through the upper oceanic crust may last for tens of millions of years and represents one of the largest fluxes of matter and energy on Earth. This leads to the incorporation of volatile elements from seawater (carbon, water, halogens) in secondary minerals such as clays and carbonates. However, there is uncertainty over the magnitude and temporal evolution of this chemical exchange[1,2], leading to uncertainty about the feedbacks between global tectonics and climate. Addressing this has been difficult until recently due to a lack of samples from *in situ* oceanic crust aged 20-100 Ma. The South Atlantic Transect (IODP Expeditions 390/393) recovered a transect of cores from 7–61 Ma upper oceanic crust, along a single crustal flow line. This unique sample set provides an unparalleled opportunity to understand the timing and chemical fluxes associated with progressive low temperature alteration of the crust.

Halogen abundances measured by neutron-irradiation noble gas mass spectrometry indicate significant and ongoing chemical exchange between seawater and slow spread oceanic crust, persisting for at least 60 million years. Highly altered samples from the oldest cores yielded the highest bulk iodine concentrations ever measured in altered oceanic crust (61 ppm). Mass-balance calculations suggest that alteration of the oceanic crust may control the iodine content of seawater unless balanced by changes in other sinks such as buried organic matter. This suggests that the iodine content of seawater may offer insight into the balance of seafloor alteration and biomass burial through geological time.

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POSTER 05

Using geochemical techniques to trace the origin of human remains

Alma Chavez *(PhD student, University of Leeds), Dr. Jason Harvey (University of Leeds), Dr. Ryan Austin (Nottingham Trent University), Dr. Evgenia Ilyinskaya (University of Leeds).*

Geochemists study processes affecting environmental samples over time. While humans are not typically considered environmental samples, geochemical methods applied to human remains are valuable in forensic anthropology.

Guatemala has many historical mass graves resulting from the decades-long civil war. Human remains from indigenous people were displaced around the country, far from their homelands. The application of geochemical techniques can help organizations, such as The Forensic Anthropology Foundation of Guatemala (FAFG), identify and return remains to their region of origin for appropriate burial and family closure.

In regions with simple geology, factors such as the local bedrock and distance from the coast can give food a specific chemical and isotopic signature, which may be incorporated into bones, teeth, hair, and nails. Consequently, the human body has the potential to reveal information about the geographic region in which individuals were raised.

For example, hair from most individuals analysed from the Baja Verapaz area of Guatemala have higher $^{87}Sr/^{86}Sr$ values (0.70947 ± <0.0001 to 0.71352 ± <0.0001) compared to individuals from the Quiché area ($^{87}Sr/^{86}Sr$ = 0.70527 ± .0.00003 to 0.70799 ± 0.00002), and Chimaltenago Department ($^{87}Sr/^{86}Sr$ = 0.70431 ± 0.00009 to 0.70518 ± <0.0001), which parallels the local bedrock $^{87}Sr/^{86}Sr$.

When combined with other isotopic indicators of dietary habits, (e.g., $\delta^{44}/^{40}Ca$, $\delta^{88}Sr/^{86}Sr$, $\delta^{34}S$, $\delta^{13}C$ & $\delta^{15}N$*),* this method can help establish a connection to the specific region of origin in Guatemala and ultimately lead to the successful identification of the region of origin of individuals from civil war mass graves in Guatemala.

POSTER 06

Quantifying changes in biomass burial over geological time: the effect of melt-back reactions to N mobilisation

Elisa Oliveira da Costa, Sami Mikhail, Fawn Holland, Kirsten Wong, Eva Stüeken, Nick Gardiner, Sally Law, Joshua Garber
University of St Andrews, UK

Earth's atmosphere has substantially changed over geological time, yet quantitative constraints are rare (Zerkle and Mikhail, 2017). Most reconstructions of past atmospheric conditions rely on the sedimentary record, which is inherently influenced by major sampling biases (e.g., decrease of sedimentary record through time due to plate tectonics). To circumnavigate this issue, recent studies have used strongly peraluminous granites (SPGs) N contents and [Equation]^{15}N as proxies to estimate biomass burial, and by extension, changes in atmospheric chemistry (Mikhail et al., 2024; Holland et al., 2026). This is possible since SPGs are mainly formed through the partial melting of metamorphic rocks with sedimentary protoliths. However, before accurate models can be made with these proxies, quantitative constraints on the intermediate processes between biomass burial and SPG formation – metamorphism and partial melting – need to be further constrained.

In this project, we aim to investigate N behaviour during partial melting starting with how melt-back reactions affect N mobilisation. For this purpose, we sampled metatexites to diatexites from Punta Bianca (northeast Sardinia, Italy). Selected samples contain up to 2 cm thick mafic selvedges composed primarily of biotite, which provide a natural laboratory to evaluate N partitioning during melt–rock interaction. Planned analyses include: (1) major element concentrations by EPMA and trace element concentrations by LA-ICP-MS in key mineral phases; and (2) nitrogen concentration and δ^{15}N measurements of melanosomes, leucosomes, selvedges, and mineral separates by IRMS. These data will allow us to constrain melt-back reaction stoichiometry, evaluate the behaviour of NH_4^+ analogues (e.g., Rb, Cs), quantify N mass transfer during melt-back reactions, and assess how these processes influence the reliability of SPGs as proxies for biomass burial and atmospheric evolution.

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Zerkle, A.L. and Mikhail, S., 2017. The geobiological nitrogen cycle: from microbes to the mantle. Geobiology, 15(3), 343-352.

POSTER 07

Targeting key unknowns in terrestrial Arctic CO_2 fluxes

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5. Graduate School, Hokkaido University
6. Department of Geography, University of Oxford

High uncertainty surrounds our knowledge of key carbon cycle processes in the Arctic stemming, in part, from a dearth of greenhouse gas flux measurements. Here, we introduce work on two distinct facets of the Arctic carbon cycle: i) winter CO_2 fluxes from tundra and coastal sea ice environments; ii) CO_2 exchange during weathering of recently exposed bare rock.

We first discuss the development and deployment of new low-cost CO_2 sensors within Arctic tundra snowpacks and over coastal sea ice. Low-cost sensor timeseries show increasing CO_2 release coincident with warming subnivean temperatures, in line with a recent pan-Arctic data synthesis (Natali et al., 2019); particularly evident during the winter-to-spring transition. Stable isotope analysis confirmed soil respiration was the source of subniveal CO_2, with fluxes of a similar magnitude measured in subsequent years. Over sea ice, we find good agreement between our low-cost instrument and a commercially available LiCOR Smartchamber ($r^2 = 0.83$), demonstrating its transferability across different cold environments. Our instrument shows potential for increasing the spatio-temporal coverage of Arctic CO_2 flux

measurements, key for undersampled and logistically challenging regions. A second project investigates the role of bare rock exposures in Arctic carbon cycling, recognising that weathering of reduced minerals (organic matter & sulfide minerals) can lead to CO_2 release as "geo-respiration". While this process may increase as temperatures warm, it may also slow down over decadal to centennial timescales with vegetation growth and Arctic greening. We present a new model framework to explore the changes in rock CO_2 emissions following deglaciation.

Natali, S.M. et al. (2019) ‘Large loss of CO_2 in winter observed across the northern permafrost region’, Nature Climate Change, 9(11), pp. 852–857. Available at: https://doi.org/10.1038/s41558-019-0592-8

POSTER 08

Stable cadmium isotopes track the evolution of carbon burial and basin redox during the Toarcian Ocean Anoxic Event

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The Toarcian Ocean Anoxic Event (T-OAE, 183 Ma) was an episode of rapid global warming associated with emplacement of the Karoo-Ferrar Large Igneous Province. The event is recorded in organic carbon (C_{org}) isotope records as a broad positive excursion (CIE) containing a more abrupt, negative CIE. Consequent weathering feedbacks resulted in higher marine nutrient input, increased biological productivity, and widespread marine anoxia–euxinia. Increased marine C_{org} burial led to localised black shale black shale deposition and associated trace-metal drawdown in reducing settings, with emerging evidence for locally-persistent high rates of C_{org} burial well after the negative CIE interval ended.

Stable cadmium isotopes (δ^{114}Cd) in marine mudrocks are a potential proxy for global changes in C_{org} cycling, a key and under-constrained feedback mechanism for removing excess CO_2 from the oceans and atmosphere. Here, we present δ^{114}Cd records from four European epi-continental shelf and Tethyan margin sections, to track the evolution of organic Cd (~carbon) burial across the T-OAE. Highly consistent isotopic compositions rising from ~-3 ‰ up to ~0.2 ‰ between sections strongly indicate a regional-scale change in the Cd cycle during this interval. Low initial values below crustal compositions trend progressively higher up-section, towards those of the contemporary ocean. This geochemical pattern is interpreted as an increase in the proportion of Cd sequestered at each site associated with increased burial of C_{org} and sulfides during the studied interval. Cd-isotope compositions remain elevated at ~0.1-0.2 ‰ following the culmination of the T-OAE interval, pointing to long-term stability in local depositional conditions.

POSTER 09

Why less stable doesn't mean less important: looking at vaterite as an underestimated calcium carbonate precursor phase

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Calcite and aragonite are ubiquitous as marine biominerals and as a result essential components in the geochemist's toolkit. Much less attention is received by the third anhydrous polymorph, vaterite – the reason being that it is significantly less stable and therefore uncommon in nature. While rare, vaterite can still be found in fish otoliths, bivalves, ascidians as well as soft corals and has even been reported in planktonic foraminifera. Furthermore, as non-classical crystallisation pathways are being explored more, calcification via precursor phases has been becoming of increasing interest to the biomineralisation community to try and explain vital effects and better understand the potential impact of ocean acidification on calcification. While a growing body of work focuses on amorphous calcium carbonate as a precursor, a handful of studies argue that some of the less stable, crystalline polymorphs could play a role as well[1,2]. Our understanding of the formation of these phases is however still minimal, even in inorganic systems.

To address this gap, we present new data from highly controlled, inorganic precipitation experiments, exploring the conditions under which vaterite is formed and how they affect its stability, structure, morphology and geochemistry. Our findings include the first extensive dataset for trace element incorporation into vaterite and indicate that at low solution Mg/Ca ratios and high saturations, vaterite is the dominant primary calcium carbonate phase. This implies that the mineral's scarcity in prior studies may partly be due to its tendency to recrystallise rapidly rather than to an overall absence, suggesting that its occurrence might be generally underestimated.

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POSTER 10

The stable hafnium isotope composition of ocean island basalts

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Hafnium stable isotopes provide a novel tool to investigate geological processes. The chemical behaviour of Hf as a refractory, incompatible, fluid immobile element, with a consistent natural oxidation state, gives it the potential to trace the differentiation of silicate reservoirs, e.g. magma ocean crystallisation and crustal extraction processes, controlled simply by its coordination number between mineral and melt.

The column separation of Hf from various matrices is well established for radiogenic Hf measurement (e.g.[1], [2]) and these have been adapted for stable Hf. A cationic column is used to separate the matrix and REEs, with the second column providing a further matrix and REE clean, as well as isolating Hf from other HFSEs. A novel ^{178}Hf/^{180}Hf double spike was calibrated and tested, with the isotopic analyses performed using multi-collector inductively coupled plasma mass spectrometry (MC-ICP-MS).

We test the robustness of this new method by determining the measurement tolerances from matrix effects and interfering isotopes such as Ta and W and monitoring the behaviour of pure Hf standard reference material (JMC-475) and column processed secondary standards (BCR-2 and BHVO-2).

This method has been applied to samples from Iceland and the Galapagos islands to obtain the first stable hafnium isotope measurements for ocean island basalts from two very isotopically distinct and well-studied mantle plumes.

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POSTER 11

Correcting for pH and temperature effects on $\delta^{13}C$ and $\delta^{18}O$ in foraminifera

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Stable carbon and oxygen isotope data from biogenic carbonates ($\delta^{13}C$ and $\delta^{18}O$) are known to be sensitive to seawater carbonate chemistry (the “carbonate ion effect” or “pH effect”) and must be corrected for this effect to allow proper interpretation. We show that the most common correction methods in the literature yield large errors below pH ≈ 7.8 (such as during the Paleogene) and review better methods. Using published isotope data, we show that foraminiferal $\delta^{13}C$ is sensitive to pH over intervals <15 kyr but does not maintain systematic offsets over longer timescales. Using an ensemble of statistical methods, we calculate pH and temperature effect strengths for 34 species of modern foraminifera. For planktonic foraminifera, we find a median effect size of –0.0072‰ per $\mu mol\ kg^{-1}\ CO_3^{2-}$ for $\delta^{13}C$ and –0.0030‰ per $\mu mol\ kg^{-1}\ CO_3^{2-}$ for $\delta^{18}O$, but with significant species-specific variation. Effect sizes are species-specific and show strong evidence of a phylogenetic signal but do not otherwise correlate with any tested environmental or ecological variable. Strongly symbiotic planktonic species also show a small but significant $\delta^{13}C$-temperature effect of +0.067‰ $°C^{-1}$, with smaller or negative effects for other species. Our results suggest that pH effects are critical to correctly interpreting $\delta^{13}C$ and $\delta^{18}O$ across glacial transitions but can be considered negligible in many deep-time applications.

POSTER 12

Nitrogen isotope variation as a proxy for pH in the Eocene Green River Formation, USA

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$\delta^{15}N$ has been proposed as a paleoproxy for pH based on the ammonia volatilization effect: ammonium and ammonia exist in a pH-dependent equilibrium, with the proportion of ammonia increasing as pH rises (1). When ammonia gas escapes from the system, the remaining dissolved ammonium becomes enriched in ^{15}N. As a result, $\delta^{15}N$ values >10‰ are considered an indicator of high pH (>9) conditions (2).

Here we test the $\delta^{15}N$ pH proxy using samples from the ~50 Ma Green River Formation, a paleolake system indepentently known to have been highly alkaline. Mineralogical evidence (i.e., the presence of nahcolite ($NaHCO_3$) and shortite ($Na_2Ca_2(CO_3)_3$)) supports alkaline conditions in this basin. We compare the nitrogen isotope record with several well-established proxies, including δ^2H of total lipid extract (δ^2H_{TLE}) for precipitation, organic $\delta^{13}C$ for organic matter sources, and carbonate $\delta^{13}C$ and $\delta^{18}O$ for salinity and atmospheric CO_2 composition. This multiproxy approach allows us to evaluate how high-pH conditions were linked to braoder environmental processes.

All isotope records shift in response to geomorphological changes within the lake basin and global climatic variability associated with the Early Eocene Climatic Optimum (~49.1 to 53.3 Ma). $\delta^{15}N$ ranges from 6 – 24‰ and show positive correlation with carbonate $\delta^{13}C$ and $\delta^{18}O$, likely tracking evaporation, and negatively correlated with δ^2H_{TLE}. $\delta^{15}N$ does not correlate with organic $\delta^{13}C$. Together, these relationships support pH-driven ammonia volatilization as the most plausible control on the $\delta^{15}N$ record. This proxy may ultimately have applications beyond Earth, including the analyses of samples returned from Martian paleolakes.

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POSTER 13

Spatially Resolved Boron Isotope Records Support a Strong CO_2–Temperature Coupling During the Late Cretaceous Hothouse

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The Late Cretaceous represents a hothouse interval in Earth’s history, with global temperatures higher than at any time in the Cenozoic. A decoupling between atmospheric CO_2 and global temperatures has been suggested for the Late Cretaceous, without any cause of the apparent decoupling. However, the evolution of atmospheric CO_2 during the Cretaceous is less well-documented than in the Cenozoic. Here, we present a multi-species planktic foraminiferal boron isotope ($\delta^{11}B$) record through the Late Cretaceous from low (DSDP Site 463) and high latitude (DSDP Site 327, DSDP Site 511, DSDP Site 690 and ODP Site 762) sites. We integrate low-latitude $\delta^{11}B$-based reconstructions with a new derivation of $[Ca]_{sw}$, using a geochemical model and cGENIE Earth system simulations to constrain $\delta^{11}B_{sw}$ and the carbon cycle. Our findings indicate that elevated CO_2 levels (~2000 ppm) were reached during the peak warmth of the Turonian, followed by a decline into the Early Maastrichtian (~600 ppm), suggesting a close coupling between CO_2 and temperature even under hothouse conditions. Our results provide improved quantitative constraints on climate forcing from CO_2 throughout the Late Cretaceous, indicating that Earth System Sensitivity was broadly consistent with that found during much of the Cenozoic. We compare low- and high-paleolatitude records to assess spatial differences during the transition from an equable hothouse to a cooler climate state. Our data support the view that from the Maastrichtian, atmospheric CO_2 decline and cooling led to steeper meridional temperature gradients and a reorganization of ocean circulation, amplifying the latitudinal contrasts evident in our records.

POSTER 14

Decoupling Carbonate Chemistry Controls on Coral Calcification Using Boron Isotopes in *Acropora millepora* and *Acropora spathulate*

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Understanding how individual components of the seawater carbonate system regulate coral calcification remains a fundamental challenge in forecasting reef persistence under progressive ocean acidification. Although many investigations quantify bulk calcification responses to variations in pH or aragonite saturation state, comparatively few directly characterise the chemistry of the calcifying fluid that ultimately controls aragonite precipitation. Boron isotopes offer a robust geochemical tracer for reconstructing calcifying fluid pH and therefore provide mechanistic insight into coral biomineralisation.

Here, boron isotope measurements are presented for *Acropora millepora* and *Acropora spathulata* cultured under experimentally decoupled carbonate chemistry conditions. Corals were grown across a multidimensional parameter space in which pH, dissolved inorganic carbon, total alkalinity, pCO_2, carbonate ion concentration, and aragonite saturation state were independently varied using a Latin hypercube sampling design. This approach enables quantitative evaluation of the relative contributions of individual carbonate system variables to skeletal growth.

Skeletal $\delta^{11}B$ was purified using a batch method prior to isotopic determination. Because boron isotope fractionation is pH dependent, $\delta^{11}B$ values preserved in coral aragonite reflect calcifying fluid pH rather than ambient seawater conditions. By combining $\delta^{11}B$-derived pH estimates with independently constrained seawater chemistry and growth metrics, the magnitude of internal pH upregulation can be assessed and its sensitivity to external forcing evaluated.

Together, these measurements support development of a mechanistic framework linking external carbonate chemistry, internal regulation of the calcifying environment, and skeletal geochemical signatures, providing quantitative constraints for coral calcification models and informing interpretation of coral-based paleo-pH proxies under evolving ocean conditions.

POSTER 15

Microscopic elemental banding in *Morozovella*: Evolutionary insights and implications for Paleogene SST proxies

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Understanding elemental banding in the calcite tests of extinct planktonic foraminiferal taxa is critical from both evolutionary and paleoclimatological perspectives. It provides direct insight into the biomineralisation strategies of early Cenozoic planktonic foraminifera, allowing evaluation of whether trace element partitioning mechanisms observed in extant species were already established during Paleogene greenhouse climates. This is also essential for assessing the evolutionary stability of Mg incorporation pathways that underpin Mg/Ca-based SST calibrations. Furthermore, nanoscale heterogeneity influences bulk proxy signals: resolving how daily or ontogenetic banding integrates into whole-test geochemistry strengthens confidence in SST reconstructions across important climatic intervals such as the PETM and EECO.

We present new nanoSIMS maps revealing nanoscale trace element banding in the Paleogene mixed-layer genus *Morozovella*, a key taxon for Paleocene–Eocene sea-surface temperature (SST) reconstructions. Our maps document exceptionally fine scale alternating high/low Mg/Ca bands aligned with Na/Ca and Sr/Ca banding in well-preserved specimens, extending observations of Mg banding in *Morozovella* using electron microprobe microanalysis (EPMA; [1]) and coupled elemental heterogeneity previously identified in modern planktonic foraminifera (e.g., [2], [3]).
We also hope to present preliminary nanoSIMS data showing the spatial association between trace element bands (Mg, Na, Sr) and organic-proxy signals (C, C_2, O, CN, P, S). In modern taxa, elevated Na and Mg are linked to primary organic sheets that template calcification (e.g., [3]). Integrating inorganic and organic nanoscale signatures offers a mechanistic framework linking biomineralisation, evolutionary adaptation, and proxy fidelity, thereby refining interpretations of Paleogene ocean temperatures and plankton evolution.

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POSTER 16

Mineralogy, Biogeography, and Proxy Potential of New Zealand/Southwest Pacific Stylasterid Corals

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Anthropogenic ocean acidification threatens marine calcifiers, particularly deep-sea taxa whose mineralogy may influence dissolution susceptibility. Stylasterid corals are widespread deep-sea ecosystem engineers that precipitate either aragonite or high-Mg calcite, yet their skeletal geochemistry remains poorly constrained. We present the first Southwest Pacific trace element dataset (Li/Ca, Mg/Ca, Sr/Ca, Ba/Ca, Li/Mg) for stylasterids, including several previously unstudied species. Elemental ratios were measured using a Thermo Scientific Element2 ICP-MS to characterise skeletal composition and assess environmental influences on mineralogy.

Mg/Ca ratios were used to distinguish mineral phases. Aragonitic stylasterids occur across a broad latitudinal range (to ~70° N and S), whereas high-Mg calcitic taxa are restricted to the Errinopsis–Errina–Errinopora species complex, indicating strong phylogenetic control on mineralogy. These high-Mg calcitic taxa are concentrated at high latitudes, consistent with a temperature influence on skeletal composition. Because aragonite is more susceptible to dissolution than calcite, this distribution has important implications for stylasterid vulnerability under continued ocean acidification.

Placing our results in a global framework alongside published datasets (Stewart et al., 2020; Kershaw et al., 2023), we identify broad biogeographic patterns in stylasterid mineralogy and trace element systematics. We also assess paleoceanographic proxy potential by calibrating Li/Mg and Sr/Ca ratios to in situ seawater temperature, and Ba/Ca to nutrient concentrations. Our findings provide new insight into stylasterid biomineralisation, environmental controls on mineralogy, and the utility of these corals as high-latitude archives of past ocean conditions.

POSTER 17

The impact of spatial weathering on atmospheric O_2 and CO_2 predictions in isotope mass balance driven models

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The chemical composition of Earth's atmosphere has changed markedly over the course of its 4.5-billion-year existence [1], gradually moving from an O_2-deficient to an O_2-rich atmosphere, capable of supporting large, complex organisms. Many methods have been utilised to back calculate atmospheric O_2 levels through time, including a number of numerical biogeochemical models.

Models such as COPSE [2] and SCION [3], which use nutrient systems to determine organic carbon burial rates over the Phanerozoic, provide temporally broad predictions of atmospheric O_2 levels; while the GEOCARBSULF(OR) models [4,5] use the inorganic carbon isotope record to generate high-resolution atmospheric O_2 reconstructions, which better showcase the likely extent of variability in O_2 through time.

However, the extent of the influence carbon sources versus sinks have on changes in O_2 (and CO_2) in these IMB models is currently uncertain, as the representation of weathering processes in them is much simplified. Thus, it is possible that atmospheric predictions of O_2 and CO_2 are solely driven by the carbon isotope record, baking in all the commensurate uncertainties which accompany the record.

Here, we incorporate the 2D climate and weathering system of the SCION model into the IMB-driven GEOCARBSULFOR model and update model degassing rates, to test whether better representations of carbon sources substantially alter predictions of the composition of the atmosphere during the Phanerozoic and late Neoproterozoic.

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POSTER 18

Differential retention of Rb-Sr and U-Pb in subducted oceanic crust, evidence from the Zermatt–Saas Ophiolite

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Recycling of oceanic crust via subduction is widely invoked to explain mantle heterogeneity, particularly the U and Th-enriched HIMU reservoir. A key question is whether the Th-U-Pb inventory of subducted oceanic crust survives dehydration and fluid-loss. Although slab-derived fluids can mobilise these elements, several studies suggest that subducted oceanic crust may retain its isotope signature to depths of >100 km (Turner et al., 1997; Himmler et al., 2019) yet direct constraints from high-pressure terrains remain limited.

We present high-precision Sr and Pb isotope data for metabasalts and metagabbros from the Zermatt-Saas Ophiolite. This area preserves subducted Jurassic oceanic lithosphere, providing a natural laboratory to evaluate how the Rb-Sr and U-Pb systems behave during slab dehydration and fluid-rock interaction. Despite extensive eclogite facies metamorphism (P > 2.3 GPa, depths of ~90 km), lower crustal metagabbros of the Allalinhorn retain unradiogenic, DMM-like Sr isotope compositions (^{87}Sr/^{86}Sr = 0.70256-0.70265) and primary Pb isotope signatures (^{206}Pb/^{204}Pb = 17.97–18.37). In contrast, Pfulwe upper crustal metabasalts possess more radiogenic Sr and Pb (^{87}Sr/^{86}Sr = 0.70394-0.70422, ^{206}Pb/^{204}Pb=18.30-18.62) consistent with pre-subduction seafloor alteration or sediment-derived fluid ingress.

Thus, oceanic lower crust remains geochemically coherent through the forearc region, retaining its original isotopic signatures despite partial dehydration. Consequently, the slab reaches the sub-arc environment with its capacity to evolve into HIMU intact. Forward modelling confirms this conservative lower crust acts as a critical buffer; its low U/Pb ratios limit radiogenic evolution to successfully evolve to HIMU reservoir signatures in mantle residence. This data identifies the deep subducted lower crust as a primary high-fidelity candidate for HIMU progenitors.

POSTER 19

Environmental Controls on Trace Element Incorporation in Coccolithophore Calcite

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Coccolithophores are both a major component of the carbonate cycle, and contributor to the carbonate geochemistry record, yet the mechanisms of lith formation and trace element incorporation during biomineralisation remain poorly constrained.

In this study, cultures of *Gephyrocapsa huxleyi* were grown under a controlled matrix of carbonate chemistry and temperature treatments designed to encompass both present-day, distant-past and projected future ocean conditions (pH 7.8 to 8.9; dissolved inorganic carbon [DIC] 1000 to 3000 μmol kg^{-1}; temperature 15 to 25 °C). By independently varying these parameters, we aim to disentangle physicochemical influences from biologically mediated ("vital") effects on trace element uptake.

Coccolith calcite was isolated using refined oxidative and physical cleaning protocols to remove organic material while preserving elemental and isotopic integrity. Trace element-to-calcium ratios (Mg/Ca, Sr/Ca, Mn/Ca, Ba/Ca, etc.) were quantified using inductively coupled plasma mass spectrometry (ICP-MS). This design enables systematic investigation of how temperature and carbonate chemistry influence ion transport, crystal growth, calcification processes and trace element incorporation in coccoliths.

By linking environmental parameters to elemental incorporation, this project aims to establish a foundation for more robust proxy calibration. It also provides a framework for predicting how marine calcifiers may respond to future ocean changes, including acidification, warming, and carbon dioxide removal strategies

POSTER 20

Temporal and Structural Constraints of Magmatism and Hosted Mo Mineralisation: The Inner Starav Granite, Etive Pluton, Scotland

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The Late Caledonian Etive Complex (surface map area 300km^2) comprises six major units of diorite to monzogranite composition. Emplacement age estimates range from 415-408 Ma [1].

The Etive Complex hosts sparse molybdenum mineralisation in both skarn- and vein-type systems. A previous study demonstrated that a Cruachan Granite (a phase of the Etive Complex) U-Pb CA-ID-TIMS zircon date (414.9 ± 0.7 Ma) and associated skarn molybdenite Re-Os ID-TIMS dates (414.7 ± 2.1 Ma) are in close agreement [2]. Here we investigate the Starav intrusion to further understand the temporal relationships of magmatism and mineralisation of the Etive Complex.

New Th corrected $^{206}Pb/^{238}U$ CA-ID-TIMS zircon dates from the Inner and Outer Starav intrusion phases are interpreted to yield crystallisation ages between 412.52 ± 0.22 Ma to 411.50 ± 0.62 Ma, and 412.43 ± 0.21 Ma to 411.17 ± 0.38 Ma, respectively. These dates are ~3 to 4.5 Myrs older than a previous CA-ID-TIMS zircon date for the Inner Starav (408 ± 0.5) [1] due to more aggressive chemical abrasion procedures now employed in U-Pb zircon geochronology (e.g. 180 vs 210°C). The agreement of these U-Pb CA-ID-TIMS zircon dates are supported by field relationships suggesting a penecontemporaneous emplacement of the Inner and Outer Starav.

In contrast, quartz vein hosted molybdenite of the Inner Starav yielded Re-Os ID-NTIMS dates between 418.0 ± 2.1 Ma and 420.1 ± 2.3 Ma.

Further studies are investigating this age disparity utilising SEM and BSE elemental mapping of molybdenite [4], and high precision SIMS analysis of zircon age domains.

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POSTER 21

Diffusion-reaction modelling to predict the boron isotope composition of photosymbiont species *O. universa* from observed physiological fluxes

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The boron isotope composition ($\delta^{11}B$) of planktic foraminifera tests is primarily controlled by ambient seawater pH and is therefore a well-established proxy for reconstructing surface ocean carbonate chemistry in the geological past. Reconstructions of past seawater pH from planktic foraminifera underpin estimates of atmospheric pCO_2 over geological time and have driven recent advances in using past climate states to improve projections of Earth's future climate. However, biological "vital effects" necessitate empirical, species-specific, $\delta^{11}B$-pH proxy calibrations for accurate pH (and pCO_2) palaeo-reconstructions. Specifically, physiological processes including respiration, photosynthesis and calcification alter the pH of the diffusive boundary layer (DBL) surrounding living foraminifera. Given it is this pH that is thought to be recorded by foraminiferal calcite $\delta^{11}B$, shell composition typically deviates from what is predicted based upon equilibrium seawater borate $\delta^{11}B$. This can be mechanically understood using diffusion-reaction modelling, which predicts pH and associated boron systematics within the DBL, and thus the expected $\delta^{11}B$ at the shell surface, if respiration, photosynthesis and calcification fluxes are known. Here we report modelled pH and $\delta^{11}B$ of individual *O. universa* specimens using respiration and photosynthesis rates calculated from direct observations using light-dark microelectrode and respiration chamber measurements of [O_2] within the DBL. Together with modelled DBL pH/$\delta^{11}B$, these provide valuable insight into the drivers of species-specific and inter-specimen offsets between $\delta^{11}B$ of foraminiferal calcite $\delta^{11}B$ and seawater borate, addressing a critical limitation in reconstructing past seawater pH, particularly during greenhouse high-CO_2 intervals, when vital effects and metabolic behaviour may have differed from the present. Ultimately, this work opens avenues to reconstruct past changes in seawater pH using single shell $\delta^{11}B$ analysis, providing a methodology to significantly improve the temporal resolution of palaeo-pH and CO_2 records relative to traditional, monospecific, bulk population analyses.

POSTER 22

Investigation of Zinc Accumulation in Cacao (*Theobroma cacao*) Trees via Natural Stable Isotope Analysis

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The introduction of strict upper limits for Cd in cocoa-based food products imposed by the European Union has made compliance challenging for cocoa producers in many countries. A previous study suggested that Zn can mitigate Cd toxicity in juvenile cacao[1]; however, Zn dynamics in cacao have not been systematically investigated in mature trees grown under field conditions[2].

In this study, we analysed the Zn concentrations and stable isotope compositions of topsoils (0-20 cm) and different organs of mature cacao trees collected from four Ecuadorian cacao farms. The Zn concentrations varied widely among different tree compartments (3.4-130 $\mu g\ g^{-1}$), with the greatest variability observed in leaves, followed by bark, roots, then fruits. The mean annual Zn mass fluxes to tree organs followed the pattern leaves > wood > fruits > roots, with one exception where the fruits acquired a larger Zn mass than wood. Total Zn concentrations in topsoils ranged from 105 to 149 $\mu g\ g^{-1}$, though only 0.3-1.3% of this was extractable by Mehlich3, which was used to estimate phytoavailable Zn. Zinc isotope compositions of the topsoils across the study sites were similar, at $\delta^{66}Zn=0.32\pm0.06‰$ (1SD). All studied trees were enriched in heavy Zn isotopes relative to the bulk soils, but substantial variability was observed, with $\Delta^{66}Zn_{total\ tree\text{-}soil}$ ranging from 0.15‰ to 0.79‰. Future work will investigate the influence of key soil properties on tree Zn isotope compositions and compare Zn and Cd isotope fractionations in mature cacao trees to better understand how these elements are processed in soil-cacao systems.

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POSTER 23

Plio–Pleistocene Indian Summer Monsoon evolution: new insights from the Bay of Bengal

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Indian Summer Monsoon (ISM) brings seasonal reversal of wind and precipitation in South Asia. During the late Plio–Pleistocene, intervals of reduced river runoff and sustained wind enabled enhanced ocean mixing in northern Bay of Bengal (BoB), leading to increased siliceous productivity[1]. Understanding whether this condition was linked to the coastal areas or extended in the basin could provide useful insights into the processes and mechanism operating during the warm climate state of the mid–late Pliocene, both regionally and globally. To investigate this, we generate new ISM records of bulk sediment geochemical data of the International Ocean Discovery Program (IODP) site U1444 in the BoB[2]. We present orbitally resolved age model for Site U1444 across 3.3 to 2.4 million years ago (Ma) using benthic foraminifera oxygen isotopes ($\delta^{18}O$) tuned to global probabilistic stack (ProbStack[3]). The X-Ray Fluorescence (XRF) core scan elemental data will be used to evaluate proxies of ISM linked continental runoff and/or wind strengths following statistical treatment. We compare these records with northern BoB site1 to better understand regional ISM dynamics and evaluate the mechanisms to comprehend whether basin scale changes occurred in the context of changing boundary conditions of the Plio–Pleistocene.

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POSTER 24

10–100 pg Nd Isotope Analysis via NdO and TE-Stabilised Emission on NuTIMS

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Picogram-level Nd isotope measurements are increasingly required for sample-limited geochemical and experimental studies. Here we present new NdO analytical performance on the NuTIMS, using switchable 10^{13} Ω amplifiers and a static Faraday array to achieve high-precision ^{143}Nd/^{144}Nd measurements from 10–100 pg JNdi loads.

Measuring Nd as NdO provides 15–27% ion efficiency (typically ~21% for 100 pg), enabling stable beams at intensities far below conventional metal-mode capability. To support low-intensity operation, we developed a Total Evaporation (TE) PID-controlled emission ramp, which regulates filament output and allows fully automated analysis. When combined with Active Tau Correction, accurate Faraday performance is maintained at integration times down to 2 s, significantly improving measurement stability and analytical throughput for ultra-small samples.

External reproducibility of ≈33 ppm (100 pg), ≈101 ppm (25 pg) and ≈130 ppm (10 pg) was achieved. Equivalent metal-mode measurements show substantially poorer performance due to an 8–9× reduction in ion yield.

These developments demonstrate that sub-100 ppm Nd isotope precision at the picogram scale is achievable on the NuTIMS, enabling high-quality Nd isotope data from previously inaccessible natural and experimental materials.

POSTER 25

Tracing the Source of Archaean Rare-metal Pegmatites using Silicon Isotopes (δ^{30}Si)

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Lithium is a critical metal mainly sourced from Archean-aged pegmatites [1], but whose ore genesis is only partially constrained. Existing petrogenetic models commonly invoke partial melting and extensive fractional crystallisation of clay-rich crustal sources to generate metal-rich melts. However, Li-pegmatites that occur in Archaean settings are rarely associated with fertile protoliths, such as S-type granites or extensive meta-sedimentary packages [1, 2], making their melt source elusive.

Silicon isotopes (δ^{30}Si) record both igneous melt differentiation and can trace sedimentary source material in igneous rocks [3, 4], making them an attractive, yet unexplored, proxy for investigating rare-metal pegmatite petrogenesis. We analysed δ^{30}Si of Archaean granitoid-gneiss suites, Li-rich pegmatites, and barren equivalents from northeastern Zimbabwe Craton.

Granitoid-gneiss suites together with barren pegmatites, define and share a similar isotopically heavy differentiation trend, analogous but offset from that of Phanerozoic I- and A-type granites [5]. In contrast, Li-rich pegmatites display lighter δ^{30}Si values than their regional granitoids and barren pegmatites, while remaining heavier than “modern” barren and fertile S-type granitic bodies.

These results suggest that mineralized pegmatite-forming melts do not derive solely from direct melting of clay-rich source rocks. Their offset towards lighter δ^{30}Si relative to regional granitoids-gneiss implies that either a) an isotopically heavy phase was removed during emplacement and/or crystallisation, or b) derivation from an isotopically distinct reservoir relative to regional granitoids. Our findings provide new constraints but raise new questions on the sources of Archaean rare-metal pegmatites and highlight the potential of silicon isotopes as tracers of pegmatite melt source.

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POSTER 26

A millennium of cold-water coral habitat loss in the East Pacific during low ENSO variability in the mid- to late-Holocene

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The evolution of El Niño–Southern Oscillation (ENSO) under past and future climate change and its influence on marine ecosystems is highly debated. To examine links between tropical climate variability, high-latitude feedbacks, and deep-sea ecosystems, we have analysed over 900 sub-fossil cold-water scleractinian corals from the Galápagos Archipelago. U-Th dating shows that these corals have inhabited the region for at least 117,000 years, thriving at depths down to ~1000 meters. However, we find a millennial-scale gap in coral occurrence ~5,000 years ago, coinciding with reduced ENSO variability and a persistent La Niña-like state. Coral presence resumed as ENSO cyclicity strengthened again toward modern conditions.

While shallow-water coral growth has been shown to generally decline in the equatorial Pacific during El Niño surface warming, the mid- to late-Holocene loss of cold-water corals may reflect the opposite: prolonged La Niña-like conditions. We hypothesize that stronger upwelling at this time intensified the oxygen minimum zone, adversely affecting cold-water coral habitats. With ENSO projected to change under continued ocean warming, the potential vulnerability of cold-water corals to future climate change is a growing concern. This study underscores the value of understanding past ENSO behaviour and its impact on deep-sea ecosystems in a warming world.

POSTER 27

Characterisation of ochreous mining waste in the UK to optimise sustainable bioprocessing of iron oxyhydroxides

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Thousands of tonnes of iron ochre waste are generated every year as a byproduct of mine water treatment plants in the UK, most of which ends up in landfill [1]. This project is focusing on developing novel processes of repurposing this waste including recovering valuable metal constituents and re-using of the resource to revalorise the material. This aims of this project are to explore the potential of using iron-reducing bacteria to convert the ochre waste into functional nanomaterials.

The initial stages of this project involve extensive characterisation of the mine wastes kindly provided by the Mining Remediation Authority (MRA) using a range of techniques such as ICP-MS, XRD, XRF, Ferrozine Assay, and ATR-FTIR to analyse the crystalline and geochemical properties, as well as iron speciation of the ochre. Six legacy mine sites have been sampled and analysed for this preliminary research, 2 from copper mines in North Wales, 1 from a coal mine in Greater Manchester, and 3 from MRA treatment sites. An analogous sample from a site of naturally occurring acid rock drainage has also been included for comparison.

The later work packages aim to sustainably bioprocess this waste using dissimilatory iron-reducing bacteria, such as *Shewanella oneidensis,* to transform the iron minerals through reduction of Fe^{3+} into Fe^{2+}, leading to precipitation of mixed valence iron oxyhydroxides nanomaterials, including magnetite. These nanomaterials can be used in a range of catalytic processes from industrial reactions to biomedical treatments [2]. These products will be characterised using the same analytical techniques to assess the properties of the transformed minerals.

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POSTER 28

Automating column chemistry for sulfur isotope analysis by solution-based mass spectrometry using a prepFAST-MC

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Sulfur isotope fractionation signatures have been critical to our understanding of topics such as the redox state of the oceans, and the evolution of the Earth's atmosphere. The advent of sulfur isotope analysis by multi-collector inductively-coupled plasma mass spectrometry (MC-ICP-MS) has enabled analysis of much smaller samples. However, it requires sample purification, which is traditionally performed using gravity-driven columns; a time-consuming and labour-intensive method which may be susceptible to human error. We have developed automated techniques for water and rock samples, using an ESI prepFAST-MC, in order to alleviate these issues. We calibrated our method by characterising the elution behaviour of both sulfate and matrix cations, demonstrating matrix removal efficiencies >99%, and a sulfate yield >90%. The methods have been tested by MC-ICP-MS analysis of international reference materials and in-house standards. Total procedural blanks are around 4 times lower than for the traditional manual technique, and $\delta^{34}S$ values for 3 international reference materials reproduce expected values within analytical uncertainty. Our two in-house standards run through the prepFAST-MC reproduce manual column ratios to within 0.1 ‰. The prepFAST-MC automated purification methods described here are capable of preparing samples for sufficiently accurate and reproducible sulfur isotope analysis by MC-ICP-MS. This innovation reduces the time, labour, and user training necessary for sample purification. It is particularly advantageous for applications requiring high throughput of large numbers of small samples.

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POSTER 29

Closed-System Behaviour of Subducted Serpentinites Revealed by Sr-Pb Isotopes in the Zermatt-Saas Ophiolite

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Subducted serpentinites are major carriers of water and fluid-mobile elements into the mantle, but their ability to retain or release volatiles depends on the extent of fluid-rock interaction during subduction. Sr and Pb isotopes are sensitive tracers of such interaction because they can record mixing between mantle-, sediment-, and seawater-derived components, and even minor radiogenic inputs can shift the compositions of ultramafic rocks. We report Sr and Pb isotope data for serpentinites from the Zermatt-Saas Ophiolite (Western Alps), a well-preserved fragment of Jurassic oceanic lithosphere subducted to eclogite-facies conditions (~3 GPa and ~600℃; [1]) affected by partial dehydration and multiple vein-forming events.

The serpentinites possess extremely low Sr and Pb concentrations (<1 ppm) and preserve near-Jurassic-seawater $^{87}Sr/^{86}Sr$ compositions (~0.706-0.708) together with unradiogenic $^{206}Pb/^{204}Pb$ (18.4-18.6). These compositions contrast with other serpentinites in the western Alps, which show substantial overprinting by metasedimentary or slab-derived fluids [2, 3]. Instead, the Zermatt-Saas serpentinites retain Sr isotope signatures close to those seen by Bouilhol et al. (2022) [4], indicating minimal Sr and Pb mobility at bulk-rock scale and limited exchange with adjacent metasedimentary or metabasic units.

Overall, Sr-Pb isotopes indicate that the Zermatt-Saas serpentinites behaved largely as a closed system during subduction and exhumation, placing them at the least-modified end of the global serpentinite spectrum. This contrasts with mélange and supra-subduction serpentinites that typically show strong radiogenic overprints from sediment-derived fluids [5]. Ongoing Re-Os and Sr-Pb analyses of discrete vein generations may further resolve the timing, sources, and pathways of fluids, and clarify how serpentinites retain their volatile-transport capacity in the deep mantle.

POSTER 30

Interglacial changes to the Greenland ice sheet and impacts on weathering

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Greenland ice sheet (GIS) melt is projected to be the biggest contributor to sea level rise by the end of the century. The long-term behaviour of the GIS and the impact of its melt on climate systems such as the Atlantic Meridional Overturning Circulation (AMOC) are poorly understood. Paleoclimate data from past warm periods can be used to understand how the GIS behaves under warmer climate conditions. We analysed authigenic Pb and Nd isotopes from Greenland marine core sites IODP U1305 and ODP 919 covering the extended warm period of Marine Isotope Stage (MIS) 11 (432-380 ka) to investigate fluctuating ice sheet dynamics and associated weathering changes.

All isotopes show correlation between 432 to 413 ka with a spike indicating increased weathering flux during deglaciation. However, between 413 to 402 ka, the ^{208}Pb/^{204}Pb and εNd records are decoupled from the ^{206}Pb/^{204}Pb and ^{207}Pb/^{204}Pb records. This difference may be explained by a shift in weathering congruence or a change in provenance associated with ice sheet retreat. Our Greenland records do not follow the same pattern as published MIS 11 authigenic records for the Laurentide ice sheet suggesting different ice sheet behaviours. The records also indicate instability of the Greenland ice sheet at the time of an AMOC reduction event at ~412 ka.

POSTER 31

New isotope and geochemical facilities at the University of Exeter, Camborne School of Mines

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Recent investment in analytical infrastructure at the University of Exeter (Camborne School of Mines) from Cornwall Council and the Shared Prosperity Fund has established a new integrated geochemistry facility designed to support high-precision isotope and materials characterisation across a wide range of Earth, environmental, and materials science applications.

This investment comprises two parts, the first part of which is the new Geotracer Facility. The centrepiece of this development is a new MC-ICPMS (Nu Instruments Sapphire) and ISO 7 clean room with ISO 5 hoods and work benches, that enable low-blank chemical processing and high-accuracy isotopic analysis. The facility supports both radiogenic and non-traditional stable isotope workflows and is configured to accommodate both established protocols and method development. This new facility complements existing geochemical infrastructure at Exeter Earth and Environmental Sciences including (LA-)ICPMS, ICP-OES, SEM, and EPMA.

Additionally, the new Critical Minerals Equipment Hub, also funded by Cornwall Council through the Shared Prosperity Fund is a suite of new instrumentation focused on rapid, non-destructive compositional and structural analysis. Fourier Transform Infrared spectroscopy (FTIR) and Raman microscopy provide molecular and mineralogical characterisation, while micro-XRF (µXRF) enables spatially resolved elemental mapping. Powder X-ray diffraction (XRD) further enhances phase identification and quantitative mineral analysis. Together, these tools create a flexible analytical pipeline that spans micro-scale screening to high precision isotope measurement.

POSTER 32

Reconstruction of marine redox landscape during the Cryogenian interglacial oceans using thallium isotopes

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The change in marine redox chemistry between the Cryogenian Sturtian and Marinoan glaciations (ca.663–654 Ma) is crucial for understanding the potential relationship between environmental conditions and the diversification of early animals. The Nanhua Basin in South China provides a nearly complete sedimentary record of this interglacial period within the Datangpo Formation. Here, we present high-resolution thallium isotope (ε^{205}Tl) records from the basal Datangpo Formation using two drill cores to constrain these marine redox changes. Our ε^{205}Tl values range from -4.9 to -0.7 (mean = -2.8). These values are lower than the upper continental crust value ($\varepsilon^{205}\mathrm{Tl}_{\mathrm{UCC}}$ = -2.1 ± 0.3) but higher than the modern seawater value ($\varepsilon^{205}\mathrm{Tl}_{\mathrm{seawater}}$ = -6 ± 0.6). We observed a negative excursion in the lower part of both drill cores and suggest an episode of ocean oxygenation in the basal Datangpo Formation. The ε^{205}Tl values shifted from lower to higher values upsection in both the Gaodi and Changxingpo drill cores, suggesting a return to widespread anoxic conditions. A simple mass-balance model suggests that well-oxygenated, Mn-oxide-rich sediments acted as a significant sink for Tl in the Nanhua Basin (Gaodi: f_{oxic} = 7-14%, Changxingpo: f_{oxic} = 13-20%). This transient oxygenation event coincides with the first significant radiation of algae, likely laying the ecological foundation for the emergence of multicellular organisms. These findings highlight the intricate link between marine redox fluctuations and early biological evolution during the Cryogenian interglacial period

POSTER 33

Greenland Sea Surface Temperatures during the mid-Piacenzian Warm Period

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The mid-Piacenzian Warm Period (mPWP; 3.3-3.0 Ma) is a key interval for understanding the behaviour of the Earth's climate as it was the last time interval where atmospheric CO_2 was similar to modern levels. However, the mid-to-high latitude North Atlantic during the mPWP presents an enigma for the understanding of the Earth's sea surface temperatures (SST): modelled temperatures are consistently lower than proxy reconstructions, the majority of which use alkenones to reconstruct temperature.

In order to test whether alkenone temperatures match an alternate temperature reconstruction within the same core, we produced sea surface temperature estimates for the mPWP from Site U1602, just south-east of Greenland, using alkenones and glycerol dialkyl glycerol tetraethers (GDGTs). We find that the two proxies produce divergent temperature estimates, with a 10 °C difference in average temperatures recorded through the interval. Furthermore, we show that GDGT-based temperature reconstructions depend heavily on the calibration method, with a 10 °C difference just between calibrations of the same GDGT distributions.

We suggest that the $U^{K'}_{37}$ temperatures are more likely to be accurate than GDGT-based proxies. Even the warmest GDGT-based estimates are significantly colder than the present, and a substantial difference in surface currents in the Nordic Seas compared to modern conditions would be necessary to explain this. Furthermore, we find no evidence for sea ice markers (IP_{25} and $\%C_{37:4}$ alkenone) that would independently corroborate very cold temperatures. We therefore suggest that further work is needed to robustly apply GDGT-based SST proxies in this region of the sub-polar North Atlantic.

POSTER 34

Using Cadmium Isotopes To Quantify Marine Organic Carbon Burial during the Paleocene–Eocene Thermal Maximum

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Organic carbon burial is a key feedback affecting atmospheric CO_2, but we currently have no proxy for how it might have varied across past events. We demonstrate how the cadmium isotope ratio ($\delta^{114}Cd$) of shales may provide such a proxy, using the PETM as a case study. Measurements of $\delta^{114}Cd$ at four PETM age sites show a global positive excursion in $\delta^{114}Cd$ of ~0.2‰. We create a box model to simulate the seawater cadmium system and link this to carbon burial, and find we are only able to drive this excursion with large amounts (~40,000GtC) additional organic carbon burial. This is the same order of magnitude as estimated CO_2 emission fluxes, suggesting that marine organic carbon burial played a major role in carbon sequestration across the PETM.

POSTER 35

Slab window processes in the final stage of an ancient convergent margin: Insights from the eastern Central Asian Orogenic Belt

Kai Wen[1, †], Andrew C. Kerr[1]

Ridge subduction and associated slab-window processes can generate intraplate-like magmatism within convergent margins and strongly influence the thermal and compositional evolution of the lithosphere. However, identifying slab-window signatures in the geological record is often challenging because they are commonly obscured by post-tectonic magmatism and surface alteration. Here we compile an integrated dataset including spatial distribution, geochronology, whole-rock geochemistry, and zircon Hf isotopes for Permian–Triassic (300–200 Ma) igneous rocks along the Changchun–Yanji Suture, northern margin of the North China Craton. By combining these geochemical datasets with quantitatively reconstructed paleo-crustal thickness using a machine learning approach, we establish a refined ocean–continent transition architecture during the Permian–Triassic.

Our results reveal evidence for slab-window magmatism triggered by ridge–trench interaction in the western segment of the suture zone. We further distinguish magmatic signatures related to slab break-off during arc–continent collision from those associated with subduction of a young and thermally buoyant slab. Comparison between the slab-window domain and adjacent regions highlights the significant role of ridge subduction in controlling crustal thickness variations, magmatic flare-ups, and crustal growth during the final stage of orogenic evolution.

POSTER 36

Simultaneous boron and silicon measurements on single biogenic silica samples

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Boron isotope ratios measured in planktic foraminifera are one of the most precise palaeo-CO_2 proxies available for the Cenozoic and, recently, the late Cretaceous. However, preservation restricts their use for further reaches of Earth history. Here, we develop a method to measure B isotopes in radiolarian silica which could greatly expand the applicability of the $\delta^{11}B$ proxy. In addition, because the resin used for B isotope chromatographic separation retains boron and allows other elements (including Si) to pass through, Si isotopes can be measured on the eluted sample, increasing the information that can be gained from each sample. Here, I will present the method we are developing to analyse B and Si isotopes in a single sample. We test this methodology on coretop, fossil and tow samples.

POSTER 37

Constraining the Temperature Sensitivity of Microbial Rock Organic Carbon Oxidation

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The traditional view that rock weathering acts as a CO_2 sink is incomplete. Organic-rich sedimentary rocks oxidise and release CO_2 upon exhumation, despite their assumed thermal and biological recalcitrance. These rock-derived CO_2 fluxes are temperature dependent[1,2,] and may represent an underappreciated positive feedback to climate warming on multi-decadal timescales. Deglaciating landscapes may therefore represent hotspots of oxidative weathering, as glacier retreat exposes large stocks of rock organic carbon to aerobic conditions for heterotrophic colonisation while rising temperatures overcome kinetic and enzymatic constraints on microbial metabolism. However, most rock organic carbon oxidation studies focus on tropical catchments, leaving the chemical and microbial drivers of temperature sensitivity in actively deglaciating settings poorly constrained.

To address this gap, a field campaign during summer 2025 was conducted in Svalbard, a region warming up to seven times the global average[3]. Over thirty sediments were collected from five deglaciating catchments for integrated geochemical ($\delta^{13}C$, C/N, ramped oxidation) and microbiological (16S rRNA, cell density) analyses. Twelve sediments spanning glacier termini to valley mouths were incubated at 5°C, 15°C and 30°C and headspace CO_2 was measured after 24 hours to quantify temperature sensitivity (Q_{10}). We derive twelve new estimates of rock organic carbon temperature sensitivity, substantially expanding the two existing values[1,2]. These Q_{10} values span and exceed those typical of soils, with carbon fluxes varying by an order of magnitude along valley gradients. Our results demonstrate comparatively high temperature sensitivity of rock organic carbon oxidation in deglaciating landscapes, with strong implications for carbon–climate feedbacks beyond current warming projections.

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POSTER 38

Quantifying changes in biomass burial over geological time

Kirsten Wong, Elisa Oliveira da Costa, Fawn Holland, Eva Stüeken, Paul Savage, Nick Gardiner, Richard White, Sami Mikhail – *University of St Andrews*

The chemistry and mass of Earth's atmosphere have changed markedly over the past 4.5 billion years, but quantitative constraints are rare. Earth's environmental history is traditionally read from sedimentary rocks that formed at Earth's surface. This approach has yielded important insights into oxygenation events that facilitated the rise of complex life. A key process is the removal of organic carbon which led to an increase in atmospheric O_2. However, despite over half a century of effort to quantify changes in biomass burial there is no agreement concerning the scale of change in biomass burial through time. For example, recent predictions range from no significant change to >10-fold increase over the past 3.5 billion years. One major issue is that there is no sedimentary rock record for most of early Earth's history because sedimentary rocks are metamorphosed and/or removed by the relentless churn of plate tectonics. However, when tectonic plate collide sediments are partially melted and produce a robust rock which dominates the oldest sections of Earth's rock record – granite. We have shown that granites produced via the melting of sediments show statistically significant enrichment in nitrogen contents since the end of the pre-Cambrian, which is coeval with the rise of complex life (Mikhail et al., 2024), with a key increase in biomass burial (and O_2 production) around 1Ga (Holland et al., 2026).

The key known-unknown required to convert the data from the granite record into the volume of biomass buried in sediments is *what happens to sedimentary-hosted nitrogen during crustal melting? To address this question, we investigated a suite of migmatites from Sardinia and the Western Alps and will determine the retention of N in different stages of melt formation and evolution.* The answer contains the variables required to quantitively evaluate the effect changes in biomass burial have had on the N_2/O_2 and CO_2/O_2 ratios of Earth's atmosphere. This project is designed to enable us to quantitively assess how plate tectonics and changes in biomass burial have co-contributed to shaping Earth's present-day environmental conditions, thus charting the co-evolution of Earth's atmosphere, biosphere, and geosphere.

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POSTER 39

Application of FT-ICR MS in Shale Oil Evaluation: A Case Study from the Saline Lacustrine Shales of the Qaidam Basin, China

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Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FT-ICR MS) offers unparalleled resolution for resolving complex organic mixtures at the molecular level. Compared to saturated and aromatic hydrocarbons, polar non-hydrocarbon compounds (N, S, O-containing species) exhibit higher sensitivity to oil generation, migration, and accumulation processes. Despite their potential as highly promising geochemical fingerprints, their significance has remained under-explored. This study utilizes negative-ion ESI FT-ICR MS to characterize 13 core extracts and one wellhead crude oil from the saline lacustrine intervals of the Qaidam Basin, China. Thousands of N- and O-containing molecular components were systematically characterized, and their geochemical implications for shale oil exploration and development were further explored. Results demonstrate significant compositional heterogeneity in non-hydrocarbons among different shale lithofacies, primarily driven by variations in organic matter input (algal vs. higher plant contributions). Evaluation of migration-induced fractionation, based on the distribution characteristics of Double Bond Equivalent (DBE) versus carbon number, indicates that primary migration across lithofacies is negligible, with shale oil predominantly retained in-situ. Furthermore, molecular similarity analysis and quantitative production allocation calculations reveal that laminated calcareous shales are the dominant contributors to wellhead production, accounting for over 60% of the recovered oil. These findings provide a robust theoretical basis for "sweet spot" evaluation and horizontal well targeting in the Qaidam Basin, and also offers a methodological template for the molecular-level assessment of shale oil systems globally.