Volcanic and Magmatic Studies Group Annual Meeting 5th- 8th January 2026, National Oceanography Centre, Southampton

Sponsored by:

Marine Studies Group

WELCOME TO VMSG 2026!

We are really looking forward to welcoming you all to the National Oceanography Centre (NOC) in Southampton for the 2026 Volcanic and Magmatic Studies Group Annual Meeting.

NOC is the UK's centre for ocean science, being the home port for NERC's two royal research ships, a hub for underwater robotics and autonomous technology, and the location of the British Ocean Sediment Core Research Facility, so we are excited to see that there will be a flavour of marine volcanism in many of the submitted talks and posters. But it is not just underwater volcanoes that will be the focus of the scientific programme as we have received a great selection of abstracts (50 talks, 70 posters, and 2 award keynote addresses), ensuring that we will get to see and share cutting-edge results and research across the **conference themes:**

1. Volcanism in the marine environment (co-organised with the Marine Studies Group of the Geological Society of London)
2. Magma generation, storage and transport
3. Syn- and post-eruptive processes
4. Volcanic monitoring
5. Hazards, risk and society
6. Research in progress in volcanology

All abstracts are included at the end of this programme volume listed alphabetically.

Breakouts and discussions

We have endeavoured to include break out discussion time in the schedule to make sure that people have a chance to reconnect with colleagues, discuss old and new collaborations and make new contacts. It is especially encouraging to see the programme is dominated by presentations by postgraduates and early career researchers - the beating heart of VMSG.

Keynotes and Awards

Two exciting keynote addresses will be delivered by VMSG's award winners on 7th January before the AGM.

- **Dr Emma Watts - Zeiss Postdoctoral Keynote Award.** Emma was nominated for her outstanding student mentorship, peer support and dedication to public engagement, as well as her recent Nature Geoscience paper "Mantle upwelling at Afar triple junction shaped by overriding plate dynamics", proving novel in both scale and scope and providing fresh new insight into rift–plume interactions.

- **Dr Paul Cole - VMSG Award.** During his many years within the VMSG community, Paul has been involved in pioneering research on explosive volcanism, delivering strong, collaborative academic output with significant impact. This includes work on La Soufrière, St Vincent, both prior to and following its 2021 eruption and successful evacuation. He also provided skilled leadership and management of scientific operations as Director of the Montserrat Volcano Observatory; integrating monitoring, hazard assessment and community communication, as well as broader innovation in hazard mapping, risk communication and public engagement to improve awareness.

Other meetings and events

We will host events to complement the scientific programme, which include:

- **Icebreaker** at 18:00-21:00 on 5th January in the NOC Waterfront Restaurant where we will have a selection of buffet food, various types of drinks, and activities to join in
- **Equality, Diversity and Inclusion Forum** at 17:30 on 6th January
- **Student Forum** at 13:00 on 6th January
- **Early Career Researcher Forum** at 13:15 on 7th January
- **Annual General Meeting** at 15:30 on 7th January

Workshops

Bookending the conference, the VMSG Annual Meeting 2026 is proud to host four workshops covering interpreting volcanic deposits in marine sediment cores, the power of storytelling for reconstructing volcanic events and experiences, pyroclastic density current stratigraphies and new frontiers in petrology. Those attending the workshops should report to the Security Desk on the 4th floor (up the stairs or via the lift from Reception – next to the Seminar Room) where you will be greeted, can collect your conference badge and will then be escorted to the correct room.

Please note that the previously-advertised laser ablation workshop will be run at another date in future.

Oral Presentations

Presenters should go to the relevant meeting room in at least the coffee or lunch session before their session starts to make sure their slides are available for presenting. Powerpoint slides should be loaded on to the laptop in the Seminar Room. Speakers should prepare 12 minute presentations (with 3 minutes dedicated for questions after that – so a total of 15 minutes) as Powerpoint slides in widescreen format.

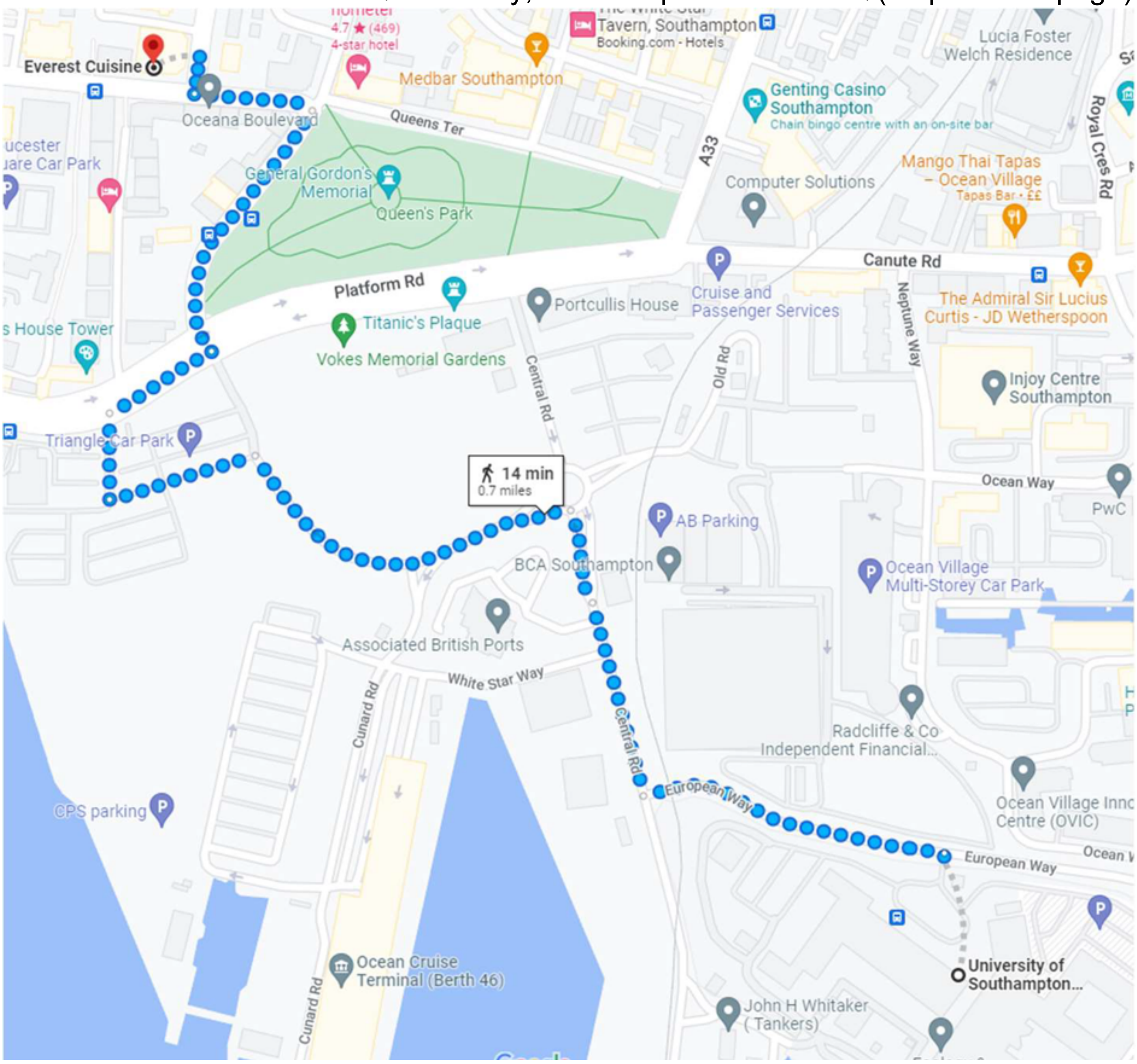
Posters

Posters should be up to A0 portrait format (and no larger!). Presenters should put their posters up in the rear exhibition space as soon as you are ready to do so. We have specifically made time in the schedule for extended discussions around posters as this method of presentation provides an ideal opportunity to gain detailed in-person feedback. Those eligible for judging for a student prize can add a sticker to their poster to mark this clearly for the VMSG committee. Posters marked with an A prefix will be presented on 5th January and those with a B prefix will be presented on 6th January, but will remain up for the entire conference. You can find the relevant poster space detailed in the Poster Schedule in this document.

Wifi
You can connect to either Eduroam using your normal login or connect to the NOCvisitor account and follow the instructions to register.

Conference Dinner – 6th January (19:00-23:30)
The conference dinner will be held at Everest Cuisine, which serves traditional Indian and Nepalese cuisine (https://www.everestcuisine.co.uk/). Dinner will consist of a three-course buffet-style meal with three drinks (your choice of non-alcoholic or alcoholic) included provided per person. Everest can be reached in less than 15 minutes (1.1 km) walking from NOC.

Everest Cuisine Address: 1 Queensway, Southampton SO14 3AQ (map on next page)



Getting to NOC and collecting your badge
All the information for finding NOC and also for suggested accommodation can be found on the conference website: https://noc-events.co.uk/vmsg-travel-noc-and-accommodation. You can pick up your badges at the Security desk – located on the 4th floor, up the stairs or via the lift from Reception.

The National Oceanography Centre's waterfront campus is located at Dock Gate 4 in Southampton (postcode: SO14 3ZH), which is a 30-minute walk or short bus ride from Southampton Central train station (details below), and 10-to-20-minute walk from the suggested hotels. The Unlink bus service U1C runs right to NOC's front entrance from many locations in the city.

There is no parking available in our on-site car park except for those who require it for accessibility. For those that require a car, alternative parking is available in the public car parks at either Town Quay or Ocean Village.

VMSG Buddy Scheme
Whether you're a first-time attendee or a regular at VMSG, this scheme is designed to help you make the most of your conference experience. It connects junior researchers with friendly, experienced peers and mentors to build a welcoming, supportive community. You can sign up for the VMSG buddy scheme here: https://forms.gle/tkP5sLgwLBAAZD3R7

We are excited to welcome you to Southampton and look forward to hearing all about the exciting ongoing and future research and to a few days of fruitful discussions!

Isobel Yeo – on behalf of the VMSG 2026 Organising Committee

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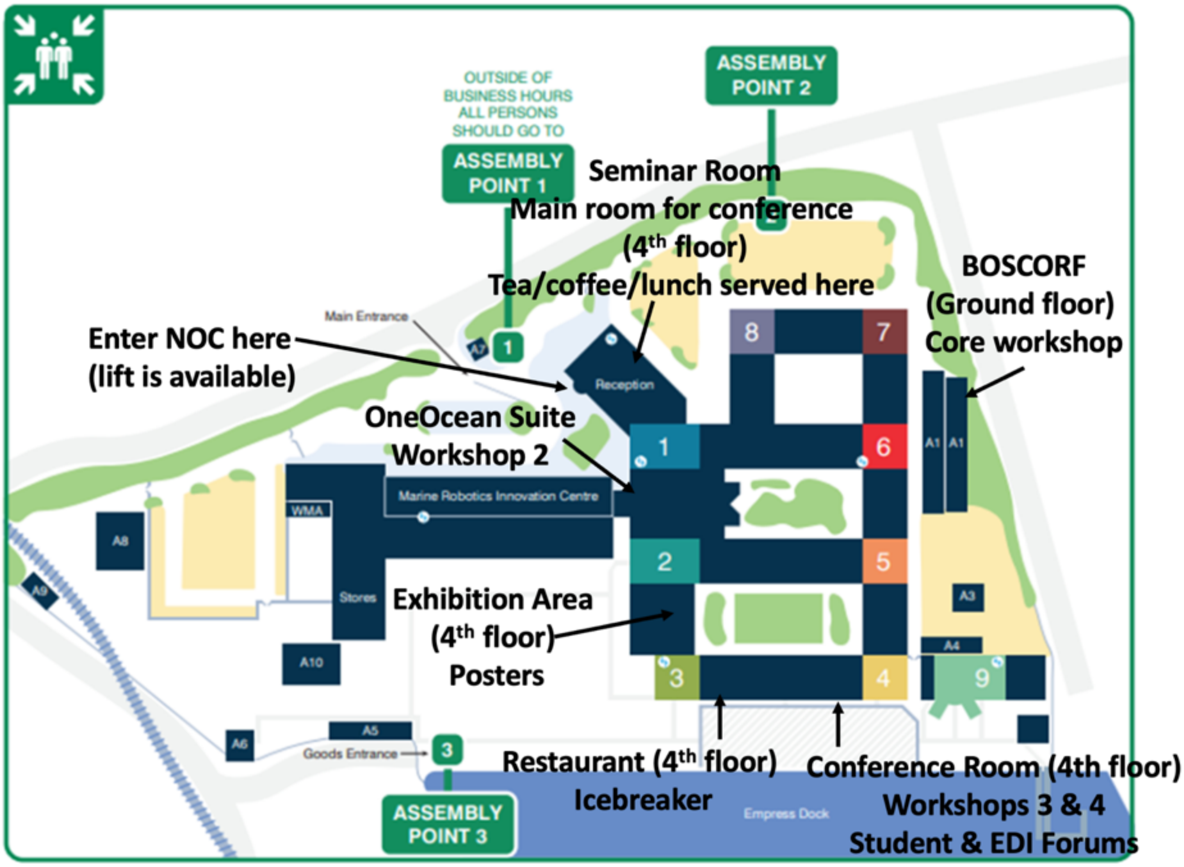
LOCATIONS OF CONFERENCE EVENTS

Confusingly, the ‘Conference’ Room is not the main location for the conference! The oral presentations and AGM will be in the ‘Seminar’ Room. Look for people wearing NOC T-Shirts if you are lost or have any queries, but there will also be signposts up to label locations accordingly.



VMSG Code of Conduct:

All attendees are reminded of the VMSG Code of Conduct that will be in place throughout this event. We aim to make VMSG26 an inclusive, welcoming and safe space for all that attend.

The Code of Conduct outlined below specifically applies to all participants in Volcanic & Magmatic Studies Group activities, including ancillary events and social gatherings. The Volcanic & Magmatic Studies Group expects all participants — including, but is not limited to, attendees, speakers, volunteers, exhibitors, staff, service providers and representatives to outside bodies — to uphold the principles of this Code of Conduct.

1. **Behaviour**

The Volcanic & Magmatic Studies Group aims to provide a constructive, supportive and professionally stimulating environment for all its members. Participants of VMSG meetings and events are expected to behave in a professional manner at all times.

2. **Unacceptable Behaviour**

Harassment and/or sexist, racist, or exclusionary comments or jokes are not appropriate and will not be tolerated.

Harassment includes sustained disruption of talks or other events, inappropriate physical contact, sexual attention or innuendo, deliberate intimidation, stalking, and photography or recording of an individual without consent. It also includes offensive comments related to gender, sexual orientation, disability, physical appearance, body size, race or religion.

3. **Breach of the Code of Conduct**

Anyone requested to stop unacceptable behaviour is expected to immediately cease and desist.

If an incident of prohibited conduct occurs (either within or outside the premises) during a meeting or event, then the aggrieved person or witness to the prohibited conduct is encouraged to report it promptly to a member of the Volcanic & Magmatic Studies Group Committee or meeting organizing committee either in person or via email.

Once the Volcanic & Magmatic Studies Group is notified, the committee member will discuss the details first with the individual filing the complaint, then any witnesses who have been identified, and then the alleged offender before determining an appropriate course of action.

Actions in response to breaching this Code of Conduct will range from a verbal warning to immediate removal from the meeting or activity without refund of registration fee. The Volcanic & Magmatic Studies Group also reserve the right to prohibit attendance at any future meeting or other society-sponsored event. Confidentiality will be maintained to the extent that it does not compromise the rights of others.

OVERVIEW OF CONFERENCE PROGRAMME

5th January 2026		
12:00-13:00	REGISTRATION / BADGE COLLECTION	
13:00-13:15	OPENING ADDRESSES: On behalf of the Organising Committee and from VMSG Chair	Isobel Yeo & Jenni Barclay
13:15-15:00 - Oral Session 1: Volcanism in the marine environment (co-organised with the Marine Studies Group of the Geological Society of London); Convenors: Jacob Nash, Isobel Yeo, Seb Watt		
15:00-15:15	BREAK	
15:15-16:30	POSTER SESSION 1 IN EXHIBITION AREA	
16:30-18:00 - Oral Session 2 (Magma Generation, Storage & Transport); Convenors: Clara Waelkens, Martin Mangler		
18:00-21:00	Icebreaker in NOC Waterfront Restaurant	

6th JANUARY		
	6th January 2026	
09:00-10:45 - Oral Session 3 (Magma Generation, Storage & Transport); Convenors: Martin Palmer, Shona Swan, James Hunt		
10:45-11:15	BREAK	
11:15-13:00 - Oral Session 4 (Syn- and post-eruptive processes); Gemma Portlock, Tom Gernon		
13:00-14:00	LUNCH and STUDENT FORUM [in Conference Room]	
14:00-15:15	POSTER SESSION 2 IN EXHIBITION AREA	
15:15-16:15 - Oral Session 5 (Volcanic monitoring); Convenors: Emma Gregory, Ismael Falcon Suarez, Mike Stock		
16:15-16:30	BREAK	
16:30-17:30- Oral Session 5 Cont'd (Volcanic monitoring); Convenors: Emma Gregory, Ismael Falcon Suarez, Mike Stock		

17:30-18:00	EDI FORUM (in Conference Room)
19:00-23:30	CONFERENCE DINNER – EVEREST RESTAURANT

7th January 2026		
09:00-10:45 - Oral Session 6 (Hazards, risks and society); Gregor Weber, Morgan Bugler, Katie Preece		
10:45-11:15	BREAK	
11:15-13:15 - Oral Session 7 (Research in progress in volcanology); Sofia dela Salla, Jenni Barclay, Mike Clare		
13:15-14:15	LUNCH and ECR FORUM [in Conference Room]	
KEYNOTES – VMSG AWARD WINNERS		
14:15	Interplay between the Afar mantle upwelling and the overriding plates	Emma Watts
14:45	Blocks, pumice, scoria, ash and water- a tale of two eruptions in the Eastern Caribbean	Paul Cole
15:15-15:30	BREAK	
15:30-17:00	VMSG ANNUAL GENERAL MEETING	

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DETAILED CONFERENCE PROGRAMME [ALL TALKS IN SEMINAR ROOM]

5th January 2026		
12:30-13:00	**REGISTRATION / BADGE COLLECTION**	
13:00-13:15	**OPENING ADDRESSES: On behalf of the Organising Committee and from VMSG Chair**	Isobel Yeo & Jenni Barclay
13:15-15:00 - Oral Session 1 (Theme 1: Volcanism in the marine environment - co-organised with the Marine Studies Group of the GeolSoc); Convenors: Jacob Nash, Isobel Yeo, Seb Watt		
13:15	Seismic imaging of Brothers volcano, Kermadec Arc	Berndt
13:30	Tracking Volcanic Unrest through Mercury: Insights from Santorini and Kolumbo during the 2025 Seismic Crisis	Della Sala
13:45	Synchronized explosive activity of Kolumbo and Santorini Volcanoes (Greece), from IODP deep drilling and core-seismic integration	Druitt
14:00	Towards an understanding of volcano-tectonic interactions at Santorini-Kolumbo	Preine
14:15	The submarine record of the largest volcanic eruption of the 21st century	Nash
14:30	From Summit to Seafloor: Quantifying the Source of the 1871 Ruang Volcano Tsunami through Integrated DEM and Bathymetry Analysis	Octonovrilna
14:45	Ocean Drilling Reveals Collapse and Resurgence of the Iceland Mantle Plume	Pearman
15:00-15:15	**BREAK**	
15:15-16:30	**POSTER SESSION A IN EXHIBITION AREA**	
16:30-18:00 - Oral Session 2 (Theme 2: Magma Generation, Storage & Transport); Convenors: Clara Waelkens, Martin Mangler		
16:30	What deep-sea magnetics tell us about volcanic systems?	Dyment
16:45	Assessing the relative proportions of recycling and juvenile mantle input during Phanerozoic crustal growth using major oxides	Bugler
17:00	Two-stage model of propagation and arrest explains ubiquitous patterns of dyke seismicity	Davis
17:15	Sheeted Dyke Emplacement of Magmatic Layering	Hepworth
17:30	Faults modulate magma propagation and triggered seismicity: the 2022 São Jorge (Azores) volcanic unrest	Hicks
17:45	When magma flow in dykes gets complicated: Insights from analogue magma intrusions	Kavanagh
18:00-21:00	**Icebreaker in NOC Waterfront Restaurant**	

6th JANUARY		
09:00-10:45 - Oral Session 3 (Theme 2: Magma Generation, Storage & Transport); Convenors: Martin Palmer, Shona Swan, James Hunt		
09:00	Magmatic timescales from an explosive shallow submarine silicic eruption of the Kameni Volcano (Greece)	Keeley
09:15	Constraining ascent velocities of kimberlite magmas using diffusion chronometry modelling	Rawlings
09:30	Disentangling Disaggregated Mushes and Conduit Crystallisation in Laki Lava Samples with Automated Quantitative Petrography	Maclennan
09:45	Liquid-rich growth, cold storage and rapid entrainment of plagioclase megacrysts in a mafic volcanic system	Mapletoft
10:00	The relationship between surface displacement, pressure and volume in analogue models of magma chamber inflation and the implications for the interpretation of deformation signals	Morand
10:15	Petrogenesis of carbonatites of Vallone Toppo di Lupo deposit, Monte Vulture, Italy	Leung
10:30	Why Automated Mineralogy needed an upgrade	Taylor
10:45-11:15	**BREAK**	
11:15-13:00 - Oral Session 4 (Theme 3: Syn- and post-eruptive processes); Gemma Portlock, Tom Gernon		
11:15	Volcano-tectonic controls on the 3D architecture of sub-volcanic magma storage at Campi Flegrei, Italy	Stock
11:30	Investigating the behaviour of sulphur under St Vincent, Lesser Antilles Arc	Taylor
11:45	Major, minor and trace element mapping of felsic volcanics: Towards a better understanding of Li behaviour in magmas	Cortes-Calderon
12:00	Investigating the source mechanics of fluid-driven volcanic earthquakes	Grant
12:15	We're going to need a bigger sieve	Johnston
12:30	Controls on Fissure Location and Fire Fountain Dynamics: Insights from Webcam Observations of the Svartsengi Volcanic System, Iceland	Rhodes
12:45	Experimental particle-laden jet noise and its application to volcanoes	Seropian
13:00-14:00	**LUNCH and STUDENT FORUM [in Conference Room]**	
14:00-15:15	**POSTER SESSION B IN EXHIBITION AREA**	
15:15-16:15 - Oral Session 5 (Theme 4: Volcanic monitoring); Convenors: Emma Gregory, Ismael Falcon Suarez, Mike Stock		

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15:15	Integrating hydrothermal and magmatic deformation models for Soufrière Hills Volcano, Montserrat	Dibben
15:30	Satellite detection of methane outburst from an East African volcano	Dualeh
15:45	Forecasting the Evolution of the 2021 Tajogaite Eruption, La Palma, with TROPOMI/PlumeTraj derived SO2 Emission Rates	Esse
16:00	Along-rift variations in magma system geometry observed using Sentinel-1 InSAR data from the East African Rift System	Ireland
16:15-16:30	**BREAK**	
16:30-17:30- Oral Session 5 Cont'd (Theme 4: Volcanic monitoring); Convenors: Emma Gregory, Ismael Falcon Suarez, Mike Stock		
16:30	Rapid Uplift at Pliocene Caldera Pastos Grandes, Bolivia	Kettleborough
16:45	Towards real-time processing of UV Camera data: first results from a new network	Pering
17:00	Monitoring Volcanic Deformation Using InSAR: Deformation Time-series at Seasonally Snow-covered Volcanoes	Zhu
17:15	Rapid-response petrology during active eruptions: techniques, timings, costs and applications	Scarrow
17:30-18:00	**EDI FORUM (in Conference Room)**	
19:00-23:30	**CONFERENCE DINNER – EVEREST RESTAURANT**	

7th January 2026		
09:00-10:45 - Oral Session 6 (Theme 5: Hazards, risks and society); Gregor Weber, Morgan Bugler, Katie Preece		
09:00	How topography and crustal structure control surface displacement at marine volcanoes	Urlaub
09:15	Magma connectivity in a continental rift: Insights from geodetic observations during the 2024–2025 dikes at Fentale, Main Ethiopian Rift	Way
09:30	Modelling surface displacement associated with sheet-like intrusions: effect of overburden thickness and rigidity variations	Williams
09:45	Communicating Volcanic Risk in the Canary Islands: Building Trust, Clarity, and Preparedness	Jones
10:00	The case for global catastrophic volcanic risk: Historical learnings and future outlook	Cassidy
10:15	Assessing Volcanic Hazards and Financial Exposure: A Closer Look at Insurance Industry Preparedness	Dalziel
10:30	Eruptions in the attention economy: Global patterns and language imbalances in volcanic eruption coverage revealed through multilingual social media analyses	Farquharson
10:45-11:15	**BREAK**	
11:15-13:15 - Oral Session 7 (Theme 6: Research in progress in volcanology); Sofia dela Salla, Jenni Barclay, Mike Clare		
11:15	Magmatic teleconnections, external forcings and the tempo of volcanic systems: perspectives from the Mediterranean	Pyle
11:30	A Detailed Tephrostratigraphic Record from Monte di Procida, Campi Flegrei caldera (southern Italy): Insights into eruption activity between the recent caldera-forming eruptions	Kane
11:45	Estimating the intensity of explosive volcanic eruptions using satellite observations of wind-blown volcanic cloud spreading	Tanner
12:00	Reviewing the Presence of Back-Arc Volcanism in the Antarctic Peninsula through a Peralkaline High-Zr Suite	Lucas
12:15	Experimental determination of crystal structure and thermodynamic properties of Martian meteorite wadalite	Cao
12:30	The effects of different topographic obstacles on the flow characteristics of dense, granular pyroclastic density currents.	Chenery
12:45	Mapping global food and nutrition impacts from volcanic eruptions	Mani
13:00	Who's at fault? Disentangling the igneous-tectonic fracture network in the Kerguelen Islands	Sidgwick
13:15-14:15	**LUNCH and ECR FORUM [in Conference Room]**	
KEYNOTES – VMSG AWARD WINNERS		
14:15	**Interplay between the Afar mantle upwelling and the overriding plates**	**Emma Watts**

14:45	**Blocks, pumice, scoria, ash and water- a tale of two eruptions in the Eastern Caribbean**	**Paul Cole**
15:15-15:30	**BREAK**	
15:30-17:00	**VMSG ANNUAL GENERAL MEETING**	

POSTERS [IN EXHIBITION AREA]

POSTER SESSION A - 5th JANUARY 15:15-16:30		
Theme 1: Volcanism in the Marine Environment		
600,000 years of Pleistocene explosive volcanism from the Canary Islands preserved in ODP Leg 157 marine cores	Wilkinson-Rowe	A1
Capturing shear instabilities, pulses and current behaviours at the current-substrate boundary zone of granular currents (part of Session 3)	Walding	A2-i
Volcanic deposits on the Tonga forearc and trench: new insights from direct crewed submersible observations	Walding	A2-ii
Characteristics and origins of two young volcano-sedimentary units within the Santorini’s intracaldera fill	Wallace	A3
Detection of Submarine Volcanic Eruptions Using Satellite Ocean-Colour and Machine Learning	Pedrycz	A4
Imaging the magma storage region and hydrothermal system of an active arc volcano using the controlled-source electromagnetic method	Nienhaus	A5
Impact of petit-spot magmatism on subduction zone seismicity and global geochemical cycles: International Ocean Drilling Programme (IODP³) Expedition 502	Preece	A6
Resolving the Final Phase of the 2025 Santorini-Amorgos Seismic Swarm Using a Local Ocean Bottom Seismometer Array	Gregory	A7
Structural controls on hydrothermal fluid flow at Santorini and Kolumbo Volcanoes	Yeo	A8
Understanding the Risk Posed by Tephra Rafts to Shipping and Marine Infrastructure	Harden	A9
Volcanic Ash Fall Risk to Marine Traffic and Infrastructure	Wale	A10
The beach signature of the 2022 Hunga volcanic tsunami (Tonga)	Bennett	A11i
Revealing Previously Undetected Submarine Eruptions Using Satellite Data	Hopkins	A11ii
Theme 2: Magma generation, storage and transport		
Assimilation-Induced Outcrop Scale Liquid Immiscibility in the Portrush Sill, Northern Ireland	Geifman	A12
Bimodal magmatism and the Daly Gap: Characterising the physical and chemical behaviour of strongly bimodal magmatic systems using the Paleogene Slieve Gullion Complex, Northern Ireland, as a case study.	Butler	A13

Does Crustal Heterogeneity Control Diversity in Volcanic Systems? A Case Study from the Gegham Neovolcanic Zone, Armenia	Whyte	A14
Formation mechanisms of glomerocrysts from high-threat volcanoes in the Cascades	Gordon	A15
Investigating variations in magma storage conditions prior to different types of eruption at Somma-Vesuvius, Italy	Brown	A16
Magmatic sulfate-melt exsolution as a mechanism for excess sulfur in porphyry systems	Huang	A17
Melt inclusions as tracers of time-dependent sampling of mantle heterogeneities during the 2021 Tajogaite eruption (La Palma)?	Buso	A18
Microstructural Record of Icelandic Crystal Mushes Preserved in Gabbroic Nodules	Subbaraman	A19
Modelling crystal settling and crystal-driven convection from crustal to planetary scales	Keller	A20
Modelling magma exchange between Aira Caldera and Sakurajima Volcano, Japan.	Mantiloni	A21
Multi-Stage Inflation and Mineralisation within the Carlingford Complex Layered Intrusion, Ireland	Beckwith	A22
Plagioclase Populations in Icelandic Eruptions: Isolating the Conduit	Abali	A23
Plume-Ridge Interactions in the Galápagos: Investigating Long-Distance Geochemical Signatures	Swan	A24
Some new insights from the OH- content of clinopyroxenes in ocean islands basalts	Taracsák	A25
Southwest Rift Zone eruptions of Mauna, Hawai‘i: lessons from the crystal cargo	Pahl	A26
Where did the gases go? Quantifying total melt inclusion volatile contents via combined 3D Raman and nano-CT analyses of bubble wall precipitates	Davies	A27
Investigating the petrogenesis and temporal evolution of magmas at Volcán Ceboruco	Brown	A28
Theme 3: Syn- and post-eruptive processes		
A framework for ignimbrite analysis methodologies for modelling and hazard evaluation	Williams	A29
A global database of pyroclastic density current deposit field data: potential use for PDC modelling and hazard assessments	Brown/Williams	A30
Blurring the boundaries between explosive and effusive eruption styles: New Evidence for Sintering-Driven Eruption Transitions	Theurel	A31
Caldera collapse into a compositionally stratified magma reservoir: application to the Loch Ba Ring Dyke	Stein	A32
Geochemical and petrological trends within the 1888–1890 explosive eruption of Vulcano island, Italy	Mackley	A33

Investigating the erosive nature of the 2021 La Soufrière, St Vincent, effusive-to-explosive eruption transition	Korwin-Szymanowska	A34
Link between magma reservoir, caldera formation and lava flow layering revealed by 3D seismic reflection imaging at Axial volcano in SE Pacific	Wang	A35-i
Seismic evidence for the upper crustal accretion by long-distance lateral dyke injection at the Lucky Strike segment of Mid-Atlantic Ridge	Wang	A35-ii
Long-term impacts of volcanic eruptions on glacier dynamics – a case study of the 2010 summit eruption of Eyjafjallajökull, Iceland	Sobolewski	A36
Lunar lava tubes and associated surface features: insights from remote sensing identification and finite-element modelling	Deng	A37
Peperite in the Borrowdale Volcanic Group: a chronology of magma–wet sediment interaction at Honister, Cumbria	Robinson	A38
Understanding the role of phase changes in eruption plume dynamics: an experimental approach	Farquharson	A39
Velocity controls on erosion in pyroclastic density currents	Cawkill	A40
The vexing variable vesicles of low viscosity explosive volcanism: what makes mafic magma explode?	Jorgenson	A41

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POSTER SESSION B - 6th JANUARY		
Theme 4: Volcanic monitoring		
A new regional seismic catalogue for Ascension Island, 2014-2024	Butcher	B1
Examining Cumulative SO_2 Time Series using Satellite Sensing on Mt Etna	Damani	B2
Fine particulate transport and exposure during Icelandic fissure eruptions: Insights from PM_1 monitoring and dispersion modelling	Lonnia	B3
Joint Analysis of Volcanic Degassing and Deformation Time Series to Understand Transitions in Unrest at Sangay Volcano	Morgan	B4
Real-Time Global Volcano Monitoring with InSAR: Coherence-Guided Interferogram Networks, Optimized Sentinel-1 Time Series, and Dynamic Updates (2014–2025)	Espín-Bedón	B5
The value of seafloor geodesy for constraining volcanic deformation sources	Campbell	B6
Using satellite data to estimate the ascent speeds of eruption columns	Taylor	B7
Theme 5: Hazards, risks and society		
An initial dating of eruptive activity at Agua volcano, Guatemala.	Jackson	B8
Future volcanic eruptions may delay the recovery of lower stratospheric ozone over Antarctica and Southern Hemisphere mid-latitudes	Chim	B9
Reliance or Resilience? Volcanism and the Ancient Maya	McLean	B10
Understanding past eruptions to mitigate future hazard: the ~ 1700 CE eruption of Sii Aks (Tseax), Canada	Osman	B11
Theme 6: Research in progress in volcanology		
‘Ex-x’: Expecting the Unexpected — understanding ‘dangerous’ eruptive transitions	Rust	B12
An integrated proximal-distal Tephrochronology of Towada Caldera, northern Honshu (Japan)	Watts	B13
An Overview of the Natural History Museum’s Petrology Collection.	Smith	B14
Beyond the SEE: Rigorous Uncertainty Propagation in Igneous Petrology Models	Boschetty	B15
Characterising the rheology of crystal-rich basaltic magma at Volcán de Fuego	Bain	B16

Exploring the use of morphometry tools in ArcGIS Pro to characterise the topography of stratovolcanoes prone to pyroclastic density current inundation, with implications for numerical and experimental modelling	Dowey	B17
Geochemical Approach to Iron Age Vitrified Hillforts	Medley	B18
Grainsize controls on non-magmatic phreatic explosions in pyroclastic deposits	Lofmark	B19
High-resolution textural and geochemical variability across the submarine basins of the Santorini and Kolombo calderas	Hunt	B20
Newly discovered pumice fall deposits on Tenerife, Canary Islands, reveal con9nuous felsic ac9vity ~0.54 – 0.175 Ma	Hamilton	B21
Preliminary characterizations of rhyolitic reticulites from Torfajokull, Iceland	Tuffen/Zhang	B22
The application of ultra-fast laser ablation to geochemical mapping	Banks	B23
Towards a genetic framework for the post-Variscan intrusive rocks of Southwest England	Unwin	B24
Tracing the Triggers: Modelling Dome Collapse Dynamics at Volcán de Colima	Ní Nualláin	B25
Understanding magma ascent – a study using geophysical, geochemical and analogue modelling techniques	Willar-Sheehan	B26
Understanding Precursory Plinian Eruptions in the Lead-Up to Large Caldera-Forming Eruptions	Sykes	B27
Volcanic plumes: A natural analogue for solar radiation management	Varnam	B28
Linking Ash Petrology with Geophysical Monitoring for Tungurahua Volcano, Ecuador (1999-2016)	Adler-Cancino	B29

Workshops

Those attending the workshops should report to NOC reception where you will be greeted, will collect your conference badge and will then be escorted to the correct room.

Workshop 1. Interpreting volcanic deposits in marine sediment cores - Monday 5th January 2026 09:00 – 12:30 [LOCATION: BRITISH OCEAN SEDIMENT CORE RESEARCH FACILITY]

This workshop will be co-ordinated by Michael Clare, Isobel Yeo, James Hunt and Jacob Nash (National Oceanography Centre) and Cian McGuire (British Ocean Sediment Core Research Facility (BOSCORF))

A huge number of the planet's volcanoes lie in, or close to, the oceans. As a result, a vast quantity of volcanic material is deposited in the marine realm every year. These volcanoes are hard to observe or monitor using traditional methods, yet their eruptions can be catastrophic, generating wide ranging hazards that impact coastal communities and infrastructure. Understanding eruption styles, frequencies and other potential hazards (like flank collapse, which can generate tsunamis) is essential to forecast and mitigate the risk posed by marine volcanoes. For many such volcanoes the only record of past events is found on the ocean floor, sampled primarily through coring. Thus, these cores provide a unique record of marine volcanism and an essential tool for understanding the hazards posed.

In this workshop we will overview the analytical capabilities of BOSCORF, the UK's cutting-edge sediment core analysis facility, with specific reference to cores containing volcanic records. We will discuss applications of different analytical techniques, including resolution, accuracy and precision. We will then look at different sediment cores held at BOSCORF (and their associated analytical datasets) that record different hazardous volcanic events, and compare and contrast characteristic and diagnostic features. We welcome volcano researchers at all career stages, particularly those interested in working with marine records and volcanic sediments, and those who would like to get hand-on experience of sediment core logging.

Workshop 2. Once upon a time in a crisis – the power of stories & storytelling - Monday 5th January 2026 09:00 – 12:30 [LOCATION: ONE OCEAN SUITE]

This workshop will be co-ordinated by Jenni Barclay (University of Bristol) and Richard Robertson (University of the West Indies).

Volcanic crises are the crucibles through which major advances in volcanology are derived, yet most volcanologist are trained only in the physical sciences with little or no practical and critical thinking skills needed to function effectively during these moments. The volcanologist involved must balance high personal and societal risk with the need for interpretation of uncertain scientific data that requires rapid communication to guide decision making. Stories that scientists tell can provide a mechanism for sharing and shaping understanding and reveals much about the critical dimensions of risk created by a volcanic crisis. So, storytelling methods can help explore and understand the tensions involved for these scientists, and through their analysis we can understand the most effective ways to navigate volcanic crises.

This workshop will use storytelling methods to explore and understand the critical tensions between scientific knowledge and the decision-making imperatives faced by volcanologists navigating a volcanic crisis. Through a series of shared reflections and stories, we will not only identify these tensions but consider the implications for populations at risk and how these can be better navigated by volcanologists.

Volcanologists at all career stages are welcome to this workshop, from those curious about this method, or interested to hear these stories, to those with stories to share and compare.

Workshop 3. New Frontiers in the Petrological Toolbox - Monday 5th January 2026 09:00 – 12:30 [LOCATION: CONFERENCE ROOM]

This workshop will be co-ordinated by Martin Mangler and Gregor Weber (University of Southampton)

From the early microscopic descriptions of minerals to today's high-precision geochemical facilities, igneous petrology continues to advance our understanding of the magmatic processes driving volcanic eruptions.

This workshop will explore key innovations that are transforming how we observe, analyse, and model igneous systems, focusing on three core aspects of modern petrology through short lectures, demonstrations, and practicals:

- Textural Analysis: We will dive into the world of crystal textures and get a practical sense of the pitfalls surrounding the acquisition, processing, and interpretation of crystal size and shape data.
- Machine Learning in Thermobarometry: We will build a machine-learning-powered thermobarometer, highlighting the rationale, mechanics, and caveats to such methods, and discuss the use and misuse of such thermobarometric data.
- Geochemical Imaging: We will visit the University of Southampton's world-class Centre for Earth Research and Analysis to explore novel analytical techniques, such as time-of-flight mass spectrometry, which enables acquisition of high-resolution geochemical maps, opening new frontiers in petrology.

We welcome both petrologists and non-petrologists at all career stages. If possible, please bring a laptop to participate in hands-on components.

Workshop 4. Recording and interpreting pyroclastic stratigraphies - Thursday 8th January 2026 09:30 – 16:30 [LOCATION: CONFERENCE ROOM]

This workshop will be co-ordinated by the FIAMME Project Team, led by Natasha Dowey (Sheffield Hallum University), Pete Rowley (University of Bristol) and Rebecca Williams (University of Hull), and the IAVCEI Commission for Volcanogenic Sediments

This workshop will challenge the way in which we record and interpret pyroclastic stratigraphies, with a particular focus on pyroclastic density currents. The workshop will provide training on recording pyroclastic sequences, and discussion around the numerous underlying assumptions and paradigms which work often builds on. Activities will focus on applying and challenging accepted practices in qualitative and quantitative data capture, sampling strategies and conceptual models for sequence interpretation, and reconstructing PDC dynamics and depositional histories. Participants will depart with a robust framework for ignimbrite analysis methodologies, for both modelling and hazard evaluation.

We welcome volcano researchers at all career stages, whether those interested in learning these methodologies, or seasoned experts who want to contribute to the discussion.

ABSTRACTS

Alphabetically-organised by Last Name

Plagioclase Populations in Icelandic Eruptions: Isolating the Conduit

Abali, D.[1] and Maclennan, J.[1]

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Crystal growth in magma depends on the pressure, temperature, and timescales of cooling. Therefore, crystals in volcanic rocks can reveal information about the processes in deep magmatic storage zones as well as syn-eruptive processes. Porphyritic textures in Icelandic basalts are commonly attributed to two stages of cooling: first, slow cooling in a magmatic system at depth resulting in crystallising phenocrysts, and second, rapid cooling at the surface, quenching into a groundmass. However, recent studies, such as Guilbaud and others [1], who investigated the CE 1783-1784 Laki eruption, suggest that crystal growth also happens during magma ascent.

This ongoing project aims to understand the different plagioclase populations, specifically the crystals that grew in the conduit, during the Skuggafjöll and Thjorsardalur eruptions[2]. Optical and SEM data (Backscattered Electron (BSE) and Energy Dispersive X-ray Spectroscopy (EDS) maps) were obtained from thin sections. These were used to calculate quantitative textural properties: crystal size distributions (CSDs), aspect ratios (ARs), and modal proportions. The CSDs are produced using Trainable Weka Segmentation on Fiji (ImageJ) trained on BSE images, which are compared to CSDs produced using MinDet[3], a deep-learning approach to quantify plagioclase crystal shapes and sizes from optical scans of thin sections. To produce the chemical maps, EDS data were processed using GPyEDS[4], an autoencoder-decoder with Gaussian processes that segments phases and their compositional variations by reducing dimensionality.

Obtaining crystal populations will allow identification of the quantitative characteristics of different crystal populations present within the products of each eruption, with a long-term aim of linking these characteristics to physical processes in the magma storage zones and conduit.

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[3] Toth, N. and Maclennan, J. (2024) “MinDet1: A deep learning-enabled approach for plagioclase textural studies”, Volcanica, 7(1), pp. 135–151. doi: 10.30909/vol.07.01.135151.

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Linking Ash Petrology with Geophysical Monitoring for Tungurahua Volcano, Ecuador (1999-2016)

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Volcano monitoring is vital for forecasting eruptions and enabling timely evacuations. While geophysical monitoring only detects surface reflections of deeper magmatic processes, petrology probes into the magmatic processes, thus contextualising geophysical monitoring data. Several petrological techniques are actively used by volcano observatories around the world [1], including but not limited to: grain size distributions (GSDs), componentry, crystallinity, and glass chemistry. The first of these give insight into crystallisation and fragmentation process in the conduit; glass chemistry gives evidence of the chemical changes into the plumbing system and triggering mechanisms behind eruptions. There have been many studies that attempt to link these methods with geophysical monitoring data, both for effusive (e.g.[2]), and explosive (e.g.[3]) volcanism, but the correlations between petrology and geophysical monitoring are not the same for different volcanoes and different eruptive styles, so it is important to gather a wide database of case studies. Tungurahua volcano, Ecuador, provides the perfect example to improve this database, as ash samples have been collected from 1999-2016, during which time, the volcano underwent several eruptive transitions – from low-intensity continuous activity, to Strombolian, Vulcanian and Sub-Plinian explosions.

This research aims to create a long-term petrological time-series of the Tungurahua ash samples and compare those results to geophysical monitoring data that was collected at the time. We begin by presenting results for the GSD and componentry analyses, comparing the distributions of grains across time, as well as to volcanological and geophysical variables such as dominant explosive style, plume height, and seismicity. We will further test several petrological methods, including those mentioned above, as well as diffusion chronometry.

References:

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[3] Battaglia, J. et al. (2019) Earth and Planetary Science Letters, https://doi.org/10.1016/j.epsl.2019.01.042

Characterising the rheology of crystal-rich basaltic magma at Volcán de Fuego

Bain, A.A.[1], Kendrick, J.E.[2], Lamur, A.[2], Wadsworth F.B.[2], Mérida, R.[3], Chigna, G.[3], Roca Palma, A.[3], Chun, C.[4], Pineda, A.[5], Calder, E.S.[6], Lavallée, Y.[2], Ponce, F.[3], Bell, A.F.[6], Escobar Wolf, R.[7], De Angelis, S.[8]

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Low-level explosive and effusive activity has been ongoing at Volcán de Fuego (Guatemala) since 1999, fed by crystal-rich basaltic to basaltic andesite magma [1]. Fuego has also generated >80 'paroxysmal' eruptions during that time, which typically feature a sustained lava fountain that waxes and wanes over a period of hours to days. Pyroclastic flows are often generated during these eruptions. Understanding the transition from persistent low-level activity to paroxysmal eruptions is crucial for risk management due to densely-populated proximal areas (>50,000 people living and working within 10 km) [1].

The eruption dynamics observed at Fuego indicate variable magma-gas coupling, with decoupled behaviour driving small Strombolian to Vulcanian explosions and more coupled behaviour driving paroxysmal eruptions [2]. This suggests an importance of deep gas and magma supply, modulated by the properties of the crystal-rich magma occupying the shallow conduit.

To characterise the rheology of shallow magma, we conducted uniaxial compression experiments at high-temperature (1000 °C) at several strain rates on cores prepared from bombs collected in 2012, 2023, and 2025. We measured the porosity and gas permeability before and after the experiments. We also collected high-resolution SEM images to characterise the crystal population. We measured whole-rock composition by X-ray fluorescence and we analysed the composition of the groundmass glass and plagioclase microlites using an electron micro-probe to understand crystallisation in the shallow conduit.

We found a range of apparent viscosity and non-Newtonian behaviour in these basaltic to basaltic andesite samples that is comparable and even exceeds the range observed in crystal-rich andesites. Our results suggest long-term variations in magma ascent rate and shallow storage at Fuego, which influence crystal micro-textures, magma rheology, and the character of persistent low-level activity.

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[1] Naismith et al. (2019). JVGR, https://doi.org/10.1016/j.jvolgeores.2019.01.001
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The application of ultra-fast laser ablation to geochemical mapping

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Femtosecond laser ablation inductively coupled plasma mass spectrometry (fs-LA-ICP-MS) is known for its advanced analytical performance in elemental and isotopic fractionation, when compared to its nanosecond counterpart. The effects of this femtosecond-scale ablation regime has been explored throughout the scientific literature (e.g. [1], [2], [3]), focussing largely on reduced matrix effects, particle size and distribution and transport efficiency. These parameters are fundamental to the precision and accuracy of spatially resolved, unidimensional isotope measurements and have therefore been explored in this context. In comparison, the capabilities of high repetition rate femtosecond lasers for elemental and isotopic mapping have remained largely underexplored.

Here, we look at the characteristics of a new femtosecond laser ablation system, the IRIDIA femto. It is equipped with an ablation chamber capable of generating ultra-fast transient signals. These range from sub- to single-millisecond duration, depending on the configuration. Using these ultra-fast signals, we explore the imaging capabilities of the system. Proven on challenging matrices, we show a comprehensive overview of the capabilities of high repetition rate femtosecond laser ablation instruments for elemental and isotopic imaging.

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

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

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

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

References:

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The beach signature of the 2022 Hunga volcanic tsunami (Tonga)

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In January 2022, the Hunga Volcano eruption produced the most explosive event of the 21st century, generating atmospheric shockwaves and tsunamis with run-ups exceeding 20 metres that devastated Tongan islands and travelled across the Pacific Ocean [1, 2]. This study analyses sediment cores and sample transects collected from beaches impacted by the well characterised tsunamis, to investigate the record left in the deposits by this extreme event.

Grain size analysis reveals a consistent trend across all cores: as depth increases, grain size generally coarsens until reaching the underlying soil and clay layers, which are significantly finer. The tsunami deposit is primarily composed of biogenic material, including shell and coral fragments, intermixed with volcanic components such as pumice and ash. Fresh organic matter, including roots and soil aggregates, was also incorporated, recording high-energy mixing of terrestrial and marine materials during deposition.

While grain size distributions remain relatively uniform throughout the cores, one core shows a marked increase in grain size, attributed to the presence of stones, rip-up clasts, and root material—likely the result of localised turbulence and sediment entrainment. Multiple wave records are recorded, including both incoming and outgoing waves. These deposits are preserved several years after the event.

The sedimentary record from this event provides crucial evidence of how extreme wave energy reshapes coastal environments, eroding, transporting, and redepositing material across terrestrial and marine boundaries. These deposits serve as valuable geological markers for reconstructing past tsunamis and understanding coastal vulnerability. Tsunami "beach signatures" within the sedimentary record enhance our ability to interpret tsunami behaviour, improve hazard assessments, and refine our understanding of the interaction between volcanic eruptions, tsunamis and coastal geomorphology. This work contributes to advancing predictive models for future volcanic-tsunami events and their potential impacts on island and coastal communities.

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Seismic imaging of Brothers volcano, Kermadec Arc

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Brothers volcano is a predominantly dacitic island arc volcano located close to the southern end of the Kermadec-Tonga subduction zone. Its summit has collapsed into a 3-4 km wide caldera in which younger volcanic cones are forming. Because it is affected by abundant hydrothermal activity that has resulted in hydrothermal mineral formation, Brothers Volcano has been studied extensively in the past - including seafloor drilling. In May 2025, we carried out a major geophysical experiment including ocean bottom seismometer deployments, high-resolution 3D seismic surveying, potential field studies, and bathymetric mapping to provide spatial context for the drilling results and to constrain the structure of the volcano and its caldera. The new 3D seismic data represent the first 3D seismic dataset ever collected to image the entire caldera of any volcano. The data show that the caldera collapse of Brothers Volcano was either “piecemeal” or “sagging” in style, and not trap door or piston style. This reduces the tsunami generation potential for this kind of island arc volcano. Seismic reflectivity inside the volcanic edifice is limited but seismic stratification within the shoulders of the volcano indicates emplacement of volcanoclastic sediments and lavas that were presumably deposited during the caldera forming eruption. Prominent seismic reflections from underneath the caldera floor are visible but still have to be compared to the results of the ocean bottom seismometer data before robust interpretations can be made. Comparing the 3D seismic data to previously acquired 2D seismic data and seafloor bathymetry shows that meaningful interpretation of island arc volcanoes in similar water depths requires 3D seismic data as side reflections obscure all relevant primary reflections in 2D seismic data.

Beyond the SEE: Rigorous Uncertainty Propagation in Igneous Petrology Models

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Models used in igneous petrology, and in the geosciences more broadly, span a continuum from empirical fits to those grounded in thermodynamic theory. These models are typically calibrated by least-squares fitting to experimental datasets, linking variables such as temperature, pressure, and phase composition. For example, mineral–melt thermometers relate phase compositions to equilibrium crystallisation temperatures. When presented, such models commonly report a standard estimate of error (SEE) that represents the average uncertainty in predicted values, derived from either calibration or validation datasets. The SEE of different models is commonly used to compare model performance, (e.g., Putirka [1]).

However, this generalisation is both limiting and unnecessary. When model parameters, their uncertainties, and their correlations are known, model-derived uncertainties can be directly and rigorously quantified. However, in practice such information is rarely published: parameter uncertainties are often omitted, and full covariance matrices, describing how fitted parameters co-vary, are not reported. Here, I demonstrate that neglecting the full covariance matrix can lead to substantial overestimation of model uncertainty, while relying solely on the reported SEE can underestimate uncertainty when models are applied beyond their calibration range.

These effects have significant implications for volcanological applications. For example, temperature estimates and their uncertainty underpin key calculations in igneous petrology, including calculating timescales of magmatic processes using diffusion chronometry, and for correcting melt inclusion compositions for post-entrapment modification. Accurate and transparent model uncertainties are therefore essential for interpreting magmatic processes.

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Investigating variations in magma storage conditions prior to different types of eruption at Somma-Vesuvius, Italy

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Somma-Vesuvius is an active volcanic system in southern Italy, renowned for the violent explosive eruption in 79 CE which destroyed the Roman city of Pompeii. In the last 2000 years, Somma-Vesuvius has produced three explosive Plinian/sub-Plinian (VEI 4–5) eruptions (79, 472 and 1631 CE). The "interplinian" phases between these events were characterised by prolonged effusive eruptions lasting weeks-years, and violent strombolian eruptions (VEI 2–3) with both effusive and explosive phases [1]. Somma-Vesuvius last erupted in 1944 and is currently seismically active; even a low magnitude eruption in the future would pose a significant threat due to the high population density and critical transport infrastructure in the immediate vicinity of the volcano.

Knowledge of pre-eruptive magma storage conditions and the depths/locations of magma reservoirs is crucial for interpreting geophysical and geochemical datasets used to monitor active volcanoes. At Somma-Vesuvius, the majority of previous studies focused on Plinian/sub-Plinian eruptions, and magma storage conditions prior to interplinian eruptions remain poorly constrained. Our study aims to determine whether there are differences in the structure of the Somma-Vesuvius magmatic plumbing system and/or magma reservoirs tapped by prolonged effusive, violent strombolian and Plinian/sub-Plinian eruptions.

Clinopyroxene is a ubiquitous mineral phase in Somma-Vesuvius eruption products [2]. Recent advances in machine-learning thermobarometry allow magma storage pressures and temperatures to be determined from clinopyroxene compositions with improved precision relative to previous models [3]. We will characterise the clinopyroxene populations from different style eruptions using petrography, backscattered electron imaging and high precision Electron Microprobe analyses, and determine the conditions at which the different populations formed. Our study will provide new insights into the structure of the Somma-Vesuvius plumbing system prior to eruptions of differing style and magnitude, which will support interpretation of volcano monitoring datasets during possible future episodes of unrest.

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Investigating the petrogenesis and temporal evolution of magmas at Volcán Ceboruco

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Volcán Ceboruco is situated within the western portion of the Trans-Mexican Volcanic Belt (TMVB), one of the most compositionally diverse magmatic arcs on Earth [1], providing a natural laboratory for testing hypotheses on arc petrogenesis and the transition from subduction-related to more intraplate-like magmatic regimes. Despite its well-documented Holocene activity, including one of Mexico's largest Holocene volcanic eruptions, the petrogenesis, temporal evolution, and textural relationships of its magma types remain poorly understood. Earlier studies recognised three principal magma types [2][3], but an investigation into the complete pre- to post-caldera eruptive sequence is missing. The majority of activity over time has produced andesitic lava flows, but recently, there has been an increasing volume of more evolved dacitic magmas generated, as well as an increase in explosivity. This study presents new petrographic and geochemical data from field sampling of major eruptive units to investigate the petrogenesis and temporal evolution. XRF analyses reveal systematic major- and trace-element variations, most notably elevated Nb concentrations relative to nearby TMVB volcanoes, indicating distinct mantle and/or crustal inputs beneath Ceboruco. Preliminary petrographic observations show a temporal shift from amphibole-bearing lavas in older units, typically in low modal abundances (<5%), to amphibole-absent assemblages in younger products. These mineralogical transitions, combined with variations in Nb/Th ratios and evidence for crystal zoning, point to evolving magma storage conditions and possible magma mixing or recharge through time. Ongoing SEM (Scanning Electron Microscope) analyses will refine mineral compositions and inclusion textures to better constrain crystallisation pathways, magma storage depths, and the relative roles of fractional crystallisation and crustal assimilation. This study represents the first integrated petrological and geochemical investigation spanning the full eruptive history of Ceboruco and provides new insights into magmatic evolution during the transition from subduction-dominated to more continental arc conditions in western Mexico.

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Assessing the relative proportions of recycling and juvenile mantle input during Phanerozoic crustal growth using major oxides

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The evolution of Earth's continental crust remains highly debated. Some models suggest crustal growth during the Hadean, while others suggest it only became important after 3.5 Ga. The debate partly originates in the relative rates of orogenic crustal growth resulting from juvenile mantle input versus the recycling of pre-existing crustal material. Most studies are centred on the zircon record and on the isotopic composition of crustal rocks. Whilst these approaches have yielded a wealth of information, their inherent biases cause the crustal recycled proportions to be overestimated. This results from the fact that the associated isotopes are incompatible during fractional crystallisation, and mantle-derived melts are zircon-undersaturated.

Here, we probe the relative proportions of mantle-derived material and recycling/reworking of crustal material using major elements that form >95% of igneous rocks. We compare a major element mass balance approach in basaltic rocks [1] with one based on the major element composition in biotite-saturated felsic rocks [2]. The results are then compared with a more traditional Nd isotope approach [3].

We use the Magma Chamber Simulator (MCS) [4,5], a thermodynamic model, to assess the accuracy and biases of each approach. This framework allows us to evaluate the models [1,2] against modelled scenarios where the mantle and crustal proportions are known. The major oxide modelling results indicate convergent-related volcanics are dominated by juvenile mantle-derived input, whereas the Nd isotope approach over-represents the extent of crustal recycling.

Using these results, we investigate the relative juvenile and recycled/reworked proportions in the Antilles, Central Andes and Anatolia. We use these settings to assess the juvenile proportions in arc (island and continental) and continent-continent collisional environments. Results for Anatolia will be combined with our regional crustal growth model, where we estimate the gross growth rate to be four times greater than previously estimated for collisional settings.

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Melt inclusions as tracers of time-dependent sampling of mantle heterogeneities during the 2021 Tajogaite eruption (La Palma)?

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Volatile heterogeneity in the Earth's mantle results from the long-term recycling of volatile elements through subduction and convection. Basaltic eruptions at oceanic islands can sample mantle heterogeneities and preserve their diverse geochemical signatures in crystal-hosted melt inclusions (MIs). How time-dependent melting and mobilisation of these mantle heterogeneities influence magma volatile budgets within single eruptions remains poorly understood.

To address this, we investigated the evolution of magmas erupted during the 2021 Tajogaite eruption (La Palma, Canary Islands), which exhibited time-dependent geochemical variability [1]. Olivine-hosted MIs were analysed using electron microprobe (major elements and S), ion microprobe (H_2O, CO_2, Cl, F), LA-ICP-MS (trace elements), and Raman spectroscopy (CO_2 density in bubbles). Since up to 85% of a MI's volatile budget can be stored within its bubble [2], we also analysed experimentally homogenised MIs to recover total volatile budgets. Preliminary data processing indicates that the MIs contained up to 1.0 wt.% CO_2, with 61 % of the CO_2 hosted within the bubble. The highest CO_2 contents are found in MIs from Stage 2 of the eruption.

To unravel time-dependent contributions from compositionally distinct mantle sources, we will additionally measure Cl, Br, and I in these MIs using neutron-irradiated noble gas mass spectrometry. Halogens are sensitive tracers of recycled components [3], and when combined with trace element data, they will allow us to track the relative and temporal contributions of diverse mantle reservoirs throughout the eruption.

Finally, by linking temporal variations in magma composition with *in situ* gas flux measurements and observed changes in eruptive style, we aim to evaluate whether differential sampling of heterogeneous mantle reservoirs influences gas emissions and eruption dynamics.

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A new regional seismic catalogue for Ascension Island, 2014-2024

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The UK Overseas Territories (UKOTs) of the South Atlantic are some of the most remote communities in the world and are particularly vulnerable to natural hazards. There is evidence for volcanism on Ascension Island as recently as 500 years ago, and felt earthquakes have been reported in recent years. And yet, there is no dedicated volcanic monitoring on-island, and our understanding of the nature of seismic unrest on Ascension is very limited. Global seismic catalogues are typically limited to earthquakes larger than magnitude 4, associated primarily with the Mid-Atlantic Ridge, 90km to the northeast of Ascension.

In this study, we use openly available seismic data from the single permanent telemetered station on Ascension, to develop a new, enriched regional seismic catalogue for the 10-year period, 2014–2024. Single station location methods are used to identify previously unrecorded events, expanding the catalogue from 116 events to 1,089 events. Primarily, seismicity is dominated by three main types of events:

- Tectonic events associated with the Mid-Atlantic Ridge, including unseen mainshock-aftershock sequences
- Recurring events with a time difference between P- and S- wave arrivals that is consistent with a location around 30km east of Ascension
- Events which appear to be volcano-tectonic (VT) occurring within the known volume of the volcano

We go on to demonstrate the potential and limitations for automatic template matching methods to enhance catalogue creation in future research. Finally, we attempt quantify just how much seismic event location uncertainties could be reduced if recorded on an expanded seismic network, both on land and using ocean bottom seismometers, by using synthetic earthquake events.

This is the first documented regional seismic catalogue of this kind. It forms the basis for future research efforts, with quantified evidence for the need and potential for further seismic monitoring.

Bimodal magmatism and the Daly Gap: Characterising the physical and chemical behaviour of strongly bimodal magmatic systems using the Paleogene Slieve Gullion Complex, Northern Ireland, as a case study.

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Bimodal magmatic systems exhibit the "Daly Gap," whereby intermediate compositions are notably scarce or absent [1]. This research aims to unravel the mechanisms driving compositional gaps, exploring factors such as liquid immiscibility, temperature-time relationships during fractional crystallisation, and the role of Rayleigh-Taylor instabilities in magmatic systems. A particular focus is the systems' physical and chemical behaviour where mafic and felsic endmembers are brought into contact.

Slieve Gullion is a Paleogene-layered central complex traversed by cone sheets and enclosed by a concentric ring-dyke, located on the border between Ireland and Northern Ireland. It belongs to the predominantly mafic British and Irish Palaeogene Igneous Province, which is part of the wider North Atlantic Igneous Province (NAIP). The central complexes of the NAIP show bimodal volcanism, mainly comprising basaltic and rhyolitic compositions with sparse hybrids. Gamble (1979)[2] previously mapped the Central Complex, with the petrological work of Emeleus (1961)[3] and Troll et al. (2008)[4] focussed on ring-dyke formation.

This study aims to integrate observations on grain to regional scale. Satellite imagery and outcrop-scale observations will be combined with qualitative and quantitative microstructural analysis (Gaussian Processes Electron Dispersive Spectra -GPyEDS)[5], geochemical data (whole and trace), and geochemical modelling to elucidate the processes and controls on the extent of magma mixing and mingling in bimodal systems. This work will advance our understanding of the structural controls on central complex emplacement, the extent of crustal assimilation, and the effects of compositional bimodality on magmatic system evolution.

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The value of seafloor geodesy for constraining volcanic deformation sources

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Monitoring and interpreting volcano deformation from geodetic observations is essential for identifying sources of unrest and understanding magmatic processes. Yet, for marine volcanoes, where much of the edifice lies submerged, monitoring relies largely on subaerial data that capture only a fraction of the deformation field. While marine geodetic techniques remain logistically challenging due to costs and infrastructure availability, only sparse offshore coverage can be obtained. In some cases, sparse data can lead to ambiguous interpretations of unrest sources in geodetic inversions, and the value of seafloor geodetic observations for reducing this non-uniqueness is unknown.

The 2025 Santorini seismic crisis highlighted these limitations. Extensive offshore seismicity and deformation between Santorini and Amorgos produced contrasting interpretations of the unrest source depending on the datasets analysed. GNSS-only modelling suggested fault slip [1], whereas combining GNSS, InSAR, and limited offshore measurements suggested a propagating dike with a Mogi depressurisation [2,3]. The offshore observations were acquired by two Ocean Bottom Pressure (OBP) sensors deployed along with five others, near Kolumbo, a fully submerged volcano northeast of Santorini. These data provide the first direct measurements of vertical seafloor deformation during a unrest episode in the region and offer a rare opportunity to evaluate how even sparse offshore observations improve our ability to resolve deformation sources.

We use forward models incorporating high-resolution bathymetry, topography, and alternative source geometries [4] to predict deformation patterns associated with the two hypothesized mechanisms. By analysing the sensitivity of these patterns to OBP-derived vertical motion, we show that including even a modest offshore network substantially reduces non-uniqueness in deformation models and reveals signals invisible to land-based geodesy alone. This work provides an initial framework for assessing the added value of offshore geodesy in marine-volcano settings and shows the advantages of forward modelling for strategic instrument placement for increased coverage of deformation events.

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Experimental determination of crystal structure and thermodynamic properties of Martian meteorite wadalite

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The mineral wadalite ($Ca_6Al_5Si_2O_{16}Cl_3$) was first discovered in a skarn xenolith in two-pyroxene andesite[1], coexisting with grossular and hydrogarnets, in a carbonaceous chondrite Martian meteorite[2]. Wadalite can also act as a weakly-hydraulic Cl-carrier in calcium-sulfo-aluminate (CSA) based cements[3]. Therefore, determining the crystal structure and thermodynamic properties is crucial in both volcanology, planetary science, and the cement communities. To investigate the thermodynamic properties, we first synthesised pure wadalite by the acid-catalysed sol-gel method, which helps to synthesise the pure phase at low temperature, 820 °C, with a mere 5-6 hours dwelling time at the University of Leeds. We then measure the thermodynamic properties (e.g., heat capacity, entropy, and enthalpy) of wadalite using a Quantum Design physical property measurements system (PPMS) at ISIS, Diamond Light Source, Oxford, from 0 to 300 K, and 600 to 1200 K using a high temperature drop calorimeter. These thermodynamic data were then combined with the enthalpy of formation results from Density Functional Theory (DFT) and previous experiments to model the thermodynamic properties of wadalite using the 3rd generation CALPHAD function.

Our Rietveld quantification phase analysis showed that the synthesised wadalite is ~98% pure with a crystallite size of ~78 nm. The pure phase required some atomic occupancy refinement to fit the diffractogram, which impacts the centrosymmetric nature of wadalite crystals. The BSE (back-scatter) image of powder wadalite grains exhibited the small grains growing on the top of large grains, a phenomenon known as Ostwald Ripening[4]. The heat capacity of wadalite shows relatively higher values of ~1000 J/mol/K at 300 K than those of hydrogrossular. This study sheds light on the stability and potential behaviour of wadalite and provides a new thermodynamic database in andesite, Martian meteorite, and CSA cements.

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The case for global catastrophic volcanic risk: Historical learnings and future outlook

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Volcanic eruptions can disrupt hemispheric or global climate, triggering shocks such as sudden cold, droughts, floods, monsoon failure, and crop losses. These events have repeatedly shaped human history, and understanding them is vital for assessing present and future risks. By examining past eruptions, we explore how 7 past climate shocks cascaded through societies, highlighting that the Volcanic Explosivity Index (VEI) alone is a poor predictor of societal impact. Clusters of moderate eruptions (VEI 5–6), particularly sourced from the Northern Hemisphere extra-tropics often produced prolonged climate disturbances with the most severe consequences.

The effects of eruptions depended less on eruption size and sulfur gas content, but more on societal vulnerability and responses. While short-term reactions were sometimes adaptive and cooperative, prolonged stress frequently led to negative outcomes, including hoarding, profiteering, trade restrictions, fiscal strain, and scapegoating of marginalised groups. Our analysis of seven major volcanically induced climate shocks reveals four recurring causal pathways: food insecurity, economic decline, disease outbreaks, and political or civil instability.

Today anthropogenic climate change, conflict, and global interconnectedness may amplify these risks. Local disruptions can rapidly escalate into global crises, making societal responses as critical as the physical impacts themselves. Historical responses demonstrate that resilience, through trade, innovation, and effective governance can help mitigate future volcanically-induced climatic shocks.

Velocity controls on erosion in pyroclastic density currents

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Pyroclastic density currents (PDCs) are one of the most dangerous volcanic hazards, with varied behaviours and the ability to inundate large areas. The basal part of these currents is believed to behave as a dense granular flow, lubricated by interstitial gas pore pressure.

PDCs can be highly erosive, leading to 'bulking' of the current which in turn may result in increased run-out, and elevated hazard potential. Changes in source conditions, local channel geometry, and interaction with other materials can cause PDCs to be unsteady and non-uniform, resulting in switches between erosion, bypass or deposition of material at any given point through the duration of a current. The capacity to erode may be influenced by substrate characteristics such as particle size, density, and cohesion, and current properties such as velocity and flow thickness.

Prior work has established a methodology to capture erosion in experiments, by setting and serially sectioning the deposits formed by fluidised granular currents interacting with substrates of varying cohesion [1, 2]. We present new experiments using similar techniques that investigate how different flow conditions influence the magnitude and style of erosion, to explore the relative importance of pore pressure and basal stress on processes occurring at the base of dense granular PDCs.

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The effects of different topographic obstacles on the flow characteristics of dense, granular pyroclastic density currents.

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Pyroclastic density currents (PDCs) are hazardous volcanic flows that have the potential to surmount topographic highs but can also be deflected or reflected by obstacles. In some hazard assessments, topographic obstacles are used to delineate safe zones vs inundation areas. Past experimental studies have found that all (or part) of a dilute current can overtop topography, depending on the height of the obstacle h_b with respect to current thickness h_c and the momentum of the flow [1, 2]. The effect of topographic obstacles on the basal granular layer of a PDC has not previously been investigated.

We address this gap by experimentally quantifying the effects of different topographic obstacles (varying in height and geometry) on flow front velocity, runout length and behaviour of aerated dense-granular currents (analogous to dense granular PDCs). Currents comprising silica ballotini (90% 45-90 µm, 10% 1000-1300 µm tracking beads) were released and flowed 0.5 m before impacting the obstacle. This interaction was visualised using a high-speed camera recording at 730 fps. The resulting videos were processed using the Dantec DynamicStudio 6.4 adaptive particle image velocimetry (PIV) algorithm to obtain estimates of 2D (streamwise/vertical) velocities revealing the impact of obstacles on internal flow dynamics.

Results show that the nature of current-obstacle interaction is dependent upon h_b/h_c and on stoss-side slope angle. h_b/h_c controls current behaviour (e.g. deflection, rollback waves, granular jetting), flow front velocity, and downstream runout length. PIV analysis reveals a loss of energy in basal layers as currents impinge upon and run-up barriers. Local pulses of energy fluctuations in upper layers are observed to propagate through the current as barriers are surmounted. The presence of high energy regions within the flow could cause increased dynamic pressures when the currents impact barriers. This has significant implications for the hazard potential of PDCs when impacting critical infrastructures.

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Future volcanic eruptions may delay the recovery of lower stratospheric ozone over Antarctica and Southern Hemisphere mid-latitudes

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Sporadic explosive volcanic eruptions can inject large amounts of sulfur into the stratosphere, which forms volcanic sulfate aerosols with the potential to affect stratospheric ozone chemistry. Future volcanic eruptions have been represented in climate projection studies with varying degrees of realism despite their potential importance for polar ozone recovery. Climate projections typically use a constant volcanic forcing based on a historical average, which very likely underestimates the magnitude of future volcanic forcing and ignores the sporadic nature of volcanic eruptions. In this study, we use stochastic volcanic eruption scenarios and a plume-aerosol-chemistry-climate model (UKESM-VPLUME) to assess the effect of future volcanic sulfur injections on lower stratospheric ozone recovery over Antarctica and Southern Hemisphere mid-latitudes. We find that sporadic eruptions can delay Antarctic total column ozone recovery by up to five years, though this delay is relatively small when compared with the long-term ozone recovery timescale. Large-magnitude eruptions occurring before mid-century can, however, episodically cause more substantial delays in the recovery. Based on a composite analysis we show that the ozone response to volcanic sulfate aerosols over Antarctica and Southern Hemisphere mid-latitudes weakens over the 21st century due to declining chlorofluorocarbon concentrations. Overall, our findings underscore the need for fully interactive volcanic aerosol-chemistry coupling to assess the resilience of the Antarctic ozone layer in response to future volcanic eruptions and other stratospheric perturbation events. Our results also support previous calls for sustained monitoring of stratospheric composition and ozone-depleting processes to better anticipate and attribute changes in ozone recovery.

Blocks, pumice, scoria, ash and water- a tale of two eruptions in the Eastern Caribbean

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This talk will focus on some scientific highlights of two eruptions in the Eastern Caribbean, from both a physical volcanology and a hazard point of view, that of Soufriere Hills Volcano (SHV) on the island of Montserrat and La Soufriere on St Vincent (SSV).

SHV, which began erupting in July 1995, has been a source of numerous important advances in knowledge about many aspects of volcanology. One of these is the behaviour of thousands of pyroclastic density currents (PDCs) by collapse of the andesite lava domes and associated with large vulcanian explosions have led to considerable increases in the understating of these phenomena, in particular how PDCs interact with topography and their impact on buildings and the environment [eg 1,2].

More than one hundred large Vulcanian explosions took place across 15 years of activity at SHV, and while some of these occurred as a series of regularly spaced events others were more isolated [3]. Multidisciplinary analysis of these events has shown they vary widely in nature, components and mechanisms. Further, during both extrusion and pauses, continuous discharge of ash was a regular feature. Coupling observations, seismic data and sample analysis has shed important light on this ash venting phenomena which is distinct from vulcanian style explosive activity [4].

The 2020-2021 eruption of SSV has provided a huge increase in knowledge of this type of short-lived effusive to explosive eruption transition. Detailed stratigraphic work made immediately following explosive activity provided the framework for understanding many key aspects of this eruption [5]. Such as the information on the magma that fed the eruption, and future work will apply this technique to other similar eruptions in the region.

This research highlights that close, careful volcano monitoring, together with field-based studies of the products is essential to gain full understanding of such complex phenomena.

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Major, minor and trace element mapping of felsic volcanics: Towards a better understanding of Li behaviour in magmas

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Lithium is incompatible in most crystalline phases, leading to its selective enrichment in felsic melts [1]. As a result, Li-bearing ore deposits are commonly associated with rhyolitic magmatism [2]. Understanding the mechanisms and extent of Li enrichment is essential for evaluating how economic Li accumulations form, yet primary magmatic Li behaviour is difficult to assess due to its high diffusivity during syn- and post-eruptive processes [1]. *In-situ* element analyses show that pre-eruptive Li inventories in melts, crystals and fluids can be significatively modified by degassing, hydration of glass and protracted cooling [1].

To better resolve these overprinting processes, we developed an integrated mapping-based analytical workflow that combines automated SEM, EPMA and LA-ICPMS. This approach links the distribution of major and trace elements with microtextures to evaluate how Li is redistributed. We applied this workflow to biotite-bearing tuffs from Cerro Galán, a cool-and-wet rhyolite centre, revealing discrete Li-, Cu- and Pb-rich microdomains. These resemble inclusions enriched in fluid-mobile elements rather than crystal-growth features, supporting the interpretation that Li-rich fluids can be exsolved from magmas [3]. Such scavenging of Li from the melt promotes diffusive re-equilibration of Li within phenocrysts and may explain discrepancies between melt inclusions and groundmass glass Li contents [1].

We further applied our workflow to vitrophyres from the Snake River Plain (SRP) and Sardinia, representing hot-and-dry and cool-and-wet rhyolites, respectively. We observe consistently low-Li rims and high-Li cores, with the cool-and-wet rhyolites exhibiting the highest Li contents. Mapping of Li and K/Na in hydrated SRP glasses indicates that leaching is concentrated along perlitic-fracture rims, reducing the effective Li contribution from altered glass to ~30 % of the original groundmass inventory. Together, these results demonstrate the value of high-resolution elemental mapping for disentangling modifications of Li in volcanic systems and improving models of Li enrichment in felsic magmas.

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Assessing Volcanic Hazards and Financial Exposure: A Closer Look at Insurance Industry Preparedness

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Within the insurance and reinsurance sectors, volcanoes and their secondary impacts are often an overlooked risk due to the long return periods associated with large explosive eruptions, and relatively low financial losses from eruption events compared to natural hazards such as large magnitude earthquakes. However, with continued population growth, globalisation and climate change increasing exposure to volcanoes, and more sophisticated monitoring and modelling methods revealing the true extent of primary volcanic hazards and secondary effects, this peril should be more thoroughly considered.

Through reviewing exposure to active Holocene volcanoes and comparing economic and insured losses of significant eruptions, we can explore how analogues of historic events could affect the modern world. The past 40 years have mostly seen eruptions of Volcanic Explosivity Index (VEI) 3–4; significant but not "super-catastrophes." Should a larger VEI 6+ event occur near a densely populated area or in a country with high insurance penetration, losses could be far higher. Countries with the highest exposed populations to volcanoes include Indonesia, the Philippines and Guatemala [1]. This differs from countries at greatest risk of insurable losses, such as China, Japan and the US, and lower insurance penetration in more exposed countries identifies a significant protection gap.

Eruptions in smaller nations show particular financial vulnerability, with recent eruptions in Tonga and La Palma leading to large losses in proportion to their Gross Domestic Product (GDP); as much as 1/3 of their economy (30-37%) [2,3]. Economic losses of accumulated volcanic activity have totalled $152.6 billion over 20 years (average $7.6 billion a year) [4]. Recent estimates suggest that a large, long return period, global climate-affecting eruption might lead to losses in the multi-trillions [5], impacting pre-existing reinsurance markets in a similar manner to tropical cyclones and highlighting the need for greater attention, preparedness and resilience measures.

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Examining Cumulative SO_2 Time Series using Satellite Sensing on Mt Etna

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This research aims to investigate trends in the evolution of cumulative SO_2 mass time series leading to, and following, persistent degassing and paroxysmal events at Mt Etna volcano, using data from the TROPOspheric Monitoring Instrument, TROPOMI, onboard the Copernicus Sentinel-5 Precursor satellite. TROPOMI allows for near global atmospheric column measurements with a spatial resolution of 3.5 x 7 km^2, giving greatly improved spatiotemporal resolution that can be applied to any degassing volcano, [1] and has been validated against several ground-based sensing methods [2].

Methods of monitoring SO_2 are of great importance for evacuation protocols in the surrounding areas of Mt Etna, as changes in SO_2 flux are often a marker of upcoming eruption. SO_2 has the benefit of being greatly abundant in volcanic activity, with Etna typically emitting 500 to 5000 t/day, as opposed to low background atmospheric levels.

A reproduceable SO_2 'dip-surge' eruption precursor sequence has been hypothesised and will be tested by examining cumulative SO_2 mass time series around periods of passive degassing, effusive and paroxysmal events using the entirety of the TROPOMI record from 2018 to the present day. The precursor would suggest a process where any dips in SO_2 must be paid for with potentially dangerous surges. The process would suggest that SO_2 stored in highly vesicular rising magma, before emissions surge rapidly once a critical decompression is reached, resulting in a paroxysmal eruption. Smaller volcanos have previously been analysed over shorter periods of time; however, extending methods to the larger and more complex plumbing system of Mt Etna has the potential to reinforce or reveal findings and increase knowledge around predicting volcanic activity.

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Where did the gases go? Quantifying total melt inclusion volatile contents via combined 3D Raman and nano-CT analyses of bubble wall precipitates

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We have identified nanoscale precipitates of carbonates and sulfides on the walls of vapour bubbles in olivine-hosted melt inclusions (MIs) from the 2021 Tajogaite eruption on La Palma. These precipitate reservoirs can contain up to 85% of the MI's total carbon budget, as well as sequestering major elements like Ca and Fe[1]. As such, MI volatile content reconstructions based solely on the silicate glass and vapour (or fluid) phases may lead to order-of-magnitude underestimations of magma volatile budgets and gas emissions. This has significant implications for calculated magmatic storage parameters (P, T, fO_2), our understanding of magmatic systems, and their associated volcanic activity.

Three-dimensional Raman mapping of vapour bubbles can identify precipitate compositions and begin to resolve their volumes. However, these reconstructed volumes can be distorted due to signal interference from above and below the region of interest. For example, an analysed spherical bubble with interior precipitates may be reconstructed as an ovoid bubble with distorted precipitate clusters[2], such that volumes will be over- or underestimated. We collected nano-XCT data (maximum resolution of ~70 nm) at the Diamond Light Source I13-2 beamline for several precipitate-bearing vapour bubbles from different phases of the Tajogaite eruption. These data provide the first independent accurate volume reconstruction of bubble wall precipitates for Tajogaite samples and can be used to correct any distortion in the 3D Raman datasets.

We combine cutting-edge 3D Raman analyses with nano-XCT imaging to better constrain the composition and volumes of bubble wall precipitates. The resulting dataset will be used to trace variations in magmatic volatile content across key transitions in eruptive activity during the 2021 Tajogaite eruption. Our work provides an analytical workflow for the *full* quantification of magmatic volatile concentrations helping to reconcile petrologic datasets with ground and satellite-based volcanic gas measurements from Tajogaite[3] and at volcanoes worldwide.

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Two-stage model of propagation and arrest explains ubiquitous patterns of dyke seismicity

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Lateral dyke intrusions are magma-filled fractures that propagate horizontally through the Earth's crust, posing significant hazards to local populations. Since 2020, four major lateral dyking events have forced the evacuation of at least 10,000 people [1,2]. Although the underlying physical processes are well established, current models are complex, and it is unclear which factors control lateral propagation speed and the movement of magma within the dyke.

By comparing data from intrusions from around the world, we show that the spatio-temporal patterns of seismicity and ground deformation are ubiquitous, and can be split into two phases:

Lateral propagation: The seismic events migrate, delineating the location of the lateral dyke tip. The migration speed decays with time and the ground deforms along the entire length of the dyke.

Widening post-arrest: After the dyke reaches its final lateral extent, it continues to open. Seismicity propagates back into the previously quiet regions, and the ground deforms at the distal end only.

We use these observations to motivate a two-stage model of dyke intrusion: lateral propagation followed by widening after arrest. The three-dimensional hydro-mechanical process associated with dyking can be reduced through scale separation to a single Partial Differential Equation (PDE) resembling the classical heat equation [3,4]. Scaling this shows that a dyke fed by a constant pressure source grows as $t^{1/2}$ while those fed by a constant flux grow as $t^{1/5}$ [5]. By solving the PDE we determine the time-dependent dyke opening distribution and the resulting stress field. We compare predictions of seismicity rates and changing surface deformation to observations from seismology and geodesy. We show that dykes are driven by a near-constant source pressure throughout lateral propagation and that patterns of seismicity and surface deformation are a result of the changing widths of the dyke both during propagation and after arrest.

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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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Lunar lava tubes and associate surface features: insights from remote sensing identification and finite-element modelling

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Lunar lava tubes serve not only as natural shelters against the harsh lunar surface environment and potential sites for future research bases, but also as key geological bodies preserving information about lunar volcanism [1]. Previous studies based on multisource datasets—including remote sensing imagery, radar, and gravity data—have identified subsurface void space in some maria regions, which are interpreted to be lava tubes [1-3]. Surface features such as collapse chains and skylights are often regarded as partially collapsed lava tubes [1]. Sinuous rilles are elongated and meandering channels that occur primarily in the maria [4]. Some researchers proposed that sinuous rilles may represent fully collapsed lava tubes [5], although this hypothesis has not yet been confirmed. However, the formation and preservation mechanisms of these tubes remain poorly constrained.

In this study, we investigate the genetic relationships between lava tubes and associated surface features such as sinuous rilles, collapse chains, and skylights. We first performed remote sensing analysis of all sinuous rilles identified by Hurwitz et al. [4] and their surrounding areas, revealing several previously unrecognized collapse chains and sinuous rilles associated with them. These observations provide evidence that collapse chains and sinuous rilles possibly represent collapsed tubes. Then we conducted finite-element modelling using COMSOL Multiphysics® to constrain the tube stability and preservation during eruptions. Results indicate that a rapid decrease in effusion rate induces instability of the upper crust of tubes, eventually leading to the collapse of tubes.

Therefore, we propose that sinuous rilles and collapse chains originate from crust collapse of lava tubes during the waning stage of magma supply. The established links between subsurface tube and surface features provide a framework for identifying and validating buried lava tubes, thereby supporting the selection of base locations for future lunar exploration.

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Integrating hydrothermal and magmatic deformation models for Soufrière Hills Volcano, Montserrat

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Soufrière Hills is an active dome building volcano on the island of Montserrat, in the Eastern Caribbean. The Montserrat Volcano Observatory conducts multi-parametric monitoring, including an island-wide ground deformation network operating since the onset of eruption in 1995. Volcano deformation models are used to simulate subsurface processes causing the observed ground surface displacement. Often, these models involve the pressurization of a magma reservoir, simulated either as a pressurized cavity or poroelastic body, in an elastic medium. At Montserrat, a purely magmatic deformation source has been unable to fully account for the observed deformation signal across the island, leading to large residuals between simulated and observed geodetic data at sites closest to the vent. In this study, we will investigate how a hydrothermal deformation source may influence the simulated displacement. An active hydrothermal system is inferred around Soufrière Hills from near-vent fumaroles and a hydrothermal seep now buried by recent pyroclastic deposits. Observations from geophysical surveys, including seismic tomography and gravity, have also suggested the accumulation of hydrothermal fluids at the intersection of faults and zones of weakness on the western edge of the island. We will compare magmatic, hydrothermal, and combined deformation source simulations to investigate how different causal mechanisms influence the modelled surface displacement field. Our models will be validated using observed deformation from Montserrat between 2010 and 2022 via GNSS records. Two different model setups will be tested: a homogeneous model as a computationally inexpensive baseline, and a heterogeneous model containing seismically defined low permeability andesitic cores in the north of the island, faults in the southwest, and a clay capped region of high permeability in the region of the inferred hydrothermal aquifer. The results from this study will assist in hazard assessment and contribute to the investigation of on-island geothermal resources.

VMSG session 4. Volcanic monitoring

Exploring the use of morphometry tools in ArcGIS Pro to characterise the topography of stratovolcanoes prone to pyroclastic density current inundation, with implications for numerical and experimental modelling

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Pyroclastic density current (PDCs) propagation is affected by topography; denser parts become channelised within topographic lows (e.g. Fuego, Guatemala, 2018) and blocked by topographic walls, while dilute parts may loft above obstacles and become redirected (e.g. Unzen, Japan, 1991). Volcanic landscapes are complex, with craters, caldera walls and gorges. Understanding how PDCs interact with topography is a critical part of hazard prediction and disaster risk reduction.

Aravena and Roche [1] used numerical modelling to demonstrate the role of topography on the run-out distance and channelisation of PDCs, and therefore on hazard zonation planning. Their work categorised how simulated PDCs interact with stratovolcano topography worldwide, using a digital elevation model (DEM) input. However, they highlighted limitations faced by modelling studies, such as DEM resolution and a lack of real-world analysis to compare to simulated outputs.

This project brings together specialists in field volcanology, experimental modelling, numerical modelling and geomorphology to address these challenges, by investigating stratovolcano topography through a multidisciplinary lens and facilitating easier linkage between real-world analogue data and PDC modelling.

The work employs ArcGIS Pro geomorphology and hydrology toolkits to characterise proximal geomorphic features prone to PDC inundation at stratovolcanoes worldwide. The impact of varying DEM resolution upon analysis is investigated, and results are compared to numerical PDC simulations. The goal is to create an open access topographic database that allows numerical and experimental PDC modellers to easily benchmark simulations to real-world analogues. Initial work has involved designing a framework for geomorphic characterisation and testing a workflow on different DEM resolutions within ArcGIS Pro, using Mt St Helens as a case study. We aim to create a workflow that is easy to use, with outputs accessible for a range of end users. This poster invites the community to comment on the framework, our methodology, and implications so far.

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Synchronized explosive activity of Kolumbo and Santorini Volcanoes (Greece), from IODP deep drilling and core-seismic integration.

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Santorini-Kolumbo is one of the most hazardous volcanic fields in Europe, as highlighted by its VEI-5 explosive eruptions of 726 CE and 1650 CE, and its bradyseismic crises of 2011-12 and 2025. IODP Expedition 398 deep-drilled the volcano-sedimentary infills of marine rift basins north of Santorini to depths of up to 628 m below the sea floor, and integrated the core stratigraphies with a dense array of seismic profiles to construct a high-resolution timeline of volcanic activity. In this overview we show that the four drill sites analyzed to date reveal >200 Santorini and 19 Kolumbo tephra layers intercalated in marine sediments. The tephras were correlated chemically between sites, either as the products of individual eruptions or as packages of layers, with the onset of explosive activity at ~1 Ma. The rift basins contain several submarine volcaniclastic megabeds from the caldera-forming eruptions of Santorini and one from the Kos caldera. The megabeds formed when pyroclastic flows poured into the sea and transformed into subaqueous gravity flows. The thickest megabed succession is < 250 ka old and lies on a seismic reflection onlap surface that records a phase of prolonged rifting. Sedimentation lagged behind subsidence during rifting, creating bathymetric troughs that served as depocenters for the megabeds. Rifting may have driven the transition of Santorini from a prolonged state of effusive and moderate explosive activity (~550 – 250 ka) typical of arc stratovolcanoes to one of repeated caldera-forming eruptions (<250 ka). The earliest explosive activity at Kolumbo Volcano is recorded at 245 ka and coincides with the explosive transition at Santorini, suggesting that explosive activity at both volcanic systems is synchronized by tectonic stresses. The main stages of construction of the Kolumbo edifice broadly coincided with periods of caldera-forming silicic volcanism at Santorini, reflecting additional interactions and feedbacks on shorter timescales.

Satellite detection of methane outburst from an East African volcano

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Methane is a potent greenhouse gas, and although natural degassing from the Earth contributes to atmospheric methane, volcanic systems are generally considered as minor sources. In this study, we present the first confirmed satellite observations of methane emissions associated with a volcanic system, likely formed from interactions between magma and organic carbon-rich sedimentary rocks. During early 2025, Fentale Volcano in Ethiopia, released 38.1 ± 4.0 kilotonnes of methane, of which 90% was emitted within 30 days and reaching a peak emission rate of 157.4 ± 40.8 t hr^{-1}, similar to those from large industrial blowouts. These emissions followed the intrusion of an approximately 50 km-long magmatic dyke and correlated with ground deformation, thermal anomalies, and a dense low-lying plume within Fentale's caldera, although no magma reached the surface. A non-double couple earthquake and about 40 m surface collapse on 14 February coincided with the last significant methane emissions, suggesting the depletion and subsequent collapse of the storage reservoirs. We propose that the intrusion disrupted an impermeable cap, allowing methane derived from hydrocarbon-rich sediment trapped beneath it to escape. These observations provide new insights into how magma-sediment interactions can mobilise methane at volcanic systems.

What deep-sea magnetics tell us about volcanic systems?

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The development of deep-sea vehicles including Autonomous Underwater Vehicles (AUV), Remotely Operated Vehicles (ROV), and manned submersibles (HOV), has given us access to unprecedented high resolutions (HR) in the acquisition of magnetic profiles or maps, allowing to study submarine volcanic systems in a way more similar to their equivalent on land. We present four examples where magnetic data prove essential in constraining the age and understanding the evolution of such systems.

The East Pacific Rise (EPR) axis at 16°N is characterized by a wide and shallow magmatic dome considered as an hyper-magmatic segment. Marked negative magnetic lows observed on a HR AUV survey over a dual axial graben system help to identify active and inactive dykes and grabens, the intruding dolerite of recent dykes being significantly less magnetized than the overlying basalt flows [1]. Further south, a HR AUV survey over three off-axis lava flows of the EPR 2°S displays a lot of details, including a small hydrothermal site, collapsed lava lakes, and inferred voids in the flows, all characterized by negative Reduced-To-the-Pole magnetic anomalies and offering an essential complement to the bathymetry to understand eruptive and post-eruptive processes in this area [2].

The next two examples come from a diffuse volcanic area in the SW Pacific Ocean, near Futuna Island. There, we determine the magnetic polarity determined from AUV and HOV magnetic data to show that the area has been active for more than a million years, as a number of edifices display a reversed magnetic polarity [3]. In the same area, we combine magnetic, bathymetric and seismic data to unravel effusive and volcaniclastic styles of eruption over a volcanic hill of the Futuna Ridge and demonstrate that 1200 m is the maximum depth for volcaniclastic eruption with the type of magma encountered in this area.

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Real-Time Global Volcano Monitoring with InSAR: Coherence-Guided Interferogram Networks, Optimized Sentinel-1 Time Series, and Dynamic Updates (2014–2025)

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Volcano monitoring has advanced substantially in recent years. Traditional ground-based instruments, while invaluable, often face challenges related to difficult terrain, data transmission, and hazardous conditions. These limitations are increasingly being overcome by remote sensing techniques that complement in situ observations. Among these, Interferometric Synthetic Aperture Radar (InSAR) has become a powerful tool for measuring volcanic deformation and gaining insights into magmatic and subsurface processes.

With the advent of the LiCSAR system [1], which automatically produces global deformation maps at ~100 m resolution, high-resolution RSLC images are now available for all volcanic regions worldwide, spanning 2014–2025. In this study, we propose an automated approach to design an interferogram network at ~30 m resolution, based on coherence analysis, using 6- and 12-day intervals to identify optimal pairs for constructing long-term interferograms (3, 6, 9, and 12 months). This framework accounts for region-specific challenges such as atmospheric artefacts, vegetation-induced decorrelation, and snow cover. The resulting interferograms are processed with LiCSBAS [2,3] to generate deformation time series, velocity maps, and cumulative deformation maps.

Our methodology is applied globally, with particular emphasis on volcanoes that have been active during 2025, while also encompassing all other volcanic regions. We present selected global results, including case studies from volcanoes in Chile, Indonesia, Ecuador, and Russia, among many others worldwide. In addition, we introduce a strategy for incremental updates that integrates each new acquisition without reprocessing the full dataset. This innovation substantially improves the feasibility of near-real-time, global-scale InSAR volcano monitoring.

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Forecasting the Evolution of the 2021 Tajogaite Eruption, La Palma, with TROPOMI/PlumeTraj derived SO_2 Emission Rates

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As global populations grow, the exposure of communities and infrastructure to volcanic hazards increases every year. Once a volcanic eruption begins it becomes critical for risk managers to understand the likely evolution and duration of the activity to assess its impact on populations and infrastructure. Here, we report an exponential decay in satellite-derived SO_2 emission rates during the 2021 eruption of Tajogaite, La Palma, Canary Islands, and show that this pattern allows a reliable and consistent forecast of the evolution of the SO_2 emissions after the first third of the total eruption duration. The eruption ended when fluxes dropped to less than 6% of their fitted maximum value, providing a useful benchmark to compare with other eruptions. Using a 1-D numerical magma ascent model we suggest that the exponentially decreasing SO_2 emission trend was primarily produced by reducing magma chamber pressure as the eruption emptied the feeding reservoir. This work highlights the key role that satellite-derived SO_2 emission data can play in forecasting the evolution of volcanic eruptions and how the use of magma ascent models can inform the driving mechanisms controlling the evolution of the eruption.

Eruptions in the attention economy: Global patterns and language imbalances in volcanic eruption coverage revealed through multilingual social media analyses

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Volcanic eruptions can have widespread effects, with impacts ranging far beyond the source and oblivious to national and linguistic borders. Understanding how people access and engage with volcanic hazard information is critical not only for immediate crisis response but also for building long-term preparedness. This becomes particularly relevant in an increasingly online world where human attention is a scarce and finite commodity: the so-called attention economy, wherein news and research results must compete against a barrage of other information to capture and retain a reader's interest.

Social media data can offer a proxy for public attention to geohazards. Previous research has analysed social media–derived datasets using natural language processing to determine the emotional tone of discourse related to specific volcanic events (e.g. Hickey et al. [1], Ilyanskaya et al. [2]) or related to a specific user account (Dunn et al. [3]). Generally, however, such analysis is limited to single events, short timescales, and/or monolingual analyses. Accordingly, we lack detail on how social media reflects real-world volcanic activity, how notable eruptions shape online discourse, and how language and geography influence information dissemination.

This study addresses these gaps through a longitudinal, multilingual analysis of specific keywords on 𝕏 (Twitter), covering 18 languages over approximately four years. Using various timeseries analyses, discrete volcanic events can be detected in these social media data. Perhaps unsurprisingly, the 2022 Hunga Tonga–Hunga Haʻapai eruption stands out as the dominant event across almost all languages, highlighting how notable eruptions can initiate a step-change in online discourse.

Results also reveal linguistic imbalance: English dominates—even for eruptions in non-English-speaking regions—disconnecting the online visibility of eruptions from their real-world significance. To foster inclusive knowledge-sharing practice, volcanologists are strongly encouraged to actively engage with diverse linguistic groups beyond the silos of their own languages.

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Understanding the role of phase changes in eruption plume dynamics: an experimental approach

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Explosive volcanic eruptions are characterised by a plume of hot ash and gas emitted into the atmosphere. The height to which a plume ascends has critical ramifications on the local-to-global scale environmental and societal impacts of explosive volcanic eruptions, including effects on aviation, human health, and climate. Plume height varies with atmospheric conditions, including entrainment of atmospheric water which undergoes phase changes in the plume. Theoretically, phase changes release latent heat and boost plume buoyancy by as much as 500% in humid and warm atmospheres [1]—particularly relevant in the face of ongoing climate change [2].

Nevertheless, the hypothesis of a dramatic plume-height increase driven by atmospheric water vapor has not been rigorously validated against observations. Analyses of plume height, eruption rate, and atmospheric profiles suggest that models better fit observations when the effect of in-plume phase changes is ignored entirely [3], in contrast to prevailing theory. To reconcile models with theory and observation, analogue laboratory plume tank experiments are critical [1]. Such experiments use one fluid as an ambient medium—representing Earth's atmosphere—with a second fluid injected into this ambient as a proxy for a turbulent volcanic plume. However, no experimental setup currently accounts explicitly for phase changes in the plume.

Our novel experimental approach exploits variable temperature dependencies of specific salt solutions to actuate controlled phase changes within the system. A system of multiplexed thermoelectric cooling modules establishes a temperature gradient in the ambient. By controlling salt oversaturation and temperature contrasts within/between the saline fluids, we can replicate phase changes in real-world eruptions: the injected saline plume cools as it rises and begins to crystallise, mimicking natural systems. These experiments will bring critical insights into the impact of atmospheric water on plume rise through improved process understanding and parameterisation of turbulent entrainment.

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Understanding the role of phase changes in eruption plume dynamics: an experimental approach

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

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The Portrush Sill, located on the north coast of County Antrim, Northern Ireland, is a bowl-shaped Paleogene (c. 58.5 Ma) intrusion emplaced into Jurassic sediments rich in disseminated pyrite and pyritised macrofossils [1].

We have undertaken a remapping of the intrusion, together with stratigraphically constrained microstructural and geochemical analysis. The middle division of the sill is characterised by a striking magmatic texture comprising centimetre–decimetre sized, rounded melanocratic regions (globules) set within a leucocratic matrix. The melanocratic globules vary in size and morphology through the stratigraphy. We sampled the two magma types, as well as the dolerites of the upper and lower divisions and geochemically characterised these using XRF for major element oxides, ICP-MS for trace elements and EPMA for mineral compositions. We also studied the modal mineralogy and petrographic textures of the two liquids. The petrographic and geochemical data indicate that the two components represent conjugate Fe- and Si-rich liquids produced by unmixing from a common parent magma.

Comparison of clinopyroxene-plagioclase-plagioclase dihedral angles in the sill with those of other sills [2] show that it intruded as a single body, in contrast to previous work arguing for several sills separated by horizons of sedimentary rock [3]. Field observations show the magma intruding along bedding planes, as well as significant anatexis and contamination of the proximal magma. Analysis of Sr–Nd–Pb isotopes indicates an increasing extent of contamination in the vicinity of sedimentary screens in the middle and upper parts of the sill. We infer that the onset of immiscibility, and the unmixing of conjugate Fe- and Si-rich liquids within the Portrush sill, was a consequence of assimilation of pyrite-rich country rock. This represents the first documented example of macro-scale assimilation-induced liquid immiscibility, with major implications for our understanding of magmatic evolution.

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Formation mechanisms of glomerocrysts from high-threat volcanoes in the Cascades

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Glomerocrysts, or crystal clusters, are common in both intrusive and extrusive igneous rocks, spanning mafic to felsic compositions. A variety of credible glomerocryst formation mechanisms have been proposed, including: mush disaggregation; heterogeneous nucleation or epitaxy; the textural maturation of dendrites; and synneusis (the attachment of independently formed crystals in melt). Each mechanism has distinct petrogenetic implications, therefore discerning between them is essential for correctly interpreting the magmatic processes recorded by glomerocrysts.

We survey glomerocrysts from a selection of high-threat volcanoes in the Cascades, including Mt. Shasta, Mt. Hood and South Sister, focusing mainly on andesites and dacites. The storage and migration pathways of these magmas are relatively poorly understood, so identifying the origin of the near-ubiquitous glomerocrysts would provide valuable information. We use electron backscatter diffraction (EBSD) to quantify the crystallographic orientation relationships present within the glomerocrysts, since some formation mechanisms, including synneusis and epitaxy, are known to produce characteristic orientation relationships between neighbouring crystals. We combine orientation measurements with detailed petrographic and textural observations to interrogate the glomerocryst formation.

The Cascades glomerocrysts contain evidence of mush disaggregation, synneusis, and epitaxy. We also find evidence of an unexpected glomerocryst formation mechanism: textural re-equilibration of reaction rims. Amphibole and biotite form mineralogically and texturally complex aggregates during their breakdown, and olivine can react with melt to form orthopyroxene-dominated glomerocrysts. Such glomerocrysts can bear superficial resemblance to mush fragments or synneusis clusters, but EBSD reveals diagnostic textural distinctions.

We discuss the petrogenetic implications of the different glomerocryst formation mechanisms identified in the Cascades. We also outline a methodological approach for categorizing glomerocryst origins, applicable to a wide variety of minerals and magmatic systems.

Investigating the source mechanics of fluid-driven volcanic earthquakes

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Seismic data are a respected proxy for understanding volcanic unrest, forecasting volcanic eruptions, and monitoring edifice stability. Here, we report new data, linking 3D microstructural features of the damage zones in volcanic rocks to a range of seismic characteristics, focusing on two types of seismic response; Volcano-Tectonic (VT) events, driven primarily by brittle fracture, and; Long-Period (LP) events, associated with rapid fluid flow [1 - 5].

Controlled triaxial deformation experiments were performed across various pressure conditions on core samples of Etna Basalt (EB), to generate seismic signals, known as Acoustic Emissions (AE). Samples comprising a central pre-drilled conduit were subjected to brittle failure via triaxial deformation. After failure, pressurised pore fluids were rapidly decompressed through the sample to generate LP events. X-Ray Computed Tomography (XCT) scans were then performed to reveal the 3D fracture damage zone within each sample. When combined with the source locations of the AE data, this reveals the interaction between the fracture damage zone and the evolution of the AE signals. Early results show LP signals are constrained to areas of high shear damage, particularly at the intersection of the conduit and fracture plane.

Additionally, AE & XCT data will be used jointly to create a future attenuation model, to better interpret crack resonance in volcanoes, and possibly, volcanic caldera systems [3]. This will include comparisons between XCT and seismic source modelling output(s), providing further insight into laboratory-scale AE signals, and how to scale these data to help better understand the physics of macro-scale volcanic earthquakes [1 - 4].

Ultimately, we hope to compare real, laboratory fracture patterns of volcanic material and AE response to the field seismic sequences observed on active volcanoes. Thus, an opportunity to infer deep structure, such as volcanic plumbing systems and deep fluid-rock processes, will be made possible via computational modelling.

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Resolving the Final Phase of the 2025 Santorini-Amorgos Seismic Swarm Using a Local Ocean Bottom Seismometer Array

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The Christiana-Santorini-Kolumbo volcanic field is the most volcanically active segment of the Aegean Arc, encompassing both the large, caldera system of Santorini, and the smaller, highly active submarine volcano Kolumbo to the northeast. In early 2025, the region experienced a strong seismic swarm, with activity initially located beneath the Santorini caldera before migrating northeastward towards the Anhydros region, between the islands of Santorini and Amorgos.

As part of the HYDROMOX project, the RRS Discovery conducted a multidisciplinary research cruise in March 2025, acquiring passive seismic data alongside heat flow measurements, hydrothermal fluid and gas samples and ROV imagery across Santorini, Kolumbo, and the Amorgos basin. Here, we present results from a local network of 12 broadband ocean bottom seismometers (OBS), deployed for approximately three weeks within the Santorini-Amorgos area during the waning phase of the seismic swarm. Despite the swarm having peaked prior to deployment, the OBS array recorded over 140,000 seismic events across 23 days. This exceptional dataset enables high-resolution analysis of microseismicity that would be undetectable using land-based networks alone. We map the spatiotemporal evolution of the swarm's tail end, revealing detailed patterns of stress release across the region following the main phase of seismic crisis. Integrating these results with regional structural information and high-resolution seismic velocity models allows us to further investigate the deduced dike intrusion [1, 2] and the reactivation of complex fault networks. Our findings provide new insights into the post-peak dynamics of this complex volcano-tectonic seismic swarm in a densely populated and seismically active region of the Aegean.

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Newly discovered pumice fall deposits on Tenerife, Canary Islands, reveal continuous felsic activity ~0.54 – 0.175 Ma

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Las Cañadas Caldera (LCC), Tenerife, is an active volcanic system that has produced multiple large-scale explosive Plinian and caldera-forming eruptions between 1.66 – 0.175 Ma [1,2]. These eruptions are interpreted to be grouped into three cycles and interrupted by hiatuses in LCC activity of ~0.2 Myr. The deposits of major explosive eruptions from LCC are well documented, yet the deposits of many smaller volume explosive eruptions between are undescribed. This, coupled with offshore marine core observations of continuous explosive activity of LCC during hiatuses [3], means our current knowledge into the magnitude, frequency, and hazards of explosive volcanic activity at LCC are incomplete.

Here, we more than double the number of known (characterised) explosive eruptions sourced during the third eruptive cycle (Diego Hernández Formation (DHF)) from 20 to >50, and extend the beginning of the DHF from 0.37 Ma to ~0.54 Ma. We document >30 previously undescribed deposits; of these, 22 are in the caldera (18 pumice falls and 4 ignimbrites), erupted between ~0.54 – 0.319 Ma [4, 5] and >10 medial deposits on the caldera flanks erupted towards the end of the DHF (<0.268 Ma) [5]. Only two DHF deposits older than 0.319 Ma have been recognized in literature [1,5], so these proximal deposits provide direct evidence for continuous felsic explosive activity during the hypothesised ~0.2 Myr hiatus between the 2nd and 3rd cycles. Paucity in dating of DHF deposits, variable erosion and pedogenesis on the island, and homogenous characteristics of deposits, leave uncertainties in correlating deposits younger than 0.268 Ma.

Nevertheless, field fingerprinting techniques coupled with granulometry and componentry, allow interpretation of eruptive styles and evolution of LCC over ~0.35 Myr, providing a more robust terrestrial tephro-stratigraphic record and improve future eruption forecasting estimates. This study suggests continuous activity between proposed eruption cycles, and that current stratigraphic models need updating.

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Understanding the Risk Posed by Tephra Rafts to Shipping and Marine Infrastructure

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The Blue Economy encompasses all ocean-based industries including passenger transport vessels [1]. Aqueous passenger transport is an important local service in remote areas, and an increasingly lucrative market projected to constitute 33% of global water transport networks by 2034. Recent work has established the vulnerability and exposure of the Blue Economy to various volcanic hazards including pumice rafts [2]. Despite this, neither volcanic nor nautical literature have assessed the physical vulnerabilities of ships and marine infrastructure to volcanic hazards. Pumice rarely endangers human life directly but can cause widespread disruption and damage to ships, buoys, and ports through abrasion; and can degrade to ash, which can clog the saltwater intakes of vessels [3]. This study uses a combination of wave tank and dry abrasion experiments to begin to explore the controls of abrasion rate and efficiency for various marine engineering materials under different raft conditions.

Numerous important shipping and passenger vessel routes pass near volcanic arcs. Therefore, we aim to combine the outputs of the experimental investigation with a GIS map of shipping traffic and volcanic activity records. This will allow us to model and explore the potential risks posed by pumice rafts to passenger vessels in our case study area, the Hellenic Volcanic Arc. This is an active volcanic system with the potential for a pumice raft-forming eruption [4] and noticeably high passenger vessel traffic involving a wide range of ship types and sizes.

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Sheeted Dyke Emplacement of Magmatic Layering

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The Rum Central Intrusion (CI) represents the deformed centre of the mafic ~60Ma Rum Layered Intrusion (RLI), NW Scotland. The CI was deformed as a result of syn-magmatic fault activity[1,2], resulting in a complex mix of steeply dipping mafic and ultramafic rocks displaying features such as brecciation and folding[1,3]. Alongside this evidence of deformation are spectacular examples of "rhythmic" layering, defined by alternating layers of plagioclase-rich troctolite and olivine-rich melatroctolite. This layering is thought to represent periodic replenishment and gravity-driven accumulation on the chamber floor, with reports of fluid dynamic "loading" structures highlighting the unconsolidated nature of the chamber floor during replenishment[3]. However, with a growing body of evidence that the RLI does not represent a classic "magma chamber"[4], areas of the intrusion where interpretation remains rooted in processes dependent on a long-lived large body of essentially crystal-free magma warrant re-investigation.

Using high-resolution outcrop mapping, coupled with structural analysis and petrography, it is argued that the "rhythmic" layering represent sheeted melatroctolite dykes emplaced into a rigid troctolite.

A key observation is that no way-up criteria were found in CI rocks, previously used to assume original horizontality of steeply dipping rocks[1,3]. As such, layering is presumed to have been originally vertical or sub-vertical, precluding gravity-driven mechanisms of accumulation. The melatroctolite layers are highly variable along strike, with irregular boundaries with adjacent troctolite, lateral discontinuities, bifurcation, and chilled margins, consistent with an origin as vertical tabular intrusions. High-resolution outcrop mapping of melatroctolite layers also reveals a complex 3D structure, further supporting an intrusive origin. Fluid dynamic "loading" structures show a tightly-oriented NW-SE trend alongside all other features (e.g. layering and faults), not possible for an unconsolidated material. Instead, these structures are interpreted as intrusive contacts between magma and rigid host, representing various stages of magmatic coalescence within a dynamic environment.

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Faults modulate magma propagation and triggered seismicity: the 2022 São Jorge (Azores) volcanic unrest

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Understanding the signatures and mechanisms of failed volcanic eruptions is vital for mapping magma plumbing systems and forecasting volcanic events. Geological structures, such as faults and fractures, play a crucial role in guiding magma, but their mechanisms remain unclear due to the lack of 3-D mapping of faults in volcanic regions and sufficiently precise earthquake locations. The triple-junction setting of the Azores Archipelago, where volcanic systems and seismogenic crustal faults coexist, provides a unique insight into the interaction between faults and magma. Using ~18,000 earthquakes relocated to ultra-high precision with onshore and ocean-bottom seismometer data, along with geodetic observations and seismic autocorrelation imaging, we analyse a failed eruption in 2022 on São Jorge Island. A magmatic dike, likely originating in the upper mantle, ascended rapidly, largely aseismically, and without apparent precursory surface deformation, into a crustal fault, before stalling beneath the island edifice, 1,600 m below the surface. Adjacent seismicity suggests that the ascending magma stalled, probably due to minor melt branching and fluids escaping laterally along the fault zone, triggering an intense, months-long seismic swarm, comprising rotated focal mechanisms. Our study reveals the dual role of fault zones in both facilitating and arresting magma ascent, highlighting the interplay between tectonism and magmatism.

Revealing Previously Undetected Submarine Eruptions Using Satellite Data

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Around three-quarters of the volcanoes on Earth are submarine yet they are relatively understudied in comparison with those on land [1]. Eruptions are often only detected due to passing ships or aeroplanes hence it is likely that many erupt unnoticed and undetected. For monitoring subaerial volcanoes, systematic remote sensing is done using a range of techniques: ground deformation, SO2 output, ground temperature etc. There are no comparable approaches currently available for submarine volcanism. However, there can be observable effects on the ocean surface of underwater volcanic eruptions: the production of pumice rafts, eruptive plumes, and the discolouration of seawater [2,3,4]. These can all be observed with sufficiently high-resolution satellite imagery. The advent of higher-resolution free access global satellite imagery datasets, for example Sentinel-2, brings new opportunities to light for the improvement of our understanding and monitoring of underwater volcanism.

Here we present our machine learning algorithm for the automatic detection and monitoring of submarine volcanic events. Supervised Machine Learning is trained on labelled Sentinel-2 and MODIS imagery and combined with other data sources, including a seamount database and remote sensing indices designed for the detection of suspended sediment in ocean settings and chlorophyll blooms [5]. Applying our methods to 3 submarine volcanoes, we detect a previously undetected eruption at Volcano F (Tofua-Kermadec arc) and produce a complete eruptive history of the frequently erupting volcanoes Home Reef (Tofua-Kermadec arc) and Kavachi (Solomon Volcanic Province), over the years since the launch of Sentinel-2.

This study demonstrates a novel combination of machine learning and satellite analysis in the detection of submarine eruptions, leading to the detection of previously undetected submarine volcanic events. The next steps for this project include applying it to areas of the ocean on a larger scale.

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Magmatic sulfate-melt exsolution as a mechanism for excess sulfur in porphyry systems

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Sulfur released by magmatic activity strongly impacts climate and is essential for ore mineralization. Many porphyry systems contain up to billions of tons of sulfur, far exceeding the sulfur capacity of silicate melt and therefore requiring an additional, efficient S-transfer mechanism [1].

We present a unique mafic rock (SiO_2 = 53–59 wt.%, MgO = 5.3–7.3 wt.%) containing ~15–20 vol.% anhydrite, ~30–40 vol.% biotite and ~40–50 vol.% plagioclase from the largest porphyry–epithermal system in China. Magmatic anhydrite, indicated by textural relations and LREE-rich compositions, yields bulk-rock S contents of ~2–3 wt.%, far above experimental S solubilities.

Plagioclase shows sharp core–rim decreases from An_{50}–$_{70}$ to An_{25}–$_{45}$, recording strong CaO depletion caused by sulfate saturation. Extensive sulfate saturation also suppressed amphibole/orthopyroxene and removed a large proportion of LREEs from the melt, producing flat REE patterns in co-crystallized apatite. Biotite exhibits pronounced Ba depletion from core to rim. Because Ba partitions strongly into sulfate melt, not into anhydrite [2,3], this Ba zoning is best explained by the formation of a sulfate melt, rather than by crystallization of anhydrite from a silicate melt.

Nd isotopic compositions (εNd(t) ≈ -1.0) indicate that the magma was derived from partial melting of the mantle wedge. We suggest that ascent of this oxidized, sulfur-rich mafic magma led to decompression-driven oxidation of S^{2-} to S^{6+}, sulfate saturation [4], and exsolution of an immiscible sulfate melt. This discrete sulfate-melt migrated upward and provided an efficient pathway for long-distance transfer of large amounts of sulfur to porphyry systems. This sulfate-melt exsolution process is a previously unrecognized mechanism that relaxes the constraint imposed by the sulfur capacity of silicate melt, and LREE-depleted apatite associated with abundant magmatic sulfate phases may serve as an indicator of sulfate-melt exsolution and a proxy for porphyry mineralization potential in the upper crust.

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High-resolution textural and geochemical variability across the submarine basins of the Santorini and Kolombo calderas

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Hydromox expedition DY190 in March 2025 returned a series of sediment gravity cores and ROV-sited surficial sediment cores from hydrothermally-influenced environments within Santorini and Kolombo calderas. An immediate result was recognition of complex and variable facies distributions across both caldera floors likely strongly influenced by the underlying geology. These sediments show both gross-scale and fine-scale, high-resolution change overprinted on complex sediment accumulation within these intra-caldera locations, including: alteration fabrics and post-depositional element remobilisation. High-resolution X-ray and CT scanning of these sediment cores has been crucial in showing the presence of fine-scale laminations, gas and fluid saturation, and mineral precipitation that may be unnoticed during visual inspection. High-resolution (sub mm-scale) geochemical core scanning has also been important to best demonstrate complex vertical changes in sediment composition.

Here, we present initial results of high-resolution (100-200 micron-scale) Xray and CT imaging and XRF geochemical core. Within the northern caldera basin of Santorini, the basin floor away from significant hydrothermal input has sediment facies more massive and contain features indicative of gas saturation. However, towards the NW vent field the cores demonstrate a metre-thick sequence of finely (mm-scale) laminated sediments of varying density and composition with physical evidence of gas saturation. Along the northern region of the southern caldera basin floor of Santorini, the uppermost sediments are massive and show evidence of gas saturation. In contrast, sediment cores from the western region of the southern caldera basin vent sites show a half metre-thick sequence of highly laminated (mm-scale) metal-bearing sediments. At Kolombo, cores from the northern caldera floor showed evidence of gas saturation but within a massive textureless sediments. In the southern caldera region, sediments are also dominated by gas saturation, but towards the SE wall also show evidence of mineral precipitation and potential mass-wasting deposits.

Along-rift variations in magma system geometry observed using Sentinel-1 InSAR data from the East African Rift System

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The Eastern Branch of the East African Rift System (EARS) is characterised by a wide variety of volcanism, rift tectonics, and volcanic deformation. In the south, mature continental rifts, the Kenyan Rift (KR) and Main Ethiopian Rift (MER), are characterised by low spreading rates (2-5 mm/yr), thick crust (25-40 km), and large, central silicic caldera systems. Further north, incipient seafloor spreading occurs in the Dabbahu-Manda-Hararo rift (DMH) and Erta Ale Volcanic Range (EAVR), characterised by higher spreading rates (10-17 mm/yr), thinner crust (15-25 km), and predominantly mafic volcanism. The implications of these variations in rifting on volcano deformation signals are important for understanding magmatic systems along the rift, and for the first time, routinely acquired and Sentinel-1 InSAR data presents the opportunity assess them.

Here we systematically model InSAR deformation patterns from 16 deforming volcanoes in the EARS between 2015-2020. For each signal, we test models for up to 9 possible source geometries, assessing model preference using Bayesian Information Criterion (BIC). The modelled deformation sources show a systematic change in melt geometry from dominantly to vertical in the EAVR and DMH. The extent and magnitude of deformation signals in the KR and MER are also generally larger than in the EAVR during this period.

Overall, the trends in deformation can be linked to along-rift differences in magmatic systems seen in geochemical and geophysical surveys, related to changes in crustal thickness, strength, and melt generation mechanisms, influencing melt residence times and subsequent fractionation. Particularly, our study implies that along-rift differences ground deformation patterns support suggestions of crustal thickness and melt supply having a significant influence on magmatic system architecture throughout the EARS.

An initial dating of eruptive activity at Agua volcano, Guatemala.

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Volcán de Agua is an almost unstudied volcano in Guatemala located between active Pacaya and Fuego volcanoes. Situated near to the population centres of Antigua, Ciudad Vieja, Amatitlan, and Palin, approximately 550,000 people live within 20 km of the volcano. There is negligible published work on either its bulk chemistry or eruptive behaviours, and with no known historical eruptions there are no previous constraints on when it was last active or what style of activity the volcano exhibited. Nearby volcanoes (Fuego, Pacaya and Atitlán) along the Guatemalan cordillera are known to erupt in a Strombolian to Plinian style which profoundly affect the local communities. We present work based on samples taken from surface-exposed deposits, demonstrating at least one phase of basaltic activity producing pyroclastic density current (PDC) deposits. These display poorly sorted granulometry, with very angular and sub-rounded clasts that lack vesicles. Charcoal identified within the deposit was subjected to reflectance studies which indicate that the flow was deposited at 300°C, and provided a radiometric dating age for this charcoal of 15,454±41 BP. The deposit shows evidence of an overbank flow, having escaped an established drainage channel where it encounters a bend. This study represents the first published date of eruptive activity at Agua. Given the location of the deposit and lack of capping deposits, we suggest that Agua may have been inactive throughout the Holocene.

We're going to need a bigger sieve

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The deposits from dome collapse pyroclastic density currents (PDCs), often referred to as block-and-ash flows, frequently contain large (>1 m) blocks of dome material and other entrained lithic clasts. However, much of the literature only addresses grain sizes within the normal sieve-sampling ranges (<64 mm). This work illustrates the usefulness of image analysis combined with traditional techniques (e.g. sieving, optical granulometry) to define full particle size distributions and assess the importance of this wider characterisation for understanding the flow and deposition conditions.

Volcán de Colima is a stratovolcano in the western portion of the trans-Mexican volcanic belt which undergoes periods of dome growth and destruction. The lava dome collapse on the 10th July 2015 and predominantly explosive eruption on the 11th July produced two PDCs which deposited along the Montegrande and San Antonio barrancas. With runout distances of 10.5 km and 6.5 km respectively; and an estimated total volume of 7.7 x 10^6 m^3.

We sampled and took photographs of exposures at ~1 km intervals along the Montegrande ravine. By combining traditional techniques with image analysis, we present particle size distributions, which allow us to characterise the blocks within the deposit, and the evolution of these distributions with distance. These show that the presence of blocks is related to the deposition of lobes and that the blocks are pervasive within the deposits; accounting for the full size distribution of blocks impacts our description of mean grain size (including Sauter mean diameter) and sorting of the deposits.

By combining this with paleomagnetic analysis of the blocks we can infer the source of the blocks and their transport history based on phases of cooling and emplacement temperature. This integrated approach provides new insights into the role of blocks in PDC transport and deposition, with direct implications for hazard assessment and modelling.

Communicating Volcanic Risk in the Canary Islands: Building Trust, Clarity, and Preparedness

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Science communication is the study and implementation of the most effective ways to communicate complex information to the general public. This field has emerged from the need to mitigate the systemic inaccessibility of academia and journal articles and to democratise science. The VolcanoStories project was conceived after the Tajogaite 2021 eruption revealed a lack of effective communication channels. This was compounded by media crisis-sensationalism and information overload, as explored in Melo et al. [1]

VolcanoStories utilises a participatory, decentralised, accessible model of science communication, inviting the public into the sphere of research. The value of this platform is to provide resources designed using a literature review of effective science communication and citizen science; combining fieldwork with creative storytelling, utilising the 'bloggability' of the science content, as discussed by Cox et al. [2]. Non-traditional innovative outputs are published and shared on social media for discussion; VolcanoStories' interactive 'historical eruption map' has received over 2,600 views.

Drawing on science dialogue literature such as Lorke et al. [3], we emphasise the limitations of the 'deficit model', whereby academics dictate what science is important to the community. By utilising GeoTenerife's 48,000 followers across Instagram, X, BlueSky, and TikTok through polls and questions aimed at resident engagement and an online forum space, VolcanoStories can prioritise their scientific curiosity and concerns, thus improving the reception of science. VolcanoStories' scientific campaign to display the geological importance of El Puertito, South Tenerife, was informed by resident sentiments. This area has since been designated a geosite with high protection priority.

The publishing of scientific information must expand to remediate the varying degrees of access to scientific knowledge. VolcanoStories explores a new method for open-access science communication, blending fieldwork and desk-based research with accessible storytelling. The free, multimedia resources and design principles demonstrate a method of democratising science.

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The vexing variable vesicles of low viscosity explosive volcanism: what makes mafic magma explode?

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Highly explosive mafic volcanism, while rare, poses a significant hazard to nearby communities due its unpredictable behaviour and often limited precursory signals. Despite several studies focussing on individual or a few mafic eruptive events [e.g. 1-3], there is no generalised model to explain why these systems erupt explosively. While it is best practice to consider unique settings and conditions for each volcano, a generalised model would aid in understanding and monitoring lesser studied volcanoes. A key factor in explosivity is if volatiles remain coupled with the magma during ascent, which is strongly influenced by magma viscosity, ascent rate, and crystal content (microlites and phenocrysts) [4]. The low viscosity of mafic magma leads to highly tortuous bubble networks that can only be accurately measured in 3D. Here we present preliminary results of a multi scale resolution (1.2 - 20 µm) X-ray Computed Tomography (XCT) dataset from 11 mafic eruptions varying levels of intensity (VEI 2 to 6) from different volcanic settings. Initial observation of 2D slices shows a striking variation in bubble texture and crystal content, between eruptions and within a single eruptive unit. While some samples have highly tortuous and closed bubble network, others have large, rounded bubbles. A defining factor in the bubble texture is likely the abundance of crystals, where the crystal rich samples have a more complex bubble network. This relationship and the variance across samples further emphasises the need for 3D data to properly assess and compare the vesicle-crystal textures. Preliminary assessment of porosity shows a wide variability ranging from 30 – 70% and showing a slight trend with increasing VEI. High vesicle connectivity across all samples (0.68 – 0.99) is consistent with reported values for explosive mafic magmas [5] and supports efficient degassing pathways for both low and high intensity mafic explosions.

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A Detailed Tephrostratigraphic Record from Monte di Procida, Campi Flegrei caldera (southern Italy): Insights into eruption activity between the recent caldera-forming eruptions

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Campi Flegrei (CF) caldera is one of the most hazardous volcanic systems in Europe, with over 1.2 million people in Naples living within 10 km of the active volcano and the neighbouring volcanoes of Ischia, Procida and Somma-Vesuvius[1]. Constraining the eruptive history of CF is critical for understanding future volcanic hazards.

Over the past 40 kyr, three caldera-forming eruptions have occurred at CF: the Campanian Ignimbrite (CI; 40 ka[2]), the Masseria del Monte Tuff (MdMT; 29 ka[3]) and the Neapolitan Yellow Tuff (NYT; 14 ka[4]). Whilst these major events are well characterised, smaller eruptions between them remain poorly constrained in magnitude and time despite representing key phases in the magmatic evolution of CF. Few proximal sections preserve a detailed record of eruption deposits from the interval between the CI and NYT.

We present new detailed field and glass geochemical data from Monte di Procida, southwest of Campi Flegrei, which records 21 tephra units, including the CI and NYT. This represents the most complete CI–NYT sequence identified to date.

Two main CF compositional subgroups are recognised: (i) a dominant NYT-like trachytic melt (~60 wt.% SiO_2) with limited variability, and (ii) a more evolved subgroup (~64 wt.% SiO_2). The section also contains distinct Solchiaro (~23 ka[5]) tephras from Procida, separated by an Ischia-derived ash, evidencing contemporaneous activity during this interval across the Campanian Volcanic Zone. These data reveal that at least 15 of the eruption deposits are from CF, indicating a higher pre-NYT eruptive tempo than previously recognised.

The Monte di Procida record reveals greater activity with 12 eruptions in the 9 kyr preceding the NYT eruption, suggesting frequent activity in the build-up to the NYT caldera-forming eruption. Inter-eruption glass compositions show similar chemical signatures with limited variability, complicating the use of tephras from this record in wider regional correlations.

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When magma flow in dykes gets complicated: Insights from analogue magma intrusions

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It is widely recognized that the physical properties of magma strongly impacts whether or not it reaches the surface and for how long it will erupt. However, how these are controlled by the ascent dynamics of dyking is relatively understudied. Magma flow in dykes is often assumed to be simple and unidirectional, however geological evidence of magma flow recorded in fossil dykes often suggests complex multidirectional flow patterns have occurred. Existing dyke models are insufficient to explain their emplacement and need to account for magma flow which varies across the dyke breadth and thickness over time as the dyke ascends through the crust.

We conducted dynamically scaled analogue dyke experiments using a laser-based stereoscopic imaging system to measure three-dimensional (3D) flow dynamics inside flux-driven fractures for the first time. An elastic, transparent host medium (gelatine) was intruded by either a simple Newtonian fluid (a glycerol solution or salt water) or more complex shear-thinning fluid (a xanthan gum-salt water solution) to represent magma with variable proportions of melt, crystals and bubbles. Our results show that the Newtonian magma model exhibits complex and strong 3D effects, whereas the shear-thinning magma model produces simple, 2D unidirectional flow. This challenges major assumptions of most numerical and conceptual models of magma ascent, impacting the dynamics of magma connections between deep crustal reservoirs and the dynamics of shallow feeder dykes.

Magmatic timescales from an explosive shallow submarine silicic eruption of the Kameni Volcano (Greece)

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The polycyclic Santorini caldera (Greece) has entered a new caldera cycle following the large-magnitude Late Bronze Age (Minoan) eruption [1]. In this new caldera cycle, low-magnitude effusive and mildly explosive eruptions have built up the Kameni islands inside the flooded Minoan caldera. However, a thick eruption deposit up to 34 m was recovered during the International Ocean Discovery Program (IODP) Expedition 398 to the South Aegean Volcanic Arc [2] at various sites inside the Santorini caldera (U1594-U1597) and has been interpreted to correspond to an explosive (VEI 5) eruption in 726 CE [3]. Such explosive eruptions are uncommon in early stages of caldera cycles where the plumbing system is recharging. The indication that Santorini can produce explosive eruptions early in a new caldera cycle elevates the hazard potential for Santorini and neighbouring islands in the eastern Mediterranean.

This study presents a petrological and geochemical investigation of juvenile dacitic pumice from the 726 CE eruption deposit at Site U1595, encompassing the full thickness of the deposit. We also report the results of diffusion chronometry on the primary crystal phases, including Fe-Mg diffusion in orthopyroxene and clinopyroxene, and Mg diffusion in plagioclase. Crystal chemistry reveals the presence of mafic, intermediate, and silicic crystal assemblages derived from compositionally distinct magmatic sources beneath the volcano, with evidence of crystal exchange between these reservoirs indicated by compositional zoning. Modelling both reverse- and normally- zoned core-rim profiles using diffusion chronology, we constrain mafic and silicic magma recharge timescales, revealing the complex recharge dynamics of the plumbing system associated with the 726 CE eruption.

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Modelling crystal settling and crystal-driven convection from crustal to planetary scales

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Magma bodies play a critical role in Earth's geological evolution across a wide range of scales from local-scale volcanic activity to crustal-scale petrogenesis, and planetary-scale magma ocean solidification. The internal flow dynamics of melt-dominated magma bodies are dominated by crystal-driven convection where flow is driven by the significant density contrast between crystalline solid phases and their carrier melt. The same density difference can also cause crystals to settle and sediment into cumulate layers with important implications for the compositional and structural evolution of magma bodies and resulting igneous rocks.

As magma bodies range in size from metre-scale crustal chambers to thousand kilometre-scale planetary magma oceans, the convection dynamics cover a wide range of flow regimes. Here we present the mathematical derivation and two-dimensional numerical implementation of a model for simulating crystal settling and crystal-driven convection with a focus on two characteristic length-scales: the crystal size governing crystal settling relative to the magma, and the layer depth governing the convective vigour of the magma as a particulate suspension.

We adapt standard approaches from particle sedimentation and turbulent flow theories to produce a model framework which treats the magmatic suspension as a continuum mixture fluid applicable across the entire range of relevant crystal sizes and layer depths. As mixture continuum models resolve dynamics at the system scale, some critical aspects of local scale dynamics remain unresolved. Here, we focus on two: the fluctuating motion of particles during sedimentation, and the development of eddies cascading down to small scales in highly turbulent convection. Our continuum model represents both processes by an effective diffusivity, i.e., the settling and eddy diffusivities, which enhance mixing. Two random noise flux fields are then added proportional to these diffusivities to reintroduce some stochasticity which is lost by not resolving the underlying fluctuating processes and instead only representing their smooth mixing effect at the system scale. Whereas this type of treatment based on statistical mechanics has found wide adoption in general fluid mechanics, it has not received much attention in geodynamic modelling.

We find that crystal size matters most in 1–10 m crustal magma bodies where the crystal settling speed comes to within one to two orders of magnitude of the convective speed and the settling diffusivity is dominant. For moderately sized (>10–100 m) crustal magma bodies up to planetary-sized magma oceans turbulent convection dominates where the flow behaviour converges towards that of a single fluid with crystallinity behaving similarly to a buoyancy-carrying scalar field like temperature or chemical concentration with eddy diffusivity dominating over settling diffusivity. Whereas our model does not consider thermo-chemical evolution and phase change we expect similar behaviours to pertain to fully coupled thermos-chemical-mechanic magma flow problems.

Rapid Uplift at Pliocene Caldera Pastos Grandes, Bolivia

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Modern-day volcanic deformation in the Central Andes is globally anomalous, characterised by spatially extensive displacements, deformation sources which remain stationary over decades, no geomorphological evidence of net uplift, and little correlation between deformation and Holocene volcanic activity [1]. It has been proposed that uplift is caused by the ascent and then temporary accumulation of magmatic volatiles from the midcrustal Altiplano-Puna and Southern Puna Magmatic Bodies; when gas is released, the ground subsides back to its initial position [1]. Here, we test this idea against satellite radar observations of deformation in the Atacama. A ~50 km region within the Pastos Grandes Caldera, Bolivia, has been uplifting since July 2023 with a linear rate of 70 mm/yr. This is the fastest measured volcanic deformation that has been observed to date in the Central Andes. Preliminary analytical elastic half-space modelling suggests the pressurisation at Pastos Grandes is caused by a 1e8 m^3 volume increase at about 13km below the surface. Pastos Grandes is a Pliocene caldera that last erupted 2.89 Ma, producing the 1500 km^3 DRE Pastos Grandes Ignimbrite [2]. There is still an active hydrothermal system with thermal springs surfacing in Laguna Pastos Grandes [3]. In our next steps, we will compare interferometric synthetic aperture radar displacement timeseries from Sentinel-1 with timeseries of median thermal anomalies [4] to assess links between geodetic sources and fresh input into hydrothermal systems.

We also discuss new observations of small-scale (<6 km) uplift at the Bolivian volcanoes of Cerros de Tocorpuri, Parinacota and Jatun Mundo Quri Warani, observations of a second uplift period at Cerro Overo, and provide updated timeseries for Cerro El Cóndor, Socompa and Lazufre. Uplift in the Central Andes has historically been episodic, with some events lasting a few years (e.g., Socompa and Sillajhuay) and some continuing for decades (e.g., Uturuncu and Lazufre) [1].

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Investigating the erosive nature of the 2021 La Soufrière, St Vincent, effusive-to-explosive eruption transition

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The 2020–21 VEI 4 eruption of La Soufrière stratovolcano, St Vincent, was characterised by an effusive-to-explosive transition, with a highly erosive explosive phase that excavated into parts of the 2020 and 1979 domes [2]. The eruption began with three months of crater-constrained effusive activity and dome-building, followed by Vulcanian to Sub-Plinian explosive events [1], creating pyroclastic density currents and ash fallout, accompanied by lahars [2]. The shift in explosivity is proposed to be driven by inefficient outgassing during ascent [4], or a pulse of more gas-rich material [1]. The nature of the initial explosions as overlying features were removed was rather different [3].

This project aims to 1) understand and characterise the processes that made the eruption so erosive and 2) refine our understanding of the explosive phase trigger, through petrological and textural analyses. Scoria microlites record ascent processes, and a detailed analysis of their textures and compositions will provide valuable clues to the system's overall evolution.

Although highly fragmented, the first unit (U1) deposited was well preserved. Samples collected from the lowermost part of U1 [1] will be used as a starting point. The first step is to map them by BSE imaging and element mapping with SEM to characterise the clasts and create a robust typology of sample types. We will then refine previous Crystal Size Distribution (CSD) analysis that only sampled a couple 'representative clasts' [1] using these typologies to understand different ascent trajectories represented in the clasts. We can understand geothermobarometric conditions for the most recent crystal growth and the differing crystal types by analysing <30-micron microlites. Vesicle Size Distribution (VSD) will contribute to investigating degassing and fragmentation processes.

Such detailed petrological study is valuable for evaluating future rapid effusive-to-explosive transitions at La Soufrière and at island-arc volcanoes more generally.

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Petrogenesis of carbonatites of Vallone Toppo di Lupo deposit, Monte Vulture, Italy

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Using Vallone Toppo di Lupo and Monticchio Lakes deposit as case studies, a source to surface model of Italian carbonatites was established. Monticchio Lakes is used to understand source regions and is well-studied [1,2], while Vallone Toppo di Lupo is the less well-known case study [3,4] that is used as a proxy for magma evolution. The mantle source of the carbonatite magma is a carbonated and sodium-rich metasomatized mantle. Abundant crustal xenoliths, no mantle xenoliths and mineral chemistry rich in incompatible elements show that Vallone Toppo di Lupo carbonatite magma has ponded in the crust and experienced fractional crystallization. Concentric lapilli texture and low consolidation suggest that a violent dry eruption occurred by carbon dioxide exsolution. Exsolution of magmatic fluids caused widespread autometasomatism, redistributing barium from phlogopite in the rock. Meanwhile, presence of mantle xenoliths and mineral chemistry relatively rich in magnesium show that Monticchio Lakes is more primitive with no ponding occurred, with evidence compatible with direct ascent from mantle. These suggest that Italian carbonatites have varied petrogenesis pathways especially on degrees of magma ponding.

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Grainsize controls on non-magmatic phreatic explosions in pyroclastic deposits

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Pyroclastic density currents (PDCs) comprise a combination of hot volcanic rock and gas which can travel at hundreds of kilometres per hour, tens of kilometres from source, and are extremely destructive as a result. The high mobility of these currents is driven by a friction reduction due to the interstitial gas pressure. The deposits formed by these currents can be tens of metres thick, and immediately after deposition can still contain a significant amount of this hot gas. This study revolves around how the characteristics of these deposited beds are affected as this pore pressure is lost, and how the sedimentary structure of the bed can control that degassing process.

As newly deposited PDC material is loosely packed, it is generally quite permeable, allowing for the efficient escape of gas. However, as gas rises out of these deposits, the way that grains are organised and consolidated may be subject to change, altering the permeability of the beds. Combined with the natural grainsize variation, and the complex vertical stratigraphy that can result from source and transport changes during deposition, this results in non-linear permeability relationships through a deposit. We use experiments to explore the variation in permeability of a bed due to stratigraphic variation in mean grainsize and reveal that the overall bed permeability can be disproportionately impacted by the permeability of interface layers between the different grainsize layers. As a result, characterising the permeability of each individual layer does not necessarily capture the degassing behaviour of the bulk deposit. Deposits with course-fine interfaces are particularly prone to developing internal overpressures, and as a result are prone to experiencing phreatic explosions.

Fine particulate transport and exposure during Icelandic fissure eruptions: Insights from PM_1 monitoring and dispersion modelling

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Volcanic air pollutants, especially fine particulate matter (PM) and sulphur dioxide (SO_2), pose significant health risks. More than 29 million people live within 10 km of an active volcano [1] and over 800 million within 100 km[2], placing large populations at risk of exposure. As highlighted by Whitty et al. [3], the eruptions most likely to affect these communities are small but frequent: low intensity events producing <0.1–1 km^3 of material account for approximately 80% of global eruptions [4], underscoring the need to understand pollutant behaviour during such activity.

Fagradalsfjall, a small fissure system on the Reykjanes Peninsula, began erupting in 2021 within Iceland's most densely populated region, where roughly 70% of the population lives within 50 km of the vents. Using Iceland's national air quality network (27 stations nationally, 14 within 40 km), Whitty et al. [3] generated the first reference-grade PM_1 timeseries for an eruption and characterised the dispersion of SO_2, PM_1, $PM_{2.5}$ and PM_{10} across populated areas. They reported significant increases in both average and peak pollutant concentrations at distances greater than 300 km. Daily peak PM_1 rose from 5–6 µg/m^3 to 18–20 µg/m^3, and the PM_1/PM_{10} ratio increased from 14% to 21–24%. Fine-scale variability was also evident: in Reykjavík, two stations less than 1 km apart recorded hourly SO_2 peaks of 480 and 250 µg/m^3.

Building on this work, and in collaboration with the Environmental Agency of Iceland, this study will investigate the mechanisms controlling the transport, dispersion and ground-level exposure of volcanic PM_1 during eruptive episodes. Expanded PM_1 datasets will be integrated with dispersion modelling to examine how plume height, meteorological conditions and topographic features influence PM_1 movement and exposure. The project aims to advance understanding of volcanic aerosol dispersion and strengthen hazard forecasting and public health resilience during future eruptions.

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Reviewing the Presence of Back-Arc Volcanism in the Antarctic Peninsula through a Peralkaline High-Zr Suite

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The Antarctic Peninsula preserves the life cycle of a subduction zone from initiation to demise. Its demise was triggered 55Ma by the collision of the Antarctic-Phoenix spreading ridge with the subduction zone to the west of the Antarctic Peninsula, leading to the development of a slab window [1]. In order to fully understand this arc and the impact ridge-trench collision had on subduction-related volcanism, it is important to fully understand all areas of the subduction zone and how they interact and evolve spatially, temporally, and chemically.

Leat and Riley [2] identified a suite of volcanic rocks from Procyon Peaks in the southern part of the Peninsula which have unusually high Zr content. They proposed this suite was part of a peralkaline group of rocks, potentially formed within a back-arc setting. However, for Procyon Peaks to be a back-arc setting it necessitated explanation of why the main arc would be further west. This led to the suggestion that the arc had migrated to the west – trench-ward – as the spreading centre approached and subducted [2].

To test this idea and assess the geodynamic setting for emplacement of the high-Zr suite, we have conducted further geochemical work, particularly U-Pb dating and detailed trace and rare earth element (REE) analysis. The new U-Pb date to provide a new window into the potential presence of back-arc volcanism. The new age constraints provided by the U-Pb date brings into question whether this suite did indeed erupt post axis migration or whether it may have been a subsidiary event within the main arc volcanism. Furthermore, the REE and trace element data highlights some key differences with global examples of high-Zr peralkaline rocks, necessitating a review of the possible petrogenetic causes of this suite in Antarctica [3, 4].

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Geochemical and petrological trends within the 1888-1890 explosive eruption of Vulcano island, Italy.

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We analysed the geochemistry and petrology of the 1888-1890 eruption of Vulcano. Although previous studies [1] showed a crude zonation existed, this study aimed to test this using a series of samples collected from a complete sequence of the eruption from a pit dug on the crater rim. The analysis involved using both whole rock wavelength dispersive X-ray fluorescence (WD-XRF), glass energy dispersive spectrometry (EDS) point analysis and standard petrological data, to understand any chemical trends.

A total of 11 representative samples were analysed for whole rock WD-XRF analysis. These were also subsequently used for the petrographic analysis and glass geochemistry. Phenocryst and enclave abundances were quantified using six representative samples to help provide new insights into the controls of the geochemical trends.

The results differ from those of previous work [1] and showed that there was a straightforward zonation from more mafic Trachyandesite to silicic Trachydacite compositions until approximately 1.6m up the sequence. Mineralogy and geochemistry indicate this was dominated by fractional crystallisation processes. The whole rock geochemical trend then diversifies after 1.6m showing marked compositional changes. This change is notably coincident with a sharp increase in enclave (xenoliths) abundance, interrupting the straightforward zonation trend, which we interpret as possibly representing an injection of more mafic magma, during the eruption. Glass, mineralogical and whole rock data all support the presence of magma mingling and mixing. A hypothetical model of a shallow magmatic system with multiple bodies of varying composition which can interact with each other both before and during an eruption has been suggested, which have generated the overall geochemical trend.

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Disentangling Disaggregated Mushes and Conduit Crystallisation in Laki Lava Samples with Automated Quantitative Petrography

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The 1783 CE Laki fissure event in Iceland is the largest historically reported basaltic eruption on Earth. It is thought to be linked to notable environmental and societal impacts. The fact that similar events are likely to occur over the next few hundred years provides an impetus for further research of the sequence of magmatic events that precede such eruptions.

Previous studies have found that Laki samples contain crystals that grew in different magmatic environments: at low pressure in the shallow conduit and lava flow and in deeper storage zones where mushes formed [1,2]. Recent developments in automated quantitative petrography that apply AI techniques to optical and electron microscopy datasets provide an opportunity to investigate the crystal record of Laki's pre-eruptive history.

The MinDet algorithm [3] was applied to circular polarised light images of 50 thin sections of lava and tephra and 178,028 plagioclase crystals were identified using instance segmentation. These were used to estimates crystal size distributions, aspect ratios and modal abundances for plagioclase. Four samples were processed using GPyEDS software [4] to obtain modal proportions of different crystal populations.

In common with Passmore [2], we find that Laki contains disaggregated mush, but our new modal proportion estimates indicate that this mush contained a liquid that is indistinguishable from the carrier liquid. We also find evidence for a population of plagioclase crystals that we define as "mesocrysts" whose characteristics correlate with the effusion rates at their time of eruption. These mesocrysts may be used to test and refine models of crystal growth during magma decompression in conduits.

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Mapping global food and nutrition impacts from volcanic eruptions

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Large-magnitude volcanic eruptions pose significant threats to global food security, yet the resilience of modern food systems to volcanic-related climatic shocks and cascading hazards remains poorly quantified. While direct fatalities from eruptions may number in the thousands, the entire global population faces impacts from atmospheric emissions-induced climate change and subsequent socio-economic cascades. Even against the backdrop of anthropogenic warming, volcanic climate shocks could simultaneously suppress agricultural productivity across multiple regions, with impacts transmitted and potentially magnified through the interconnected global food system. Eruptions may further disrupt international trade and logistics supply chains, with outcomes potentially exacerbated by public, institutional, and governmental responses.

To address this critical knowledge gap, we conducted a two-day participatory systems mapping (PSM) workshop bringing together interdisciplinary experts to collaboratively develop a causal map of interactions between volcanic hazards and food systems. Through structured interactive discussions, participants constructed a systems map identifying key nodes, feedback loops, and cascading pathways linking volcanic events to nutrition outcomes. The resulting map was subsequently stress-tested using multiple volcanic eruption scenarios to examine system behaviour under various perturbations. This work represents the first systematic exploration of modern food system resilience to future volcanic hazards and provides a foundation for quantitative modelling of these complex interactions. Our findings reveal critical vulnerabilities in the global food system and highlight priority areas for building resilience to low-probability, high-consequence volcanic events.

Modelling magma exchange between Aira Caldera and Sakurajima Volcano, Japan.

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Sakurajima is Japan's most active volcano, posing significant hazards to the densely populated area of Kagoshima Bay. The volcano sits at the rim of Aira caldera, located within the Kagoshima graben. Ground deformation modelling and seismic imaging over recent decades have inferred the presence of a large magma reservoir ~10 km below Aira caldera and one or multiple smaller reservoirs below Sakurajima [1]. Assessing the stability of such reservoirs, and whether they may become connected, is challenging, but critical to assessing the current hazard of the volcano, as melt build-up in the deep reservoir and exchange with the shallower plumbing system might prime the volcano for another major eruption [2]. Investigating such a connection requires accurate models of the current state of stress below Aira caldera. The complex tectonic setting of the region makes this system especially compelling, as the state of stress is likely to be influenced by several processes other than reservoir pressurisation. Moreover, the possibility of melt storage in partially crystallised reservoirs offers the opportunity to test dynamic magma-mush models to explain the observed ground deformation and investigate dynamic stress change in the crust [3]. In this work, we apply Finite-Element numerical models of the coupled plumbing systems of Aira caldera and Sakurajima volcano to recently acquired GNSS data. Describing the deep reservoir as a poroelastic magma mush, we show how simulation of ground deformation data can constrain the geometry and location of the reservoirs, as well as melt supply parameters. Estimating the volume of the active magma source is especially critical, as it provides an upper limit to the magnitude of current eruptions. Then, we produce stress models accounting for gravitational loading, reservoir pressurisation, and tectonic stress to assess how and when the deep and shallow systems might become interconnected, potentially escalating the volcanic activity.

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Liquid-rich growth, cold storage and rapid entrainment of plagioclase megacrysts in a mafic volcanic system.

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Knowledge of magma storage conditions are critical for constraining volcanic hazards. Two end-member models of magma storage are currently proposed: (1) cold, non-eruptible storage requiring remobilisation before eruption [1], and (2) warm storage in which magma remains readily eruptible [2]. Recent studies of silicic systems have consolidated these models to suggest the presence of thermally heterogeneous reservoirs at near-solidus conditions, in which short-lived, high temperature, eruptible magmas are rapidly mobilised prior to eruption [3]. Here, a detailed petrological and geochemical study is carried out on the plagioclase-rich tephra deposits from Mt Yasur Volcano, Vanuatu, in order to elucidate the storage conditions in a mafic volcanic system. Major and trace element profiles across plagioclase megacryst indicate quasi-steady-state equilibrium was achieved. Using Mg quasi-steady state profiles, the temperature dependent C1–I1 transition and dichotomous partitioning of Mg into plagioclase [4], equilibration and storage temperatures were estimated (890°C). These are cooler than estimates from geothermobarometry using literature data [5,6] (1021 ± 36°C), pointing to warm crystal growth followed by cool storage within a plagioclase-rich mush. Quantitative textural analysis of dihedral angles reveal textural equilibration and limited growth during cooler storage, entrainment and eruption. Durations of crystal entrainment into a geochemically distinct magma and eruption are interpreted as rapid. These results indicate that mafic volcanic systems can be described by storage models similar to those proposed for silicic systems.

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Reliance or Resilience? Volcanism and the Ancient Maya

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The ancient Maya, renowned for their remarkable cultural achievements and complex societal structures, prospered for over a millennium within the volcanic landscapes of Mesoamerica (a region that today includes Mexico, Guatemala, Belize, Honduras and El Salvador). Although interwoven into Mayan history, and possibly even a contributing cause for their decline during the Terminal Classic Period (AD 800 – 1000), the precise nature of this relationship with volcanism remains unresolved. Volcanic ash (tephra) is known to have frequently blanketed the Maya lowlands, yet previous evidence has been limited to spatially patchy records with poor chronological control. This project utilises the cryptotephra record of newly recovered, annually laminated (varved) lake sediment sequences from the Yucatán Peninsula, (Lake San Claudio in Mexico, and Lake Petexbatún in Guatemala) to reconstruct the sub-annual timing and dispersal of eruptions for the first time. These tephrostratigraphies will form the basis for a volcanic framework for central Mesoamerica, providing key markers for synchronising and dating archaeological and palaeoclimate records. This work will offer new insight into the climatic and societal impacts of volcanism, helping to unravel the complex interplay between environmental change and reliance/resilience of the ancient Maya.

Geochemical Approach to Iron Age Vitrified Hillforts

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Vitrified hillforts are an archaeological phenomenon found across Iron Age Europe, with more than 130 examples documented [1]. Vitrification refers to the melting of rock through intense burning, resulting in a glassy matrix that fuses surviving rock together. This takes place at atmospheric pressure, the condition of which is understood to require high temperatures of between 1000-1250°C [2]. The purpose and origin of vitrification remain uncertain, understanding the temperature conditions and material factors involved is central to solving this problem.

Glasses formed in this way frequently contain quenched micro-crystalline minerals (e.g. olivine, pyroxenes) which may be used in geothermometers which are the same as those developed for magmatic systems at depth. For use on hillfort data thermometers must be calibrated for surface pressures. 5826 individual temperature estimates were calculated in total, across 14 hillforts using 23 different thermometers. The global average was 990.8°C. Raman spectroscopy of charcoal fragments which are residues of burning may provide an additional means of refining temperature ranges and calibrating geochemical thermometers for surface processes. 97 individual charcoal samples were scanned, from a variety of difference sources, using Raman spectroscopy and a mean temperature estimate of 489.3°C was calculated using Formation Temperature equation (1) from Theurer, et al. (2022) [3]. This is lower than the geothermometer readings, most likely due to decreased survival rates of charcoal when burned at higher temperatures. Therefore, these estimates can only be treated as a minimum burn temperature.

The geochemical approach to an otherwise archaeological problem provides a more detailed understanding of vitrification mechanisms, while also highlighting uncertainties relating to fuel quantities, burning duration and scale, and environmental conditions required to achieve vitrification. This demonstrates how igneous geochemistry can be used to solve ancient mysteries within our society.

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The relationship between surface displacement, pressure and volume in analogue models of magma chamber inflation and the implications for the interpretation of deformation signals

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Satellite-based maps of surface deformation are increasingly being used to monitor volcanoes, providing information on subsurface magma movement for forecasting and hazard management. We performed a set of laboratory-scale analogue experiments aiming to reproduce the idealised case of a spherical source in an elastic medium and compare them to analytical solutions and Finite Element Method models in COMSOL. A pre-formed cavity in a tank of gelatine is filled with a liquid of a given density and viscosity and then pressurised by injection of more liquid at a constant rate until dykes form and reach the surface. We measure the initial properties of the gelatine and fluid and track the injected volume (dV), source geometry, pressure (dP), surface deformation (u_z) and shear strain field during the experiment. As in previous studies, we find that chamber pressure at dyke initiation is controlled by the fluid viscosity. Unlike commonly assumed, we find that the dyke does not immediately propagate away from the cavity and the magma chamber pressure continues to increase after dike initiation. During inflation, our experiments follow the linear relationships predicted by simple analytic models: $dV \propto VdP$, $uz \propto dV$, and $uz \propto VdP$, but with different constants of proportionality. We use COMSOL models to test the effects of various aspects of the experimental setup on the observations (e.g feeder system). Our results have important implications for the relationships between surface deformation, pressure and volume in real systems (laboratory or full-scale) and the design of numerical models.

Joint Analysis of Volcanic Degassing and Deformation Time Series to Understand Transitions in Unrest at Sangay Volcano

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Historically, a lack of continuous observations from volcanoes has been a hurdle to establishing how unrest leads to eruptions. Multi-parameter remote monitoring of volcanoes by global satellites makes it possible to observe changes in unrest and activity at increasingly improved resolutions. TROPOMI imagery from the ESA Sentinel-5P satellite offers a significant improvement in resolution of SO_2 gas emissions [1,2]. Reconstruction of these emissions using PlumeTraj trajectory analysis will allow us to observe and analyse volcanic degassing over longer time-series. The temporal and spatial coverage of volcano deformation observations, via Sentinel-1 InSAR data, has also expanded dramatically in recent years [3]. We will use joint analysis of volcanic degassing and satellite radar-derived deformation time series to develop conceptual models of unrest, increase our understanding of subsurface magmatic processes, and identify signs of pre-eruptive activity.

Since 2019, Sangay volcano (Ecuador) has entered a new eruptive period, with continuous ash emissions, explosions, and lava flows. Due to its remote location, and harsh conditions, monitoring of this volcano is difficult and thus limited. SO_2 is monitored by a permanent ground-based station, though this data is intermittent [4], highlighting the potential for satellite remote sensing at this volcano. We present new measurements of SO_2 emissions from Sangay, from investigations of degassing dynamics in eruptive intervals, to a multi-year comparison of long-term trends in emissions with trends in deformation behaviour [5]. In particular, we aim to better understand the sustained inflation observed at Sangay since 2019 and explore the changing degassing behaviour as the volcano transitions from persistent low-level unrest to higher intensity eruptions.

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The submarine record of the largest volcanic eruption of the 21st century

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On January 15th, 2022, minor volcanic activity at Hunga Volcano, Tonga, suddenly and without warning escalated into the most explosive volcanic eruption in over 140 years. The Volcanic Explosivity Index (VEI) 5-6 eruption, at the shallow-submarine caldera, triggered worldwide tsunamis and generated atmospheric shockwaves that circumnavigated the globe twice. At the volcano, the majority of the 6.9 km^3 of material erupted was rapidly emplaced across the seafloor for over 100 km by underwater sediment density currents that destroyed deep-sea telecommunication cables connecting Tonga to the global internet [1–3].

Despite their hazardous nature, understanding of explosive submarine eruptions is limited by a sparsity of observations and minimal direct measurements. The Hunga 2022 submarine deposits are the most detailed and comprehensive record of the eruption. As such, these deposits are fundamental for reconstructing the eruption and understanding the critical processes driving it, here, and at other shallow-submarine volcanoes globally.

Here, we present the petrological and geochemical characterization of the submarine eruption deposit sequence preserved in deep-sea sediment cores collected two-months after the eruption. By identifying the temporal and spatial changes in deposit componentry and volcanic glass geochemistry we constrain the chemostratigraphic record of the 2022 Hunga eruption and investigate key eruption processes that enabled the most explosive eruption since Krakatau in 1883. Furthermore, we compare the eruption record preserved in the submarine deposits to terrestrial eruption sequences to investigate the capability of turbulent underwater sediment density currents in preserving a coherent eruption signature.

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Imaging the magma storage region and hydrothermal system of an active arc volcano using the controlled-source electromagnetic method

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The Brothers volcano, located 400 km NE of New Zealand, has been the focus of many international studies over the past ~25 years, including IODP drilling up to a depth of ~450 m below seafloor and seismic and shallower drilling experiments in 2025. While surface processes and the shallow subsurface have been well investigated, information on the magma storage region and the hydrothermal system's deep flow pathways is missing. Hydrothermal circulation is an important driver for the chemical and thermal interaction between solid Earth and ocean, such as the formation of mineral deposits on the seafloor. Geophysical methods can be used to image the geometry of these pathways, the magma storage region, as well as mineral deposits, providing a deeper understanding of hydrothermal circulation. The controlled-source electromagnetic (CSEM) method is sensitive to electrical conductivity in the subsurface, and thus to the presence of highly conductive materials such as fluids, partial melts, and metals.

Our CSEM method employs a long electrical dipole transmitter, towed by a vessel to emit electromagnetic waves that induce electric currents in the Earth. Secondary electromagnetic fields are measured by receivers either at the ocean bottom or towed behind the transmitter to gather information about the conductivity distribution beneath the seafloor. During a cruise scheduled for February-March 2026, we aim to measure data at the same locations and along some of the same survey lines used in the recent seismic study. The CSEM technique is sensitive to conductive structures up to several km deep. We aim to determine the size and shape of the magma storage and fluid pathways at Brothers volcano, and by extension, to estimate the temperatures and melt fractions present, using high-resolution 3-D images of the electrical resistivity generated from the results of our experiment. Furthermore, we seek to demonstrate the capabilities of the CSEM method for investigating hydrothermal systems of other volcanoes.

Tracing the Triggers: Modelling Dome Collapse Dynamics at Volcán de Colima

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Volcanic lava domes are hazardous geological structures that form when viscous magma extrudes from a vent and accumulates and cools around it [1]. Dome collapses can produce destructive pyroclastic density currents or debris avalanches that pose serious risks to nearby communities. Factors such as pre-existing dome morphology, oversteepening, gravitational loading, and weak or altered rock layers within the volcanic edifice can contribute to instability and collapse [2].

On 10 July 2015 at Volcán de Colima, a dome collapse generated a pyroclastic density current that travelled 11 km from the vent [3]. Due to visual obstruction (clouds) and the volcano's complex summit structure, the mechanisms that caused the collapse remain poorly constrained. Observations suggest that two successive pyroclastic flows occurred. The first was likely triggered by failure of the crater wall, allowing dome material to advance downslope. The second may have resulted from a rapid pressure release following the initial collapse, producing an explosive event that excavated a deep depression within the crater.

Our objectives in this study are (i) to analyse pre- and post-collapse remote sensing imagery and digital surface models to characterise the geometry and dimensions of the 2015 Volcán de Colima dome and crater; and (ii) to produce a 3D Distinct Element Method (DEM) numerical model to investigate the dominant mechanisms that led to the initial collapse. In the latter, we aim to construct a heterogeneous model in which mechanical parameters such as cohesion, Young's modulus, and friction angle vary according to values reported in studies of Volcán de Colima. Our preliminary simulations focus on the southern flank, where the initial crater collapse occurred. We simulate dome growth to reproduce the observed dome volume and assess whether (1) overburden alone, (2) the presence of a weakened layer, or (3) a combination of both factors could have triggered the flank collapse.

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From Summit to Seafloor: Quantifying the Source of the 1871 Ruang Volcano Tsunami through Integrated DEM and Bathymetry Analysis

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The 1871 eruption of Ruang Volcano in the Sangihe Islands, Indonesia, generated a destructive tsunami, causing over 400 deaths on the neighbouring island of Tagulandang. The cause of the tsunami is not well constrained, which has prevented accurate modelling of the event and the assessment of future volcanic tsunami risk. Here, we present new field, archival and remote-sensing observations from the event, identifying the most likely source as a flank landslide from the northern sector of Ruang's summit. The mass balance between the onshore landslide and offshore deposits helps constrain the source volume and the volume that entered the sea, an essential step to accurately modelling the tsunami. This study integrates topographic and bathymetric data to quantify the spatial extent and volume of the 1871 collapse and associated submarine deposition.

A pre-event digital elevation model (DEM) was reconstructed by restoring the missing flank morphology based on remnants of older surfaces and slope continuity, while a post-event surface was obtained by removing younger volcanic infill. The difference between these surfaces defines the subaerial failure volume. Bathymetric data around Ruang and the strait toward Tagulandang were analyzed to identify mounds and depressions consistent with the deposit area, showing the presence of thickened, lobate and mounded features interpreted as submarine deposits formed in the 1871 event.

Preliminary results indicate that consistency between the submerged deposits and an identified landslide source region. This has been used to model the event and test if this landslide volume can generate tsunami impacts consistent with the observed impacts of the event. only part of the failed material entered the sea. This integrated DEM and bathymetry approach provides new quantitative constraints on the 1871 Ruang collapse and contributes to understanding volcanic tsunami coupling in the Sangihe Arc.

Understanding past eruptions to mitigate future hazard: the ~ 1700 CE eruption of *Sii Aks* (Tseax), Canada

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Small explosive mafic eruptions occur frequently and we can use tephra deposits to understand past events and plan for future eruptions. The Northern Cordillera Volcanic Province (NCVP) in British Columbia has> 100 volcanic centres identified and is the most active of five volcanic regions in western Canada with [1]. However, as Canadian volcanoes are mainly situated in remote locations, they have been relatively understudied. We present analysis of tephra deposits from the ~ 1700 CE eruption of *Sii Aks* (Tseax) volcano, the southernmost volcanic centre in the NCVP. Measured tephra thicknesses from 96 locations have enabled us to produce isopach maps and estimate the volume of tephra fall during the eruption as ~ 3 x 10^6 m^3. This provides the first field-based estimate of tephra fall volume for a Canadian mafic eruption and classifies the eruption as two on the Volcanic Explosivity Index.

In addition, we have analysed grain size data from ~60 samples to produce an estimate of the total grain size distribution (TGSD) of the eruption. We are now using our results as inputs for TephraProb [2] modelling to further constrain the eruption source parameters. Our analysis of the explosive phase of the ~ 1700 CE *Sii Aks* (Tseax) eruption provides a model for interpreting older mafic volcanic successions across the NCVP and for highlighting what we might expect in a future eruption.

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Southwest Rift Zone eruptions of Mauna, Hawai'i: lessons from the crystal cargo

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Mauna Loa has erupted 34 times since 1843, posing significant hazards to island communities on its slopes [1]. Eruptive activity at Mauna Loa occurs either in the Moku'āweoweo summit caldera or along the Northeast or Southwest Rift Zones. Mauna Loa's magmatic system is less well understood than Kīlauea's because there have been only two well-monitored eruptions in the last 50-70 years (1984, 2022), and the network of geophysical instruments is more sparse on Mauna Loa compared to Kīlauea. Southwest Rift Zone eruptions (e.g., 1868, 1887, 1907) pose an increased hazard due to their proximity to local communities, as seen in the 1868 eruption, one of the greatest natural disasters in Hawaiian history. Rift zone eruptions are important for several reasons. Firstly, this sequence of events is observed in many Kīlauea and Mauna Loa eruptions, where eruptions begin at the summit and move downrift following a large earthquake [2]. Understanding this sequence is critical for hazard assessment. Secondly, the crystal cargo contains an archive of information related to magma storage beneath the summit and the Southwest Rift Zone.

The crystal cargo consists of olivine, orthopyroxene, clinopyroxene, and plagioclase phenocrysts, exhibiting a wide range of compositions and zoning patterns, indicating the occurrence of at least two different magmatic environments. The evaluation of the crystal cargo enables the construction of a framework of understanding to explain the magma's origin and what the crystals may tell us about the structure of magma storage regions beneath the Southwest Rift Zone of Mauna Loa. Mauna Loa's 2022 eruption underscores the need to study its plumbing system [3], as the volcano remains active and poses a significant threat, with numerous unanswered questions.

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Ocean Drilling Reveals Collapse and Resurgence of the Iceland Mantle Plume

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The long-term behaviour of mantle plumes, and the nature of their interaction with mid-ocean ridge systems, is not well understood. To address this, International Ocean Discovery Program (IODP) Expedition 395 drilled into five sites east of the Reykjanes mid-ocean ridge, approximately 600 km south of Iceland. Recovered basalt records 32 million years of interaction between the Iceland mantle plume and the ridge system. Basalt from the oldest site (32 Ma), targeting crust characterized by transform faults, has an isotopic and rare-earth element (REE) composition that can be modelled by passive upwelling and melting of ambient (potential temperature = 1300◦C) mantle of average depleted mantle composition. This site is underlain by thin crust (~ 6 km), indicated by nearby wide-angle seismic data. In contrast, younger drilling sites (3-14 Ma), situated at two V-shaped ridge and trough pairs (where transform faults are absent), have REE compositions that require elevated mantle temperatures and relatively high melt fractions, and isotopic compositions that imply incorporation of plume components within the mantle source. These results suggest the thermal influence of the plume on crustal production collapsed at the sampled latitude by 32 Ma, before progressively resurging to present day. These significant changes in the extent of plume-ridge interaction critically influenced mantle composition, crust formation, and likely the pattern of deep-water ocean circulation in the North Atlantic Ocean region.

Detection of Submarine Volcanic Eruptions Using Satellite Ocean-Colour and Machine Learning

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Submarine volcanic eruptions, which account for roughly 80% of current volcanic activity, are challenging to monitor due to their remote locations. These eruptions influence the environment by releasing heat, gases, and minerals, affecting nutrient levels, and local marine ecosystems [1]. Shallow submarine eruptions can produce ocean plumes that alter water colour, offering a potential indicator for detection via remote sensing. Such discolourations often remain visible after the main eruptive event and provide insight into eruption dynamics and the surrounding marine environment.

In this study, we applied a U-Net convolutional neural network, a machine learning model architecture commonly used for image segmentation, to Sentinel-2 satellite imagery to automatically detect ocean discolourations associated with submarine eruptions [2]. A training dataset was constructed from annotated discolourations at multiple near-surface active submarine volcanoes, including Kavachi (Solomon Islands), Home Reef (Tonga), and East Epi (Vanuatu). The model was trained to identify discoloured satellite images and validated using known eruption events.

Applying the model to the highly active Kavachi volcano successfully detected a high majority of eruptions between 2016 and 2025, including those under light to moderate cloud cover. The model was able to capture both large and subtle discolourations, revealing previously unreported events. While the model struggled to detect eruptions under very extensive cloud cover or occasionally misclassified phytoplankton blooms and shallow-water features as eruptive discolouration, it demonstrated an overall strong detection capability. Further work will explore the application of machine learning and satellite remote sensing to identify submarine eruption events at other volcanoes and to better understand their impacts on the surrounding marine environment.

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Towards real-time processing of UV Camera data: first results from a new network

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We report on the results of a growing network of ultraviolet (UV) cameras installed at seven volcanoes, based on the low-cost PiCam design from the VolcanoTech group at the University of Sheffield. The instruments are installed at: Kīlauea (USA), Cotopaxi and Reventador (Ecuador), Lascar and Lastarria (Chile), Merapi (Indonesia), and Colima (Mexico) volcanoes. Each location has a bespoke setup ranging from completely remote to integrated into existing monitoring systems with telemetry. The UV cameras provide notable advantages over other common sulphur dioxide (SO_2) emission measurement techniques, providing improvements in spatial and temporal resolution which facilitate comparison with other key data streams. Given the range of activity styles imaged, we have gained unique insights into the performance of the UV camera technique. We have grappled with common issues such as the challenges of measurements during varied emission quantities, fluctuating plume direction, and the ever-present effect of light dilution. Here, we present results across three specific activity styles at Kīlauea, showing good agreement of our results with those of traverse DOAS measurements. At Merapi, we compare our results to those from an independent NOVAC scanning spectrometer network. Finally, given optimal measurement conditions at Lastarria, we demonstrate the full capability and benefits of UV cameras, working towards near real-time availability of data. Overall, we suggest that installations of UV cameras for SO_2 emissions measurements offer a significant opportunity for our community to understand short and long-term gas release patterns across a range of targets.

Impact of petit-spot magmatism on subduction zone seismicity and global geochemical cycles: International Ocean Drilling Programme (IODP^3) Expedition 502

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Petit-spot volcanism forms on the down-going oceanic plate at subduction zones via the extraction of pre-existing melt from the upper asthenosphere, driven by lithospheric flexure prior to subduction. Tectonic stress initiates the migration of melt along the base of the lithosphere, after which, fracturing facilitates the ascent of magma to the surface, forming intrusive bodies and small-volume eruptions of highly alkaline, CO_2-rich basalt [1, 2], distinct from the tholeiitic basalt of the oceanic crust.

Petit-spot activity is hypothesised to modify the chemical and physical properties of the subducting sediment-laden oceanic plate, thereby influencing the occurrence and magnitude of subduction zone earthquakes and global geochemical cycles. Since its first discovery in the Japan Trench [3, 4], petit-spot volcanism has now also been documented at the Java, Chile and Mariana Trenches, suggesting a broader global distribution. However, due to their deep-marine setting, the detection, observation, and sampling of these systems remain challenging. Until now, limited petit-spot basalts have been sampled by dredging and submersible dives [e.g. 3, 5], which can only provide surface snapshots of these systems. International Ocean Drilling Programme (IODP^3) Expedition 502 (31 Oct. – 24 Nov. 2025) directly cored a petit-spot region in the NW Pacific near the outer rise of the Japan Trench, providing an unprecedented sub-surface sequence of petit-spot basalts and their in-situ interactions with surrounding sediments.

The primary scientific objectives of Expedition 502 are to: 1) characterise the nature of the acoustic basement at the expedition site; 2) assess the impact of petit-spot activity on the physical and chemical properties of pelagic sediment; 3) refine estimates of geochemical cycling at subduction zones. Findings from this expedition will advance our understanding of submarine volcanism and the role of petit-spot processes in shaping Earth systems, with implications for assessing geological hazards including earthquakes, tsunamis and volcanic activity.

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Towards an understanding of volcano-tectonic interactions at Santorini-Kolumbo

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The Christiana–Santorini–Kolumbo volcanic field in the central Aegean is among the most hazardous volcanic systems in Europe. The seismic unrest of early 2025 highlighted ongoing hydraulic connections between Santorini and Kolumbo, expressed by concurrent uplift and deflation at both volcanoes. To investigate the long-term interplay between volcanism and tectonics in this system, International Ocean Discovery Program (IODP) Expedition 398 recovered twelve deep drill cores from the volcano-sedimentary infill of marine rift basins and the Santorini caldera. By integrating ground-truthed stratigraphies from drilling with an extensive seismic dataset acquired during eight expeditions, we refine previous seismo-stratigraphic frameworks and directly link basin-fill architecture to volcanic events. Our combined stratigraphic and structural analysis reveals a previously unrecognized neotectonic graben that hosts the Kolumbo volcanic field and extends toward—and potentially beneath—Santorini. We show that this graben developed through accelerated rifting prior to the onset of highly explosive volcanism at Santorini and the emergence of Kolumbo Volcano. Subsequent eruptions produced extensive volcaniclastic megaturbidites that buried the graben structure, concealing it from the modern seafloor. Within this tectonic depression, volcanism at both Santorini and Kolumbo localized along internal strain-accommodation zones that acted as preferred magma pathways. The spatial co-location of the volcanoes within the same graben and their temporal correspondence indicate that their activity is synchronized by regional tectonic stresses. Notably, no volcanic center younger than ~190 ka has developed outside this structure, underscoring the fundamental spatial control of crustal extension on volcano emplacement in the South Aegean Volcanic Arc.

Magmatic teleconnections, external forcings and the tempo of volcanic systems: perspectives from the Mediterranean

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Volcanoes of the Mediterranean region have long and rich historical and geological histories, and records of past activity preserved as distal tephra or in historical archives that include some of the most complete of anywhere around the world [1]. These datasets allow for the quantification of eruption rates and eruptive fluxes through time, both at individual volcanoes and at the arc scale. They can be used to test hypotheses about magmatic teleconnections (links between records at neighbouring systems); and about external forcings (for example, from tectonics and eustatic sea-level changes on 10^5 - 10^3 yr timescales; to the scale of luni-solar cycles and solid earth tides) [2, 3, 4]. Recent unrest and new work at volcanic systems in the Mediterranean, including at Santorini and Campi Flegrei, have provoked new interest in these sorts of questions.

Many of the hypotheses about volcanic forcings and teleconnections originated from observations based on around Mediterranean volcanoes, including early inferences on tidal influences on the eruptions of Vesuvius by Luigi Palmieri in the 1870s, and Frank Perret in the 1900s; reflections on subterranean linkages between Campi Flegrei and Vesuvius from the 19th century to the satellite era; and studies of the links between the timings of volcanic eruptions and rates of eustatic sea-level change. In this presentation, I will review the current status of some of these hypotheses, based on a synoptic analysis of the literature; and draw comparisons between the behaviour of individual volcanoes within a single arc, and between volcanic arcs and other volcanic settings.

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Constraining ascent velocities of kimberlite magmas using diffusion chronometry modelling

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Kimberlites are enigmatic igneous rocks which transport diamonds to Earth's surface. Despite their scientific and economic importance, many aspects of kimberlite volcanism remain unknown. We aim to constrain ascent velocities of kimberlite magmas using diffusion chronometry.

We analyse fresh lavas from the youngest known kimberlites, the Igwisi Hills Volcanoes (IHV), Tanzania (~12.6 ka) [1]. Microanalytical work has revealed 4 distinct olivine populations in the lavas. Macrocrysts are ellipsoidal, > 1000 µm and have an Mg-rich core derived from mantle peridotite. Nodules are similar in morphology and size to macrocrysts but contain small olivine crystals called neoblasts. Microcryst-a crystals are subhedral-euhedral, < 1000 µm, and have an Mg-rich peridotite core. Microcryst-b crystals have a similar size and morphology to microcryst-a crystals but possess a Fe-rich core, likely derived from disaggregated neoblasts. Cores from all populations are surrounded by up to four magmatic zones; internal zones, rims, rinds and outermost rinds, which have distinct compositions.

Geochemical profiles have been collected across grains of interest and used to conduct diffusion chronometry modelling in the DFENS (Diffusion Using Finite Elements and Nested Sampling) program [2]. Results suggest that diffusion between cores and internal zones is slower than expected for kimberlite ascent (average timescale = 264 days) and may represent magma storage. Diffusion between internal zones and rims gives average timescales of 33 days or 0.17 m/s, indicative of fast ascent. Diffusion between cores and rims gives timescales of 9 days or 0.27 m/s, also suggesting very fast ascent. Diffusion between rims and rinds gives longer timescales (average = 252 days) suggesting a second period of magma stalling. Diffusion between rinds and outermost rinds gives timescales of 5 days or 0.11 m/s suggesting a fast final ascent. This work illustrates kimberlite ascent speeds are more complex than previously thought, with multiple distinct phases of ascent.

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Controls on Fissure Location and Fire Fountain Dynamics: Insights from Webcam Observations of the Svartsengi Volcanic System, Iceland.

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Recent fissure-fed eruptions of the Svartsengi Volcanic System have repeatedly impacted infrastructure on Iceland's Reykjanes Peninsula, including damaging homes, affecting hot water supply, and displacing the town of Grindavík, home to ~3800 residents. As eruptions on the Reykjanes Peninsula may continue for decades to centuries, understanding the controls on the locations and propagation of these fissure-fed eruptions is important for continued hazard assessment and risk mitigation. This study maps the fissures produced during eruptions of the Svartsengi Volcanic System between December 2023 and September 2024 from helicopter flight imagery, and measures the evolution of fire fountain heights during eruptions from webcam footage. Later eruptions have been excluded from this study due to the discontinuation of the webcam network. Fissure locations are heavily affected by high topography, including by features parallel to the strike of fissures, and features formed during previous eruptions. Variations in fire fountain heights between different fissure segments and through time during a single eruption, are primarily controlled by fissure segment length and conduit erosion, with larger conduits increasing mass eruption rates and fountain heights. Understanding the key controls on fissure propagation helps to highlight areas that are most vulnerable to future fissure opening, helping to inform the positioning of protective barriers and infrastructure. Reinstating the disbanded webcam network is important to ensure that continuous, high quality monitoring of these eruptions continue. This will also help to refine models of fire fountain evolution.

Peperite in the Borrowdale Volcanic Group: a chronology of magma-wet sediment interaction at Honister, Cumbria

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Interaction between magma and unconsolidated, wet sediments commonly forms a volcaniclastic rock termed peperite. Peperite deposits provide a frozen record of the numerous dynamic and often simultaneous processes involved in their genesis, including magma fragmentation, host sediment fluidisation, and magma-sediment mingling. Accordingly, a formation chronology can be interpreted from these deposits.

We investigated a peperite outcrop at Honister in the Borrowdale Volcanic Group of the central English Lake District. Here, blocky peperite formed by intrusion of an andesite sill into subaqueously reworked volcaniclastic sediment. To move beyond qualitative descriptions, we applied a novel morphometric approach to this exposure, representing the first quantification of a peperite deposit.

Based on our field observations and complementary dataset of clast morphological and textural characteristics, the following chronology is proposed: (1) shallow emplacement of a poorly-vesicular sill into wet, unconsolidated sediment; (2) localised vesiculation of the sill margins; (3) rapid cooling-contraction granulation of the sill margins forms an initial population of blocky, in-situ clasts, while simultaneous heating of sediment pore water generates a vapour film at the magma-sediment interface; (4) fluidisation of the host sediment and bulk magma-sediment density contrasts drive clast dispersion, with transient instabilities in the vapour film driving fine fragmentation.

‘Ex-x’: Expecting the Unexpected — understanding ‘dangerous’ eruptive transitions

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The impacts of volcanic eruptions are driven by their magnitude and speed of evolution. Although 61% of high-impact eruptions transition between effusive (relatively low impact) and explosive (higher impact) states during single eruptions, volcanologists still cannot fully explain and thus reliably anticipate or provide warnings for these transitions. Examples of higher-impact changes include the generation of deadly pyroclastic density currents and the occurrence of larger or directed explosions. This ‘grand challenge’ for volcanology demands a significant step forward in process-driven, coupled, time-dependent modelling.

In the Ex-X project, we aim to achieve an essential advance in understanding the underlying factors that drive dangerous accelerations in behaviour in arc volcano systems worldwide, using several volcanic systems in the Eastern Caribbean as archetypes. This grand challenge cannot be addressed without important conversations between different disciplinary expertise within volcanology and strong partnerships.

We will: (1) develop new methodologies that capture fluctuating conduit input and consequent variations in eruptive behaviour by using: (i) ‘microstratigraphies’ to capture the spatial and temporal changes that drive transitions, which are uniquely recorded in the eruptive deposits, and (ii) nodal seismometers and machine learning to enhance the spatial and temporal resolution of geophysical records of eruptions and their changing conditions;

(2) develop time-dependent models that describe unsteadiness in each part of the system, beginning with the current state-of-the-art knowledge for disequilibrium conduit flow and unsteady eruption columns;

(3) create end-to-end descriptions of drivers of past eruptive transitions through a new coupled model capturing fragmentation and column collapse, validated and refined via our physically derived datasets;

(4) demonstrate how this knowledge can improve monitoring and warning systems in the Eastern Caribbean and beyond, by using the coupled model to predict geophysical precursors, and evaluating the range of likely eruptive scenarios and trajectories that may lead to dangerous eruptive transitions.

Rapid-response petrology during active eruptions: techniques, timings, costs and applications

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When monitoring volcanic activity, understanding how an eruption will evolve and end is as important as predicting when and where it will begin. During active eruptions, volcanic rocks (magma), glasses (melt), and crystal cargoes (minerals) become available for study, whilst shallow geophysical signals often become noisier. Rock and tephra compositions directly record magma plumbing system processes that prime, drive, modulate, and halt eruptions, providing valuable insight into syn-eruptive dynamics with immediate applications for risk assessment, hazard management and civil protection.

Effective petrological monitoring requires rapid-response strategies that optimise technical and financial resources to acquire meaningful data in near real-time. We assess various traditional and innovative methods, evaluating key aspects such as sample preparation, analysis time, cost, and practical value of information obtained. One lesson our group learnt during the 2021 La Palma eruption was that preparation before the eruptive crisis would have significantly improved our response capacity.

Optical microscopy, SEM and QEMSCAN analyse mineral compositions and textures that track magma cooling, crystallisation, ascent and eruptive style; XRD identifies mineral and glass proportions and chemistry, providing insights into magma composition and cooling; XRF measures whole-rock compositions recording changes in magma source and temperature; microthermometry on fluid inclusions can permit calculation of temperatures and pressures to reconstruct magma storage depths and ascent dynamics; and, micro-CT rapidly and non-destructively images porosity, vesicularity and mineral distribution in 3D, which are key to understanding magma ascent, fragmentation, and degassing.

Integrating petrological information, particularly from daily time series samples, with geophysical, gas geochemistry, and phenomenological monitoring data can provide critical insights into connections between: earthquake depths and magma storage; magma intrusion and rejuvenation; eruption dynamics; and mush mobilisation and filter pressing.

Use of near real-time petrological monitoring is expanding. Bridging the gap between what is analytically possible and what is practically achievable remains a central goal.

Experimental particle-laden jet noise and its application to volcanoes

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Sustained explosive volcanic eruptions produce vast quantities of acoustic energy, generally referred to as jet noise. Jet noise can be easily recorded in the field using cheap microphones. The resulting frequency spectra will depend on multiple parameters related to the eruption dynamics (e.g. gas and magma exit velocity, mass eruption rate), magma properties (e.g. particle size and density), crater topography, and observer's location (e.g. distance and angle to the vent). Being able to extract information on the eruption parameters from jet noise could advance near-real time ash dispersion forecast and in turn support for eruption crisis management. However, current classical jet noise theory is limited to pure-air jets, thus hindering any application to ash-laden volcanic jets which are fundamentally multiphase. We conducted a series of experiments investigating how jet noise is impacted by the addition of ash. We produced experimental jets from nozzles with diameters 3.5—8 mm, and fully expanded Mach numbers in the range 1.4—2.0, in the pure-air case. I will first introduce pure-air jet noise theory, which is formed of two distinct large-scale and fine-scale turbulence spectra. I will then present experimental results for particle-laden jets. Jet noise theory fits particle-laden data, though with reduced accuracy. The main difference occurs at high observation angles, where the large-scale turbulence component could not be identified in the presence of particles. I will discuss these results in the context of infrasound observations at erupting volcanoes, for which a good angular resolution is difficult to obtain.

Who's at fault? Disentangling the igneous-tectonic fracture network in the Kerguelen Islands

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Magma emplacement often induces surface uplift and bending of the overlying strata, producing forced folds. During bending, the outer upper edge and lower inner edge of the fold undergo tension and compressive stresses, respectively [1]. Tensile stresses promote fracturing, weakening the strata, influencing its mechanical response. In 3D, these stresses generate characteristic circumferential and radial fractures around a central axis, indicative of forced folding [1]. These fractures are records of intrusion-induced folding, reflecting underlying magmatic processes (intrusion inflation-pressurisation) Pre-existing structures, such as tectonically induced fractures, may influence the propagation of igneous-induced fractures [2], producing fracture patterns that deviate from expected distributions. Additionally, regional tectonic stresses can overprint igneous-induced fractures, producing a complex interconnected fracture network. The Kerguelen Islands exemplify this interplay, where tectonic stresses induced by seafloor spreading along the Southeast Indian mid-ocean ridge (SEIR) and reactivated transform faults have created a highly fractured surface [3]. These fractures crosscut intrusion-induced circumferential and radial fractures around Mont Ross, the youngest magmatic complex on Kerguelen [1, 3]. Glacial rebound of the Cook Glacier has created additional fractures [4], adding further complexity. Therefore, to reconstruct the formation of this network, we need to distinguish the origin of these fractures.

The fractures were mapped with optical satellite imagery and analysed in FracPaQ to distinguish fracture sets based on their geometry and spatial distribution [5]. Preliminary results show dominant fracture orientations predominantly trending NE-SW, E-W and NW-SE, ranging between 10^2-10^3 m. This variability in length could be attributed to igneous or tectonic fractures reactivating faults and propagating further. The fracture density is highest around the southwest of Kerguelen, coinciding around the Cook Glacier and Mont Ross, signifying the superimposition of multiple fracture sources. These findings highlight a feedback mechanism between competing tectonic and igneous forces, influencing the fracture orientation, propagation and overall network complexity.

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An Overview of the Natural History Museum's Petrology Collection.

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The Natural History Museum's (NHM) Petrology Collection contains over 177, 000 rocks from around the world collected over the past 250 years. The collection contains a variety of sedimentary, igneous, and metamorphic rocks from historic expeditions and from scientifically important acquisitions. Individual and group samples are held, as well as thin sections, powders, and in some cases mineral separates. The purpose of the collection is to preserve historical and scientifically valuable specimens as well as supporting the ongoing petrology research in the NHM and wider community. The NHM collections are available to the scientific community for research and searchable on the NHM data portal [1].

The Petrology Collection has particularly strong collections of historic specimens from expeditions, mantle xenoliths, and carbonatites. Recently we have been reviewing other areas of the collection and are seeking feedback on which collections would get more use if we prioritised their accessibility. These include the thin section collection, teaching collection, and economic mineral collection. This feedback will be greatly beneficial as it will allow for the prioritisation of large projects and help increase the scientific output potential and development of the collection moving forward. More information can be found at the poster session.

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Long-term impacts of volcanic eruptions on glacier dynamics – a case study of the 2010 summit eruption of Eyjafjallajökull, Iceland

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During the 2010 summit eruption of the glacier-covered Eyjaflallajökull volcano (Iceland) different areas of its glacier were affected by volcano-ice interactions of varying duration and severity. These include: (i) the summit caldera affected by the formation of two eruption vents—the main one active for six weeks; (ii) the short-lived (one day) eruption fissure on the southern flank; (iii) the outlet glacier Gígjökull impacted by subglacial lava propagation over more than two weeks. Lava accumulation started in the caldera and continued northwards, reaching a final length of more than 3 km.

Here we study how the ice cap has evolved after the eruption and how individual areas have changed with time. We use elevation data obtained from Pléiades, SPOT5, LiDAR scans, and overflights, which enabled calculations of elevation changes over varying time periods. Glacier areas from previous studies were used to illustrate the changes in glacier extent, while aerial photographs and on-site investigations helped documenting visual changes. Lastly, we investigated the subglacial environment via Ground Penetrating Radar (GPR) and mapped the depth of tephra layers and volcanic bedrock.

While signs of the eruption on the southern flank have completely vanished, the areas in the caldera have not fully recovered. This is most notably where the subglacial lava was emplaced. Observations from October 2024 also indicate the formation of a new minor cauldron (depression) in the northern part of the caldera. Gígjökull started to recover from the eruption impacts, although the glacier front alternates between advance and retreat—similar to the pre-eruption time. GPR measurements revealed tephra depths ranging between ca. 27–149 m in the caldera, while the bedrock reaches maximum depths of more than 430 m.

Our studies are critical for understanding how single events can impact long-term glacier dynamics and glacier recovery in times of global warming.

Caldera collapse into a compositionally stratified magma reservoir: application to the Loch Ba Ring Dyke

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The Loch Ba ring dyke felsite, part of the Mull igneous centre, exhibits striking magma mingling textures including mafic enclaves, streaks and bands within a rhyolitic host. Mingling textures are dominated by mafic enclaves between 30 and 3000 μm across. The dyke's infill is made up of 85-90% silicic and 10-15% mafic material. The felsite formed in a ring fault magma injection along a ring fracture following a caldera collapse event. Here we image and categorise the mingling textures and develop an analytical model to describe the conditions in the magma chamber before the collapse, and the flow of magma resulting from the fall of the caldera block. The thickness of the mafic layer in the magma chamber is found to have been 5.5–6% of the total chamber thickness. This finding allows constraints to be placed on the compressibility of the overlying silicic magma, which may have been 6×10^{-9} Pa^{-1}, equivalent to a water content of approximately 3 wt%. The compressibility of reservoir-resident magma places an inherent limit on the amount of mafic injection that can occur prior to triggering an eruption via development of a critical overpressure, with wetter magmas being able to accept much higher mafic magma intrusion fluxes prior to eruption triggering, which may have implications for the mechanisms of mixing and mingling that may follow, as well as for eruption style. Collapse of the caldera block would have resulted in differential flow between the two compositionally distinct layers in the chamber, owing to their differences in rheological properties. The mingling textures are thought to have been formed in the ring dyke conduit rather than the magma chamber. Flow in the conduit was complex due to the viscosity contrast of the magmas, volatile exsolution and crystallisation.

Volcano-tectonic controls on the 3D architecture of sub-volcanic magma storage at Campi Flegrei, Italy

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Understanding pre-eruptive magma storage depth(s) is essential for the reliable interpretation of monitoring data at active volcanoes. While geophysical datasets provide important information about the current state of a volcanic system, petrological studies of historic eruptions are essential for determining variability in pre-eruptive conditions beneath long-lived centres. However, as petrological methods rely on pressure-dependent phase equilibria, they provide an inherently one-dimensional insight into magma accumulation depths with no lateral information. Such lateral information may be particularly important in large caldera systems such as Campi Flegrei (Naples, Italy) where recent (<15 kyr) eruptions have been dispersed across a wide area, with vents located in diverse volcano-tectonic settings.

Here, we present an overview of historic petrological and geophysical constraints on magma storage conditions at Campi Flegrei which reveal a complex multi-level magmatic system. We then use a novel machine learning-based clinopyroxene thermobarometric model to systematically supplement these with new high precision crystallisation depth estimates for post-15 kyr magmas erupted at vents across the caldera. By comparing the crystallisation depths of magmas erupted in different spatial locations, we identify lateral variations in magma storage conditions, gaining a three-dimensional picture of the sub-volcanic architecture which agrees with independent geophysical constraints. Importantly, our results show a difference in magma storage depths which correlates with volcano-tectonic setting, indicating a regional structural control on magma storage and evolution. Our results are important for volcano monitoring, suggesting that pre-eruptive activity in different parts of large volcanic systems might be characterised by distinct signs of unrest.

Microstructural Record of Icelandic Crystal Mushes Preserved in Gabbroic Nodules

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Cohesive yet porous frameworks of solid crystals with interstitial melts – crystal mushes – form geometrically complex plumbing systems beneath many active volcanoes [1,2]. In oceanic settings like Iceland, percolating melts and exsolved fluids may generate small eruptible lenses within mush-rich reservoirs stacked between solidified rock [3,4]. Examining pre- and syn-eruptive crystal mush textures can help improve models of magma behaviour (e.g., [5]), as they leave evidence that helps us decode magma storage, remobilisation, and ascent.

We collected gabbroic nodules from Gígöldur in Central Iceland, likely representing fragments of crystal mushes (e.g., [6]). These nodules provide a rare opportunity to investigate mush microstructures and fabrics. EBSD maps were acquired for four nodules spanning troctolite to gabbro to anorthosite, providing crystallographic, textural, and deformation information. This study addresses the following questions:

- Are there deformation structures, crystallographic preferred orientations (CPO), and shape preferred orientations (SPO) present?
- If present, are deformation microstructures controlled by dynamic or static recrystallisation?
- How do CPO and SPO vary with lithology and mineralogy, and what are their origins – deformation, crystal growth, or settling?
- If present, is strain localisation preferentially associated with specific minerals or textural domains?
- Do observed fabrics primarily reflect magmatic alignment, compaction, or post-crystallisation overprint?

The EBSD results of nodules will be contextualised through comparison with fabrics from ophiolites, layered intrusions, and arc cumulates [e.g., 7,8,9,10].

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Plume-Ridge Interactions in the Galápagos: Investigating Long-Distance Geochemical Signatures

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Geochemical variations in lavas erupted from nearby hotspots and mid-ocean ridge volcanism could provide key insights into how these systems interact dynamically in the shallow mantle. At several locations on Earth, mid-ocean ridges and hotspots occur in close proximity, leading to interaction between the two systems [1].

The Galápagos archipelago is an ideal case study for investigating plume-ridge interactions, as the Galápagos plume and the Galápagos Spreading Center (GSC) are ~250 km apart, allowing them to remain geodynamically distinct yet close enough to interact geochemically [1].
Geophysical and geochemical studies of the GSC report evidence of plume-derived geochemical signatures along the ridge, as well as volcanic features such as seamount chains linking the two systems [1,2]. However, the processes that govern geochemical exchange and transport between the systems are poorly understood [2]. Two contrasting hypotheses of transport mechanics have been proposed to explain plume ridge interaction [2,3].

The first hypothesis suggests asthenospheric mantle flow entrains plume material and transports it towards the ridge (single-phase Stokes flow). The second proposes that interconnected melt networks enable lateral melt transport between the two systems (two-phase Stokes-Darcy flow) [2,3]. Both proposed transport processes are expected to operate over different timescales and generate distinct geochemical signatures between the plume and the ridge.

To test these competing hypotheses and explore the parameter space governing plume-ridge interactions, we have developed a two-dimensional staggered-grid finite difference model in MATLAB, based on the framework of [4]. Unlike previous models [3,5], this approach incorporates both solid state flow and two-phase flow to enable direct comparisons between the two end-member transport mechanisms. Additionally, the model contains a multi-component geochemical model that tracks the evolution of a suite of major oxides, trace elements, and isotope ratios. This allows for comparison with the observed geochemical signatures of the Galápagos system.

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Understanding Precursory Plinian Eruptions in the Lead-Up to Large Caldera-Forming Eruptions

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Caldera-forming eruptions represent some of the most significant explosive events throughout Earth's history, yet the processes that lead to their initiation remain debated. Many major caldera eruptions are preceded by minor Plinian phases, which may reflect changes in magma composition, volatile content and thermal conditions within the crust prior to catastrophic failure. This project investigates whether consistent patterns can be identified between these precursory and climactic stages by comparing several well-documented volcanic systems.

We have compiled published whole-rock, glass, and melt inclusion data from peer-reviewed literature and global databases such as GEOROC and LaMEVE. Krakatau (1883 CE) is examined in detail as the primary case study, with additional comparative analysis of Tambora (1815 CE), Santorini (~1600 BCE), Santorini (~172 ka), Vesuvius (79 AD), Tenerife (~600 ka), Kurile Lake (~7.6 ka), Ksudach (240 AD), Mount Mazama (~7.7 ka), Oruanui Taupō (~26.5 ka), and Aira Caldera (~30 ka). Major-oxide compositions, volatile concentrations, temperature estimates and documented intervals between eruptive phases are standardised and assessed together to evaluate temporal and geochemical trends.

Initial synthesis suggests that systems with short precursor intervals tend to display larger contrasts in SiO_2, FeOt, volatile contents and pre-eruptive temperatures between precursory and climactic phases. These contrasts may reflect more rapid recharge of hotter, volatile-rich magma into shallower, cooler reservoirs, leading to overpressure and instability. By comparing multiple volcanic systems, this project aims to clarify whether such relationships are consistent across different tectono-magmatic settings, and how they contribute to develop large caldera-forming eruptions; in turn potentially providing an opportunity to more accurately forecast eruptions in the future.

Estimating the intensity of explosive volcanic eruptions using satellite observations of wind-blown volcanic cloud spreading

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The dynamical evolution of volcanic plumes has important implications for the prediction of ash cloud formation and dispersal, and its associated hazards. Volcanic ash transport and dispersion models rely on input eruption source parameters, of which the eruption intensity is one of the most important. There are several methods to estimate eruption intensity, most notably; (i) a posteriori quantification from field work, which is not relevant operationally, (ii) inverting from plume height using an eruption column model, and (iii) inverting the volume flux from the spreading rate of the volcanic cloud, which can then be converted into a mass flux (i.e., eruption intensity). Here, we expand on the third method by utilising geostationary satellites to retrieve the spreading rate of the volcanic cloud, which is then inputted into spreading rate models to determine the volume flux. Previous studies typically assume that the plume spreads axisymmetrically, as an umbrella cloud, in a quiescent atmosphere and are thus not applicable for the full range of eruption intensity and wind conditions governing volcanic cloud spreading. Existing workflows to extract volcanic cloud growth rates also propagate few sources of uncertainty, if any, and might be challenging to apply to volcanic plumes rising in cloudy atmospheres. Here, we present a new workflow to extract volcanic cloud growth rate which is applicable to a wider range of eruption and atmospheric conditions and characterises most uncertainties relevant to spreading rate models. We then compare volume flux predictions from existing models to those from a new non-axisymmetric model which accounts for atmospheric wind. We discuss systematic differences between models, the magnitude of uncertainties, and their dependence on eruption and atmospheric characteristics; whilst also considering applications to operational ash dispersion forecast and volcanic plume modelling.

Some new insights from the OH^- content of clinopyroxenes in ocean islands basalts

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Clinopyroxenes (cpxs) are common as phenocrysts in many volcanic rocks and are often used to study the physico-chemical properties of magmatic systems located under volcanoes. While cpx is a nominally anhydrous mineral, it contains trace amount of structural OH^- (broadly defined here as "water") present in various vacancy sites within its crystal lattice [1]. In theory, by utilising H_2O partitioning models between silicate melts and cpxs [2], the water content of silicate melts in equilibrium with cpxs can be calculated. This approach has been used to estimate the pre-eruptive water contents of melts from various geodynamic settings (ocean island-, continental intraplate-, and subduction-related magmas [3-5]) and can potentially be used at localities where other methods, such as analyses of rapidly quenched glassy melt inclusions (MIs), are not feasible.

To investigate whether cpxs faithfully record the water content of magmas, we analysed 49 cpx crystals from five ocean islands (El Hierro in the Canary Islands, Pico and São Miguel in the Azores, Saint Helena, and Tristan da Cunha). Our dataset is based on 14 different samples, including lavas, scorious blocks, and loose scoria deposits. Water contents in cpxs vary from below detection limit (<3 µg/g) to 440 µg/g; both these values were measured in Saint Helena samples. The maximum value corresponds to 2.6 wt% H_2O in the equilibrium melt. In comparison, Tristan da Cunha cpxs contain less than 60 µg/g H_2O, indicating <0.5 wt% melt water content. Experimentally homogenised olivine-hosted MIs from the same samples contain up to 0.4 wt% H_2O at Saint Helena but reach 1.7 wt% at Tristan da Cunha. Low cpx H_2O contents were determined from Pico (up to 196 µg/g), Sao Miguel (up to 144 µg/g), and El Hierro (219 µg/g), and calculated equilibrium melt water contents are mostly below those measured from olivine-hosted MIs from the same islands.

While low water contents indicate that most studied cpxs lost H_2O via diffusion [3], we find no significant difference between the H_2O contents of most crystal rims and cores. This can indicate that most cpxs have completely re-equilibrated between magma storage and the surface, but in some cases, they will not lose any OH^- at all (such as three of our four Saint Helena samples). Surprisingly, we find the highest water contents in slowly cooled lava samples from Saint Helena, while mostly water-poor cpxs were present in fast-cooled scoria samples from other islands. This indicates a complex post-eruption cooling history for our samples that, in most cases, overprints magmatic water contents in clinopyroxenes.

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Investigating the behaviour of sulphur under St Vincent, Lesser Antilles Arc

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The formation and accumulation of crustal sulphides in volcanic arcs is sensitive to changes in pressure, temperature, oxygen fugacity and magma composition during differentiation [1]. Investigation of sulphide occurrence and composition informs on magmatic processes in the crust. The Lesser Antilles Arc (LAA) is a key location to investigate these processes due to the abundance of crustal xenoliths which provide insight into magmatic processes at a range of depths [2].

From St Vincent 111 xenoliths, 31 sulphide-bearing, were examined petrographically to identify sulphide relationships with host phases and volume proportions. Six textural groups were identified, with variable sulphide abundance, composition and occurrence. Sulphide abundance is highest in altered xenoliths, including recrystallised meta-igneous and hydrothermally altered samples, compared to true igneous cumulates, indicating sulphur remobilisation is important in crustal sulphide accumulation. Cumulate, meta-igneous and plutonic crustal xenoliths, predominantly from upper to mid-crust (pressure range ~0.2-0.7 GPa), showed compositions dominated by olivine and hornblende gabbro. Sulphide-hosting silicate mineral composition in these xenoliths, measured via electron probe micro-analysis, was used in thermobarometric calculations to estimate silicate crystallisation pressure and temperature conditions. These, with modelling of sulphur concentration at sulphide saturation (SCSS) during magmatic differentiation using PySulfSat [3], were used to constrain conditions where SCSS was reached within the magma. Finally, a mass balance approach was used to calculate the mass of sulphur stored within the crust which was used alongside literature data to develop a sulphur budget for this magmatic system.

Results show the importance of amphibole and titanomagnetite fractionation in multi-stage sulphide saturation during magmatic differentiation. SCSS was reached at ≥ mid-crustal pressures with a temperature range of 930-1060 ^{o}C. Mass balance calculations, using the LAA magma production rate over the St Vincent arc segment [4], suggested significant storage of sulphur (~3.5×10^{-4} kg S/kg magma) within crustal sulphide accumulations below St Vincent.

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Why Automated Mineralogy needed an upgrade

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Automated Mineralogy – the past

The automated classification of mineral phases in rocks has been a mainstay of the Geoscience analytical community for over 40 years. While we have seen great leaps forward in AI in µCT and light microscopy/petrography, the automated capabilities for the SEM have progressed and changed very little in decades, relying heavily on outdated methods that were available at the time.
The technology come with several significant problems moving forward, including excessive hardware-software dependencies, complex mineral libraries and classifications, inconsistent user experience, and difficult workflows outside their intended use.

Recent technological advances

There are two broad shifts that are taking place across a number of microscopy and microanalysis techniques – the acquisition of more quantitative data, and the application of deep learning neural networks. As a general trend this can be thought of as building better datasets, and building bigger datasets.
EDS as a SEM-based technique is fertile territory for both of these shifts. As an analytical technique EDS is commonly applied qualitatively, or as an image based method for distinguishing regions based on chemical maps. In recent years it has become easier than ever before to calibrate systems and detectors for concentration data, meaning the SEM can generate more robust datasets without having to fall back on other techniques.
Deep Learning is a topic that covers a broad range of mathematical applications to everything from the acquisition of microscopy datasets, through to data processing and interpretation across almost all sciences. There are many different flavours of deep learning neural network (DLNN) and each type lends itself to different applications, particularly in the varied data rich environments of microscopy. DLNN are inherently hard to track exactly how they operate, but at their best should be easy to use, and easy to understand how they've been applied to a scientific problem.

Automated Mineralogy – the future

The introduction of both quantitative mineral chemistry and DLNN to automated mineral classification is a huge leap forward, solving many of the problems of traditional software. Detaching data acquisition from processing removes software dependencies and frees users to build their ideal system. An DLNN-driven, unsupervised data processing approach can be data led rather than user led, making it more robust and consistent across instruments and facilities. Quantitative analysis can build on the DLNN approach by allowing a "best fit" classification, removing the need for constant modification of mineral libraries, and simply allowing "textbook" globally consistent mineral compositions to drive the labelling of segmented data.

Using satellite data to estimate the ascent speeds of eruption columns

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The Advanced Baseline Imager (ABI) on the Geostationary Operational Environmental Satellite (GOES) made measurements of a large fraction of the April 2021 La Soufrière eruption on St Vincent at one-minute intervals. In a previous study, we used this data to identify individual explosive events: totalling 35 events in a 2-week period [1].

The high-resolution dataset offers a unique opportunity to observe the rising ash columns and the dispersal of the ash away from the source. Combining information about the maximum height (based on a variety of satellite methods and datasets, including [2]), the time at which the column reaches it maximum height (as seen in the satellite data) and seismic information [3] which indicates the start time, we've estimated average ascent rates for 18 events. For the majority of events studied this was between 20 and 35 m/s.

Expanding on this, we are currently employing multiple methods to estimate how the ascent rate varies in the rising column. This includes employing temperature measurements, the parallax between the satellite and volcanic cloud and the changing radius of the rising column.

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Blurring the boundaries between explosive and effusive eruption styles: New Evidence for Sintering-Driven Eruption Transitions

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Understanding the controls on explosive-effusive volcanic eruption transitions is central to hazard management and fundamental to building a more complete picture of eruption dynamics. While traditional models suggest that explosive and effusive eruptions represent very distinct behaviours, timescales, and eruption-associated hazards [1],[2], most silicic eruptions exhibit a more complex eruptive behaviour, with distinct dominantly explosive and dominantly effusive phases ranging from simultaneous to separated in time by years [3]. A recent conceptual eruption model [4] proposed that the fragmentation and subsequent sintering of material within the conduit may explain both explosive and effusive eruptions, thereby blurring the eruptive style boundaries previously established. Here, we investigate this model by measuring material properties – porosity and permeability – of 150 samples from more than ten iconic eruptions representing both explosive (ignimbrites) and effusive (lava domes) events, and present macro- and micro-textures with a focus on the pore network. Our results provide visual and empirical evidence of sintering dynamics in dome rocks, supported by a large database revealing shared characteristics between effusive and explosive magma samples. We identify that there is a significant overlap in physical properties across both types of samples, including the presence of clastic sintering relic textures in dome rocks, features previously associated primarily with explosive products. We provide evidence here that sintering is a key process governing eruptive transitions. By quantifying the similarities between effusive and explosive volcanic rocks, these discoveries and new datasets contribute to our understanding of eruption styles, paving the way for a new interpretation of conduit processes operating before, during, and after volcanic eruption.

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Preliminary characterizations of rhyolitic reticulites from Torfajokull, Iceland

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We present preliminary characterizations of a series of juvenile rhyolitic pyroclasts with unusually high porosities, from deposits of the VEI~3 c.877 CE (HRN) eruption, Torfajökull volcanic complex, Iceland, sampled from a proximal (<2km from vent) fall tephra deposit. We quantitatively analyse samples of these clasts by gas pycnometry, transmitted light microscopy, scanning-electron microscopy (SEM), and X-ray computed tomography (XCT).

The high-vesicularity endmember clasts are ~95% porous and near-isometric, with polyhedral, honeycomb-like vesicle structures. Importantly, these clasts contain very low bubble number densities (BNDs) of ~10^{10} m^{-3}, compared to typical BNDs for rhyolitic pumices (~10^{14}-10^{17} m^{-3}; [1]). As such, these HRN pyroclasts are texturally comparable to basaltic reticulites [2], but with most vesicle walls remaining intact, such that they remain impermeable on >mm lengthscales.

The extremely low BNDs of the HRN reticulites largely preclude them as the direct products of rapid decompression alongside the "standard" pumices within the deposit [3]. Instead, we posit that these HRN reticulites form, alongside associated obsidian pyroclasts, from sintering materials on the conduit linings [4]. In this framework, formation of the reticulites may be attributed to either a prolonged dwell in the conduit lining, and/or response to transient pressure decrease, both of which may facilitate a high total vesicularity, low- number density vesicle population.

Ultimately, the presence of these reticulites reflects the complex interplay between sintering and vesiculation in the shallow conduit during rhyolitic eruptions [5]. Additional, ongoing work aims to examine if these reticulites reflect unique conditions during the HRN eruption or record a previously unrecognised but more common feature of moderate-intensity rhyolitic eruptions.

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Towards a genetic framework for the post-Variscan intrusive rocks of Southwest England

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Volcanic units are typically classified using lithostratigraphic conventions such as the North American Stratigraphic Code, but intrusive igneous rocks (lithodemes) currently lack an internationally accepted hierarchical system. In the UK, existing approaches vary widely: some classifications are highly detailed but locally focused – based on individual plutons or groups of intrusions – or rely on mapped intrusion morphology and arbitrary spatial divisions [e.g. 1]. These inconsistent approaches hamper data integration with digital systems and obscure genetic relationships between mapped units.

We propose a hierarchical framework for igneous intrusive units to address these challenges and support both digital geological model development and stakeholder engagement with the UK's igneous systems. This framework prioritises capturing magmatic architecture formed during the incremental construction of intrusive systems and identifying cogenetic relationships across multiple scales. It is designed to be flexible, accommodating variable data density, natural variability and future updates or additions.

We demonstrate this approach using the post-Variscan rocks of southwest England – a geologically complex and data-rich intrusive suite. In addition to lithological descriptions, the framework draws upon the rich petrographical, mineralogical, geochemical and geochronological data of the suite [e.g. 2]. While intrusive igneous systems do not follow the law of superposition that underpins lithostratigraphical classification, we highlight the importance of integrating the relative field-based temporal constraints with high-precision geochronology to define hierarchical relationships within these systems.

This 6-rank framework is transferable to other intrusive systems across the UK and beyond and is interoperable with existing stratigraphic schemes. By placing genetic relationships at the core of the classification, it supports a more consistent understanding of UK magmatism and enables geological models that better reflect the complexity of intrusive systems. It also opens new opportunities to refine stratigraphic frameworks by aligning intrusive units with their volcanic counterparts across spatial and temporal scales.

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How topography and crustal structure control surface displacement at marine volcanoes

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Magma ascent and gravitational readjustments cause deformation of volcanic edifices. Robust knowledge of these deformation source types and their parameters are critical for hazard assessment. Geodetic monitoring of volcanoes constrains models that shall reveal these sources. Monitoring networks are typically installed near the summit, where the largest deformation signals are expected. In the case of marine volcanoes, measurements are typically limited to the subaerial part only. With often >90% of the edifice being submerged [1], it is obvious that the resulting models are only well constrained for a marginal part of the edifice.

In our numerical and analogue models, we consider volcano topography from seafloor to summit and variable basement structures underneath and away from volcanoes. We analyse surface deformation and structure and find that (i) deformation tends to focus on morphological features and complexities often found offshore (Fig. 1), (ii) the structural setting also away from the edifice influences deformation patterns as well as magnitudes, and (iii) volcano topography impacts dike propagation through heterogeneous distribution of shear stresses. This suggests that monitoring networks may miss out significant deformation signals and models limited to subaerial sectors and ignoring topography may be ill-constrained. Both shortcomings will lead to erroneous source parameter estimations, which are particularly relevant for marine volcanoes. If we want to be able to interpret deformation signals correctly, we need to include the structure and the dynamics of the submerged surroundings of the volcano in our monitoring networks and models.

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Volcanic plumes: A natural analogue for solar radiation management

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With current mitigation efforts, it is "almost inevitable" that global warming will exceed 1.5 °C above the pre-industrial average [1]. Consequently, some research examines an overshoot scenario, where Greenhouse Gas Removal (GGR) stabilises atmospheric carbon dioxide concentrations to achieve <1.5 °C warming after a period exceeding these temperatures. However, adverse impacts from global warming are already widespread [2]. As a result, there is increasing interest in Solar Radiation Management (SRM), such as Stratospheric Aerosol Injection (SAI) and Marine Cloud Brightening (MCB) [3, 4]. These controversial technologies could lower temperatures during an overshoot and avoid key tipping points in the Earth Climate system, though researchers generally warn that SRM alone is an insufficient policy response to climate change [3].

Volcanoes provide a natural analogue to both SAI and MCB. The 1991 Pinatubo eruption demonstrated that sulfate aerosols in the stratosphere can reduce global temperatures by reflecting sunlight [4]. Similarly, observations at marine volcanoes measured reduced cloud droplet size and increased albedo as a direct consequence of SO_2 injection from quiescent degassing into the marine boundary layer [5]. The MACE Project at the University of Bristol, as part of the broader ARIA 'Exploring Climate Cooling' funding programme [7], will study volcanoes as a natural analogue of both SAI and MCB. We are developing an ~8 m wingspan UAS solar glider capable of carrying a 1 kg payload to 10,000 m altitude. Among other measurements, we will quantify the SO_2, the albedo, particle size, and particle number of aerosols in the plume. We aim to illuminate chemical and aerosol processes occurring in volcanic SO_2 plumes, helping inform volcanic, climate and climate intervention models.

We welcome discussions on the chemical and particulate properties of volcanic plumes, climate engineering ethics and other potential volcanological applications of the UAS airframe we are developing.

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Volcanic deposits on the Tonga forearc and trench: new insights from direct crewed submersible observations.

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A multitude of complex and dynamic geological and environmental processes produces a highly variable and incomplete record of rock exposures at depth. Volcanic sequences in forearc regions can provide insights into records of past eruptive activity otherwise missing from proximal exposures and therefore inform reconstructions of arc evolution.

This study reviews crewed submersible footage from two dives of the Tonga Trench Expedition (Inkfish Open Ocean Program), targeting volcanic sequences and exposures on the Tonga forearc and trench slope at depths of 5273 and 8497 mbsl. The aim is to establish a baseline visual characterisation of these volcanic units and contextualise them by documenting their spatial relationships, depositional settings and likely origins.

Interpreted sequences reveal repeating units from subaerial explosive and effusive eruptions, capturing key stages in Tonga forearc volcanism. These observations represent the first crewed submersible documentation of volcanic exposures on the Tonga forearc and trench, providing rare insights into previously inaccessible depths. Targeted geological transects enhance understanding of the region's geological evolution and the structure of the exposed basement. Overall, this study highlights the value of in-situ visual investigation in advancing knowledge of forearc structure and guiding future sampling and research.

Capturing shear instabilities, pulses and current behaviours at the current-substrate boundary zone of granular currents.

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The dynamics of granular currents, such as mass flux and unsteadiness, together with the strength of the underlying substrate, can fundamentally control erosion and deposition. In turn, these processes influence current behaviour. Sedimentary features preserve crucial records of current-substrate interactions, but their formation is typically obscured in natural settings and may be difficult to interpret in the sedimentary record. Analogue modelling can enhance understanding of these interactions, improving interpretations of physical processes, deposit formation, and potential hazard.

This study employed analogue flume experiments to observe interactions between a fluidised granular current and a stationary erodible substrate with varied moisture conditions. The final deposit was solidified using gelatin and sectioned longitudinally to reveal internal 3D features. Under dry conditions (0 wt.% moisture), complex, stepped flame-like features formed, driven by current unsteadiness and pulsatory behaviour. The influence of apparent cohesion on current-substrate interactions was investigated by adding 2.5 wt.% moisture to the loose substrate. The addition of moisture suppressed erosion and remobilisation, resulting in the lofting of discrete clumps of cohesive material into the current and less intricate flame-like features.

We apply these insights to current-substrate interactions in pyroclastic density currents (PDCs). The experiments provide direct evidence that substrate cohesion can fundamentally alter erosion and remobilisation, changing interactions at the current-substrate interface and offering new insights into flow boundary zone interactions and PDC behaviour.

Volcanic Ash Fall Risk to Marine Traffic and Infrastructure

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We present a framework to assess the risk from volcanic ash fall to marine traffic and infrastructure on a regional scale. No method currently exists to assess the risk that ash fall poses to marine activity, despite evidence that vessels and port infrastructure are vulnerable to this hazard. Scenario-based ensemble simulations for ash dispersal were performed using the AshDisperse model, incorporating monsoon season constraints. Scenarios conditional on the volcanic explosivity index (VEI) were informed by volcano-specific eruptive histories for the study region in Indonesia. Exposure was evaluated using shipping density data and port locations. Vulnerability was incorporated into ash thickness thresholds, determined by the potential to damage or disrupt critical marine infrastructure.

We further explore the impact of seasonal variation on the hazard distribution for several case study volcanoes in the region. Seasonal winds influence the strength of the prevailing easterly winds. Whilst dominant in all seasons, northwest monsoon winds introduce a secondary westerly component. In the VEI2 to 4 scenarios this influence is evident through a west-east ash dispersal axis. Winds from the southeast monsoon strengthen the prevailing easterly wind, shifting the ash dispersal footprint westward and reducing dispersal to the east. Traffic activity and port locations are unevenly distributed within the study region and therefore the exposure and subsequently risk changes with seasons. Further work is required to develop a suitable description of the full range of exposed activities to properly quantify the risk posed to marine traffic and infrastructure.

Characteristics and origins of two young volcano-sedimentary units within the Santorini's intracaldera fill

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Santorini (Greece) is an active multi-cyclic caldera within the Southern Aegean Volcanic Arc [1], resulting from the subduction of the African Plate beneath Eurasia [2]. Although Santorini is one of the best documented caldera systems in the world, understanding of the post-collapse volcanic and non-volcanic activity preserved in its volcano-sedimentary intracaldera fill remains incomplete. Sediment cores collected during International Ocean Discovery Program Expedition 398 provide an opportunity to characterise and understand the composition, history, and origins of these intracaldera deposits and elucidate the recent evolution of the Santorini volcanic system [3].

In this study, we characterised two independent major volcano-sedimentary units, L4 and L2, through physical componentry and scanning electron microscope analysis of their volcaniclastic components. L4 is a 40m thick sequence of coarse pumice lapilli and heterogeneous lithic gravel clasts. It was found to be graded but structureless, with features characteristic of gravity-driven sedimentation and reworking during emplacement. We interpret L4 as a caldera-flooding submarine turbidite, aligning with the volcaniclastic flow deposits expected from numerical models of post-eruptive caldera-flooding [4]. Higher up in the stratigraphy, L2 is a 34m thick deposit of pumice and ash, interpreted as the eruptive products of the submarine 726 CE eruption [5]. Trends in core stratigraphy, microtextures, and petrography confirm L2 as a single submarine explosive eruption with interpretations of an initial lithic-rich vent clearing phase and later increased juvenile material production with phreatomagmatic explosions. The results highlight hazards from both post-eruptive flooding, volcaniclastic flows and explosive volcanic activity within Santorini's current post-collapse volcanic cycle. Ultimately, this implies the need for improved hazard assessments and risk mitigation strategies in the event of future post-collapse activity at Santorini.

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Link between magma reservoir, caldera formation and lava flow layering revealed by 3D seismic reflection imaging at Axial volcano in SE Pacific

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Large lava flows form shield volcanos on land, and every active large shield volcano has a magma reservoir at depth and a caldera, but how the lava flows shape and re-shape the caldera and how the magma reservoir drives the caldera formation remain unknown because of the lack of high-resolution images of the lava flowing layering and magma reservoir. Using 3D seismic reflection imaging technique, here we present 3D image of magma reservoir at depth and lava flow layering from seafloor down to the magma reservoir, allowing to construct the time evolution of different calderas and lava flow layering. Although the present caldera was formed around 1200 years ago, the eastern part of the caldera has been filled by lava flows since its formation. We also observed a couple of more caldera buried by lava flows. Lava flow layering gently dip inward towards the rift zones, possibly caused by subsidence due to extension and emptying of magma reservoir. These lava flow layering coalesces with the magma reservoir, indicating the absence of thick dike sequence, possibly caused by assimilation of lava flows and dike sequence with the magma reservoir. The magma reservoir is marked by a strong reflection, which interpret as the crustal lithosphere-asthenosphere boundary (LAB). The seismic reflectivity below the LAB indicate that the magma migrates upward along this thermal boundary, accumulates in a shallow melt sill before eruption.

Seismic evidence for the upper crustal accretion by long-distance lateral dyke injection at the Lucky Strike segment of Mid-Atlantic Ridge

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Oceanic crust is formed along mid-ocean ridges by a combination of magmatic accretion and tectonic extension. The conventional view of oceanic crustal accretion is that magma migrates from the mantle to a crustal magma reservoir, which erupts to the surface forming lava flow through narrow vertical dykes, together making up the upper crust that is subsequently modified and thinned by faulting. This simple one-dimensional model magmatic accretion and two-dimensional tectonic extension stems from the observation of nearly continuous axial melt lenses (AMLs) beneath fast- to intermediate-spreading ridges and limited variation in upper crustal thickness along ridge axis. However, the available observations at slow-spreading ridges suggest that the AML is concentrated to the central portion of ridge segments (e.g. [1]), challenging the conventional model of oceanic crustal accretion. By applying full waveform inversion to wide-angle ocean bottom seismometer data from the ~70 km-long slow-spreading (full rate of 21 mm/year) Lucky Strike segment at 37°N on the Mid-Atlantic Ridge, we show that although the crustal thickness varies from ~8.4 km at the segment centre to ~3.9 km at segment ends, the upper crustal thickness remains nearly constant (~3.0 km) [2]. The large variation in crustal thickness is dominantly due to the thinning of lower crust, which accounts for ~2/3 of crustal thickness at the segment centre but only 10% at segment ends. We suggest that most of the upper crust on this ridge segment is formed by lateral dyke propagation from the melt-rich segment centre to melt-poor segment ends. The petrology of basalts from the Lucky Strike segment indicates that melt is more primitive at the segment centre and gets more evolved towards segment ends, supporting our interpretation [3]. These observations suggest that the magmatic accretion and tectonic extension along slow-spreading ridges are highly three-dimensional.

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Interplay between the Afar mantle upwelling and the overriding plates

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The arrival of upwellings within the mantle from Earths deep interior are commonly observed worldwide, but their role in driving volcanism during continental breakup has long been debated. Given that only a small fraction of Earth's upwellings are situated under continents and a limited number of them are associated with active continental rifting, our understanding of these processes remains incomplete.

Here, we investigate the interplay between continental breakup and mantle upwellings using the classic magma-rich continental rifting case study of the Afar triple junction in East Africa. Some studies previously proposed that the region is underlain by mantle upwelling(s), yet others argue for limited involvement of mantle plumes. Several discrete segments of the rift have been studied in terms of magma petrogenesis. However, until now, a paucity of high-precision geochemical data across the broader region has hampered our ability to test the models and evaluate the spatial characteristics and structure of this upwelling in the recent geologic past.

Within this study, we present extensive new geochemical and isotopic data spanning the region and integrate these with existing geochemical and geophysical datasets shedding light on the spatial characteristics of the mantle beneath Afar. By combining geophysics and geochemistry using statistical approaches, our multi-disciplinary approach suggests that Afar is underlain by a single, asymmetric heterogeneous mantle upwelling. Our findings not only validate the heterogeneous characteristics of mantle upwellings, but demonstrates their susceptibility to the dynamics of the overriding plates. This integrated approach yields valuable insights into the spatial complexity of mantle upwellings.

An integrated proximal-distal Tephrochronology of Towada Caldera, northern Honshu (Japan).

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Integrating proximal volcanic records with distal tephra (marine-lacustrine-ice) archives is essential to: reliably reconstructing the past eruptive activity of a volcano, tackling potential near-source eruption under-reporting, and offering opportunities to robustly constrain the timing and scale of past eruptions. Towada volcano, located in northeast Japan, became active ~220 ka [1,2] and has undergone a minimum of 20 eruptive episodes [3]. Towada provides an opportunity to showcase an integrated proximal-distal tephra record, with the volcano providing a key node in the Tephrochronological framework of East Asia and beyond. Large-magnitude events at Towada caldera are known to produce widely traced tephra deposits as both visible and cryptotephra (non-visible) layers, thus providing the potential to better constrain its eruptive history and tephra dispersals.

Here, we present new volcanic glass geochemical data (EMP and LA-ICP-MS) from proximal sequences, alongside tephra deposits preserved in lacustrine, marine, and ice core records to further refine the ash fall distributions associated with large-scale eruptions at Towada. Alongside this, we report improved ages for the last two caldera forming eruptions To-H and Towada Ofudo (To-Of), with a precise wiggle-match ^{14}C date for To-H allowing a re-assessment of the regional ^{14}C marine reservoir correction factor for the NW Pacific during the late glacial. These new data allow us to present an updated chronology of the Towada caldera eruptive event stratigraphy, highlighting the requirement of detailed geochemical fingerprinting when correlating tephra units, whilst also emphasising the importance of distal sedimentary records in evaluating eruptive histories in Japan.

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Magma connectivity in a continental rift: Insights from geodetic observations during the 2024-2025 dikes at Fentale, Main Ethiopian Rift

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Direct observations of dike intrusions during continental magmatic rifting are rare. Therefore, magma plumbing systems and associated hazards in continental rifts are not well understood. The 2024-2025 rifting event in the Fentale-Dofen magmatic segment of the Main Ethiopian Rift involved the prolonged intrusion of a ~50 km long dike into ~35 km thick continental crust. The intrusion was accompanied by deflation at Fentale lasting over 2 months. Satellite-based Interferometric Synthetic Aperture Radar (InSAR) observations at regular intervals throughout the intrusion allow us to monitor the co-evolution of the magma source and the intrusion using surface deformation data.

Modelled dike volumes (>1 km^3) are 4-9 times larger than the volume loss of the ~6 km deep deflating magma reservoir beneath Fentale. At other systems, this volume mismatch has been attributed to host rock rigidity, reservoir geometry, and magma compressibility. While the total dike to source volume ratio is typically reported, this ratio may vary during the diking event due to changes in gas content and compressibility, or involvement of multiple sources. Temporally-dense displacement measurements of the intrusion at Fentale present an opportunity to investigate the evolution of the dike to source volume ratio *during* a continental rifting event, providing a novel constraint on the conditions for magmatic storage and transport.

We create a timeseries of magma source to dike volume ratio over the ~3 month-long diking episode, comparing this against analytical models to test whether and how the mechanical properties of the magma, or the magma sources(s) being tapped by the dike changed over time. Our model is further informed by ongoing post-diking ground uplift at Fentale, pointing towards magmatic recharge and re-pressurisation of the system. Continuous monitoring of deformation will contribute to our understanding of threshold conditions for reservoir failure, with implications for forecasting the spatio-temporal likelihood of future intrusions.

Does Crustal Heterogeneity Control Diversity in Volcanic Systems? A Case Study from the Gegham Neovolcanic Zone, Armenia

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The propagation and storage of magma within the crust is strongly influenced by lithological, structural and mechanical variations that govern permeability, migration pathways, and stalling depth. These crustal factors, including bedding orientation, fault geometry and impermeable layers, shape magmatic architecture [1]. Recent scientific understanding has shifted to recognise a complex, multi-tier, mush-dominated model rather than the single, molten chamber [2]. The diversity of upper-crust magmatic structures implies that crustal heterogeneity is a fundamental control on magma evolution and surface expression [3]. The greatest variability exists in tectonically complex crust such as continental collision zones, where contrasting lithologies and fault geometries can exert the most influence on pre-eruptive magmatic development.

Central Armenia provides an ideal setting to investigate these interactions, featuring heterogeneity in the form of multi-collisional-zone continental crust. Two Palaeogene collisional events resulted in highly varied bedrock geology, with extensive faulting separated by apparent crustal blocks, and contrasting metamorphic and sedimentary lithologies [4]. The Gegham region hosts Plio-Pleistocene volcanic products widely varied in composition and eruptive style, with a significant temporal gap between collisional events and the onset of volcanism [5].

This multi-disciplinary project combines petrographic, geochemical and remote sensing data to gain new insights into the control of crustal architecture on magmatic variability within Armenia. Mineral and whole-rock major and trace element data are utilised in conjunction with petrography, and at this stage in the project, trace element analysis of plagioclase provides evidence of variable storage conditions prior to eruption. GIS analysis maps surface indicators of heterogeneity as well as the distribution of volcanics, and has revealed extensive fault systems, variations in bedrock lithology, and variations in crustal thickness. These datasets will be combined to reveal how heterogeneity in the crust impacts magma storage, migration and evolution in a complex continental setting.

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Poster presentation, Session 2: Magma generation, storage and transport

600,000 years of Pleistocene explosive volcanism from the Canary Islands preserved in ODP Leg 157 marine cores

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Ocean island volcanoes in the North Atlantic (Azores and Canary Islands) have experienced numerous large explosive eruptions, dispersing ash over Europe and the North West African continent. The proximal eruption stratigraphies of these are fragmentary, owing to significant off-shore deposition and on-shore erosion, which results in incomplete volcanic histories. Marine cores recovered from the ODP Leg 157 cruise, within 150 km of the Canary Islands, are valuable records of explosive volcanism from Tenerife and Gran Canaria over the last 600,000 years, but these have not yet been comprehensively explored. Here, we present the tephrostratigraphic record preserved in three cores (953, 954, 956), used to build an integrated eruption record for Tenerife, with preliminary geochemical results obtained from single-grain glass shard analyses. We find evidence of ~90 volcaniclastic deposits in core 953 spanning the last ~600,000 years, consistent with frequent eruptive activity, likely relating to the Tenerife Formations Diego Hernandez (>370,000 – 175,000 years) and Guajara (850,000 – 570,000). Accurately distinguishing between primary and secondary tephra deposits in these sequences will be vital for constraining the timing and tempo of explosive volcanism from both Tenerife and Gran Canaria. Moreover, integrating these with the incomplete near vent record will offer valuable insights into the eruption histories of the islands and improve constraints on the origin and ages of distal ash fallout preserved in archaeological sequences in North West Africa, a key aim of the CAVES Africa Project.

Understanding magma ascent – a study using geophysical, geochemical and analogue modelling techniques

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Improving eruption forecasting is crucial for reducing volcanic risk. This was illustrated during the 2021 eruption of La Palma, the most significant in the island's recorded history, which caused significant damage to infrastructure and property. This eruption is extremely well studied, and has allowed the forewarning signals prior to the eruption to be well constrained and analysed. The key to interpreting forewarning signals is understanding magma ascent in the crust. This is often done using surface imaging from geodetic data to monitor magma movement, and importantly, these techniques are often used in decision-making in the event of volcanic unrest. Analogue modelling provides unique insight into the processes occurring in the subsurface, and allows 'intrusions' to be visualised in a way that is not possible in natural systems. This project aims to use analogue modelling techniques to improve interpretations from geodetic data, by recreating datasets using a gelatine analogue. By adapting existing inversion modelling approaches (e.g. Geodetic Bayesian Inversion Software (GBIS) [1]), their accuracy can be evaluated, as many struggle with complex crustal architecture (e.g. layers, faults, mechanically diverse beds), topographic variations and complex magma plumbing systems. By recreating these features in an analogue model and applying inversion modelling approaches, the geometry of the analogue intrusion can be compared with that predicted by the inversion model, and its accuracy assessed. By improving these inversion models and combining with analogue modelling techniques and real geochemical and geophysical data, a comprehensive model for magma ascent can be developed. This project will use the well documented 2021 eruption of La Palma to integrate the physical and chemical signals of magma ascent, laying the groundwork for improved interpretation of eruption precursory signals worldwide.

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Modelling surface displacement associated with sheet-like intrusions: effect of overburden thickness and rigidity variations

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Magma transport within dykes and sills fractures and deforms the country rock, leading to displacements that can be detected at the surface. The form and magnitude of this displacement relates to the geometry and size of the intrusion, as well as its emplacement depth and the overburden properties. The surface displacement around volcanoes is monitored using ground- and satellite-based tools such as tilt meters and global navigation systems, with the data inputted into models to estimate the properties of the source intrusion. Estimations of intrusion volume, geometry and depth are crucial for constraining eruption timescales, eruption locations and potentially eruptible magma volumes. However, the influence the overburden properties have on the extent of the displacement caused by an intrusion is poorly constrained, leading to model outputs which do not accurately represent the underlying intrusion.

To test assumptions about the behaviour of the elastically deforming crust to an intrusion of a dyke-fed sill, scaled analogue experiments were conducted using elastically deforming gelatine as the crustal analogue and water as a magma analogue. The movement of the seeded gelatine surface is tracked by two cameras positioned above the tank using 3D digital image correlation. The overburden thickness and the Young's Modulus of the upper layer is varied between experiments. Through varying overburden properties, the increase in displacement associated with thinner overburdens is captured, where this difference occurs during early sill propagation. The geometry of the surface displacement also varies with overburden thickness, where a narrower dome occurs above the shallow sill intrusions compared to the broad dome of the deep intrusions. The influence of Young's modulus variation on the surface displacement is less diverse, with small changes in displacement but the same overall geometry. These experiments provide valuable insights into relationships which could be incorporated into ground deformation models.

A global database of pyroclastic density current deposit field data: potential use for PDC modelling and hazard assessments

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The internal dynamics of pyroclastic density currents (PDCs) cannot be directly observed and much of our understanding of their complex physics is inferred from analysis of the deposits they leave behind. Data obtained directly from PDC deposits, such as grain size distributions and particle density, are key input parameters for numerical simulations of PDCs, and estimates of hazard impact metrics, used for hazard assessments. Comparison of numerical and analogue model outputs with field observations from natural PDC deposits can be used to validate the extent to which these models realistically simulate natural PDCs. However, our ability to compare and collate field datasets for integration with numerical and analogue models is limited by a lack of a publicly available database of PDC deposit characteristics.

We present a global database of PDC deposit characteristics (PDC-DAT [1]) incorporating quantitative data (e.g., grain size, particle density, bedform dimensions) and qualitative descriptions of deposit appearance (e.g., sedimentary structures, lithofacies). The database includes data from 85 source publications, covering 97 eruptions, and 214 depositional units, from 55 volcanoes across 6 continents. Eruptions recorded in the database vary from VEI 1-8 and have magma bulk compositions ranging from trachybasalt to rhyolite.

The database can be used for a variety of applications, including i) comparison of single deposit case studies to global datasets, ii) informing numerical and analogue model input parameters, iii) validation of numerical and analogue models against a wide variety of natural deposits, iv) calculating hazard impact metrics of PDCs from past eruptions to inform hazard assessments. We explore these applications with worked examples and case studies. Finally, we demonstrate that the limits to this approach posed by inconsistent methodologies and methodological reporting in the existing published literature requires urgent address by the community.

References

[1] Brown et al., (in revision). J of Applied Volcanology, https://doi.org/10.31223/X5RF13

A framework for ignimbrite analysis methodologies for modelling and hazard evaluation

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Our understanding of pyroclastic density currents has been largely driven by analysis of the deposits they leave behind (and evidence of bypass or erosion). Despite significant advances, there remain fundamental gaps in our knowledge of PDC processes, how these change with time and space, and how they result in high mobility and destructive behaviours. Recent advances in our understanding are driven by numerical and analogue modelling. However, there is a disparity between the field data typically collected and the input/output parameters needed for the analogue and numerical models that aim to simulate key processes. Models that test relationships between deposit properties and the currents that formed them are critical, but are hindered by a lack of systematically collected, comparable, quantified field datasets to both inform and validate them.

The rock record can provide an extensive archive of PDC processes and behaviours and there is a vast literature describing and interpreting PDC deposits. However; (1) there is no consistent approach to characterisation, measurement or sampling of deposits in the field; (2) a proliferation of laboratory techniques has led to increased quantification of sample characteristics, but there is a lack of standard reporting practices, including uncertainty reporting; (3) the highly variable nature of deposits is rarely captured in publications reporting deposit properties. This hinders our ability to compile and compare field datasets (such as PDC-DAT [1]) to inform or compare to numerical and analogue modelling.

Here we propose a new framework, intended to be a rigorous approach to PDC field data collection and reporting that can be used to inform, benchmark and validate numerical and analogue models. The framework includes directly comparable, standardised metrics and measuring protocols for quantifying and modelling the sedimentation of PDC deposits. We invite the community to provide feedback on the framework and welcome discussion.

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Structural controls on hydrothermal fluid flow at Santorini and Kolumbo Volcanoes

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Santorini and Kolumbo volcanoes in the Aegean Sea are some of the best characterised marine volcanic systems on our planet. However, less is known about the controls on hydrothermal fluid flow circulation and venting which is present at both volcanoes and which displays a wide variety of temperatures, fluid chemistries and venting styles. In 2025 expedition DY190 on board the RRS Discovery aimed to map hydrothermal fluid flow in 3-dimensions in these caldera volcanoes in order to better understand their connections to the magmatic systems and the geological and tectonic controls on fluid flow pathways. In this submission we present the preliminary results of this work, showing where hydrothermal venting is occurring on the seafloor, the temperatures and styles present at these different vent sites, and using heat flow data to better constrain the extents of fluid flow.

Together, these data allow us to identify relatively narrow corridors of fluid flow along previously mapped or inferred faults that cross both volcanoes. These fluid flow corridors are more constrained at Santorini, which has lower temperature venting (< 50ºC), and broader at the high temperature, CO_2 rich vent sites present at Kolumbo (where temperatures exceed 200ºC). This work also highlights the importance of diffuse flow through sediments around more focussed vent sites, which likely accounts for as much, if not more heat flow than the vents themselves.

Additionally, as the expedition occurred during the seismic crisis, which saw hundreds of earthquakes in the region every day, limited time series information allows us to map out associated changes in some sites of hydrothermal venting during, before and after the seismic swarm.

Monitoring Volcanic Deformation Using InSAR: Deformation Time-series at Seasonally Snow-covered Volcanoes

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Satellite-based Interferometric Synthetic Aperture Radar (InSAR) has been widely used for monitoring volcanic deformation, especially since Sentinel-1 launched in 2014, providing an unprecedented volume of routinely acquired, open-access data. Automated processing systems now generate interferograms and regularly update deformation time-series. However, seasonal snow leads to coherence loss, resulting in unwrapping errors in interferograms, causing network gaps in the automated time-series analysis and reducing accuracy.

Here, we calculate the snow persistence at subaerial Holocene volcanoes using MODIS snow products and find that ~40% exhibit seasonal snow (Snow Persistence of 7-90%), mainly in high-latitude and high-altitude regions. We choose Laguna del Maule (LdM) in Chile, a seasonally snow-covered volcano with snow persistence of 51% and steady uplift since 2007, to test the ability of MODIS 8-Day Snow Product to predict InSAR coherence. Results show an overall prediction accuracy of 77% and a coverage accuracy of 86%, confirming that snow cover is the primary cause of coherence loss here.

The accuracy of auto-processed time-series is affected by coherence loss due to seasonal snow. At LdM, the default product from the LiCSBAS auto-processing system underestimates the average line-of-sight deformation by 28% at GNSS station MAU2 between 10/2014 and 06/2023. Therefore, to improve time-series accuracy, we adapt the LiCSBAS time-series processing strategy using the relationship between MODIS 8-Day Snow Products and Sentinel-1 InSAR coherences. We design a workflow including an algorithm using Graph Theory to optimise the network selection. This reduces data requirements by ~90% and processing time by ~80%, while improving the accuracy of the LiCSBAS-processed deformation to match GNSS observations.

Our workflow can be applied to the ~40% of subaerial volcanoes with seasonal snow to optimise the automated processing of multi-year deformation time-series. This has implications for the accuracy and efficiency of global volcano monitoring, improving the quality of modelling and forecasting.

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