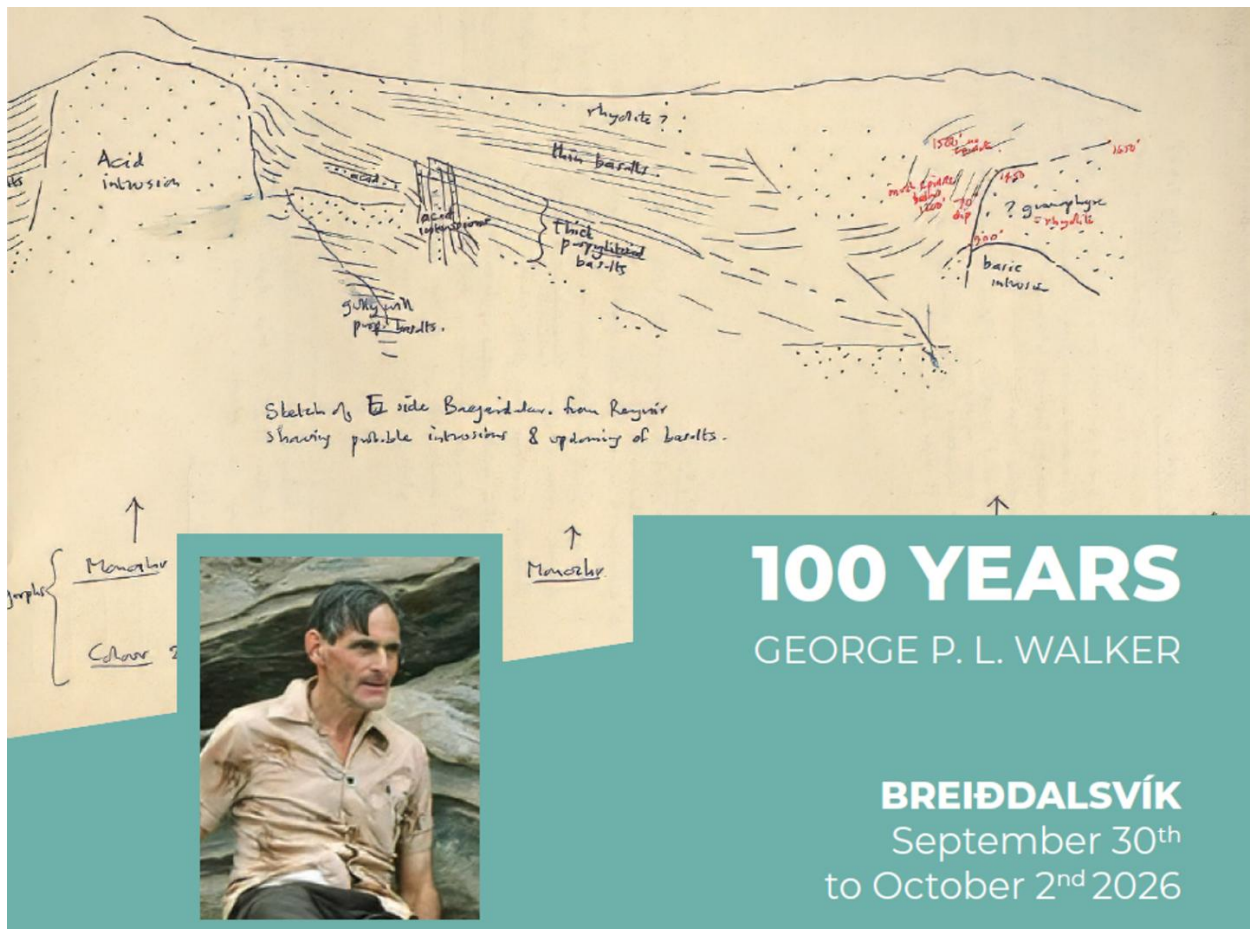




Abstract Volume

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Introduction

March 2nd, 2026 marked the 100th anniversary (centennial) of George P.L. Walker, one of the main pioneers in research on the volcanic succession of Iceland and the founder of modern geological mapping in this country.

On this occasion, and to commemorate the legacy that Walker contributed to Icelandic geology, a three-day "mini" conference was held in Breiðdalsvík, one of Walker's bases when conducting his research in Iceland in the years 1955-65.

The conference took place from September 30th to October 2nd with 43 participants and two volunteer organizers. The conference featured two one-day trips around East Iceland (days 1 and 3), where Walker's geological footprints in East Iceland were partially traced. These trips were separated by a one-day meeting (day 2) which featured talks and posters on a range of topics including an overview of Walkers contribution to Earth Sciences and the outcome of recent studies on the Neogene volcanic successions in Iceland, to name a few.

The event also included a visit to the drill-core library that the *Natural Science Institute of Iceland* operates in Breiðdalsvík and an evening in "Gamla kaupfélagið" (The Old Coop) which hosts a museum dedicated to George Walker, his career and contribution to the geology of Iceland.

In this volume the abstracts submitted for the talks and posters presented at this conference are published. The event was hosted by:

The Breiðdalssetur Foundation

and

The University of Iceland's Research Centre in Breiðdalsvík



The "Old Coop"

Program and timetable for Thursday October 1st, 2026

Opening and Plenary lectures

08:00	Welcome Hátiðarsalur, Frystihúsið	Jóna Árný Þóráðsdóttir 07:50 - 08:00	Plenary lectures
	The life and career of George Walker, volcanologist (1926 to 2006) Hátiðarsalur, Frystihúsið	Steve Self 08:00 - 08:50	
09:00	Volcanism, evolution and structure of Iceland - current problems and ways forward Hátiðarsalur, Frystihúsið	Gillian Foulger 09:00 - 09:30	Hátiðarsalur, Frystihúsið 07:50 - 09:40
	Coffee break Hátiðarsalur, Frystihúsið		
			09:40 - 10:00

Session 1: Iceland as a laboratory for physical volcanology studies

10:00	George Walker and the flood basalt stratigraphy of Eastern Iceland Hátiðarsalur, Frystihúsið	Birgir Vilhelm Óskarsson 10:00 - 10:20	Scientific Program: Iceland as a laboratory for physical volcanology studies
	Stratigraphic mapping in a pre-modelled field by the grand master - a word of warning. Hátiðarsalur, Frystihúsið	Gudmundur Omar Fridleifsson 10:20 - 10:40	
11:00	The SECRET volcanoes of South-East Iceland – mapping plutonic-volcanic connections between Slaufudalur plut... Hátiðarsalur, Frystihúsið	Robert Alexander Askeew 11:00 - 11:20	Scientific Program: Iceland as a laboratory for physical volcanology studies
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12:00	Lava flow architecture and vent distribution of the Dabbahu central volcano and Manda Hararo fissure swarm in Et... Hátiðarsalur, Frystihúsið	Charlotte Vye-Brown 12:00 - 12:20	Scientific Program: Iceland as a laboratory for physical volcanology studies
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	The Leiðólfssfell Rootless Cone Group Tephra: Insights into Sustained Rootless Eruptions Hátiðarsalur, Frystihúsið	Glen L'Estrange 12:40 - 13:00	10:00 - 12:20

Session 2: Iceland and similar regions as a laboratory for magmatic studies

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14:00	The petrological architecture of Ingólfshöfði and its relationship to Öraefajökull (Iceland) Hátiðarsalur, Frystihúsið	Helga Torfadóttir 13:40 - 14:00	Scientific Program: Iceland and similar regions as a laboratory for magmatic studies
	Hydrothermally Altered Sheeted Dikes Recovered From IDDP-2 Drill Hole, Reykjanes, Iceland Hátiðarsalur, Frystihúsið	Robert Zierenberg 14:00 - 14:20	
15:00	The Drill Core Library of the Natural Science Institute of Iceland Hátiðarsalur, Frystihúsið	Maria Helga Guðmundsdóttir 14:20 - 14:40	Scientific Program: Iceland and similar regions as a laboratory for magmatic studies
	The magmatism of 2021-23 Fagradalsfjall Fires, Reykjanes Volcanic Belt, Iceland Hátiðarsalur, Frystihúsið	Thor Thordarson 14:40 - 15:00	
			13:00 - 15:00

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List of Participants

<i>FULL NAME</i>	<i>AFFILIATION</i>	<i>COUNTRY</i>
Aradóttir, Nína	Náttúrufræðistofnun	Iceland
Askew, Robert Alexander	Náttúrufræðistofnun	Iceland
Árnadóttir, Sigurveig	Norðurorka	Iceland
Árnason, Knútur	Reykjavíkúrakademían	Iceland
Barache, Marieke	Instut de Physique du Globe de Paris	France
Bergþórsdóttir, Antonía	Berunes	Iceland
Björnsson, Glúmur	HEF veitur	Iceland
Burchardt, Steffi	Uppsala University	Sweden
Butler, Frankie	University of Cambridge	UK
Chen, Bin	University of Hawaii at Manoa	USA
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Foulger, Gillian	Durham University	United Kingdom
Franzson, Hjalti	Geological consultant	Iceland
Fridleifsson, Guðmundur Omar	Geology and Geothermal Consultant	Iceland
Friðriksson, Þráinn	Orkuveitan	Iceland
Gallagher, Catherine Rachael	Íslands	Iceland
Gautason, Bjarni	University of Iceland	Iceland
Gísladóttir, Margrét	Náttúrustofa Austurlands	Iceland
Guðmundsdóttir, María Helga	University of Iceland	Iceland
Hjartarson, Árni	Vatn og Jörð ehf.	Iceland
Höskuldsson, Ármann	Institute of Earth Sciences	Iceland
Jónsson, Höskuldur	Vegagerðin	Iceland
Karlstrom, Leif	University of Oregon	USA
Kristjánsson, Bjarni Reyr	Orkuveitan	Iceland
Kshirsagar, Raghavendra	University of Iceland	Iceland
Lestrangle, Glen M.	Háskóli Íslands	Iceland
Li, Jie	University of Michigan	USA
Mazur, Weronika Anna	Háskóli Íslands	Iceland
Óskarsson, Birgir	Natural Science Institute of Iceland	Iceland
Planke, Sverre	University of Oslo	Norway
Rene Julian, Bruce	Durham University	United Kingdom
Rougemont, Raphaël	Uppsala University	Sweden
Self, Stephen	University of California, Berkeley	USA
Shareef Shalla, Yaasameen	University of Iceland	Iceland
Silveira G Alvarez, Diana Brum De	Háskóli Íslands	Iceland
Sparks, Stephen	University of Bristol	Iceland

List of Participants (continued)

<i>FULL NAME</i>	<i>AFFILIATION</i>	<i>COUNTRY</i>
Tegner, Christian	Aarhus Universitet	Denmark
Thor Thordarson	Háskóli Íslands	Iceland
Torfadóttir, Helga Kristín	Háskóli Íslands	Iceland
Vye-Brown, Charlotte	British Geological Survey	United Kingdom
Waiblinger, Emma	University of Kiel	Germany
Wallukat, Pia	Náttúrufræðistofnun	Iceland
Wang, Bo	Nanjing University	China
Zierenberg, Robert	University of California Davis	USA



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The SECRET volcanoes of South-East Iceland – mapping plutonic-volcanic connections between Slaufudalur pluton and volcanic facies

Robert Alexander Askew¹ Steffi Burchardt², Catherine Gallagher³, Orlando Quintela², Kristján Jónasson⁴, Olivier Bachmann⁵, Razvan-Gabriel Popa⁵ and Sæmundur Ari Halldórsson⁶

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Magma intrusion and the generation of silicic magmas are fundamental processes controlling volcanic behaviour and continental crust formation. Exposed plutons provide key constraints on these processes, yet the geological context of silicic plutonic systems in oceanic rift environments remains poorly resolved. Southeast Iceland hosts large Neogene plutonic complexes within anomalously thick (>40 km) oceanic crust, making it a prime natural laboratory for investigating silicic magma generation in a basalt-dominated, plume-influenced setting.

Here we present new detailed geological mapping, photogrammetric analysis, and three-dimensional reconstruction of the Slaufudalur pluton, Iceland's largest exposed granitic intrusion, and its surrounding rocks. Our results reveal a complex volcano-tectonic system comprising four previously unrecognized silicic volcanic centres preserved as fracture bounded pyroclastic successions, conduit facies, or shallow intrusions. The spatial association between these volcanic centres and the pluton indicates a close genetic and mechanical relationship (Gallagher et al this conference). Detailed field mapping reveals structural and lithological relationships between the volcanic and subvolcanic facies and the pluton itself.

Our findings provide new insights into possible geodynamic scenarios of magma differentiation and silicic magma accumulation in long-lived silicic systems and associated caldera structures. This framework also provides new constraints on Icelandic geodynamics, oceanic silicic volcanism, and the plutonic – volcanic connection.

Iceland's 250.000 geological maps: Digitisation and modernisation of a legacy dataset for a modern dataset

Robert Alexander Askew¹ and María Helga Guðmundsdóttir²

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2 Natural Science Institute of Iceland, Breiðdalsvík, Iceland

The 1:250,000 geological map series of Iceland [1] represents decades of geological research and mapping. Despite its continued scientific value, much of the series only has remained available as analogue map products, limiting its use and outreach. To preserve and improve access to this legacy dataset, a project was undertaken to create a digital vector version of this national geological map series. The project combined georeferencing, digitisation, geological interpretation, and database development to convert the published map series into a modern geospatial dataset. Sheets 1 (West Fjords), 2 (West Iceland), 3 (Southwest Iceland), 6 (South Iceland), 7 (Northeast Iceland), and 9 (Southeast Iceland) were digitised directly from georeferenced scans of the original maps with some small changes based on expert knowledge. Sheet 4 (northern Iceland) was reconstructed from mapping slips and supporting material, while Sheet 5 (Mid-Highland) lacked sufficient source information for direct digitisation and was instead compiled from alternative geological maps, more recent mapping, and other available geological datasets. Similarly, coverage for eastern Iceland (Sheet 8) was assembled from alternative map sources in order to complete the national coverage.

The digitisation focused initially on bedrock geology polygons, which form the first completed vector product. Throughout the project, substantial effort was devoted to resolving inconsistencies between map sheets, including differences in geological unit boundaries, classification schemes, and cartographic styles. In many areas bedrock geological data was incompletely mapped, or absent altogether, requiring reconstruction based on surrounding geology, newer geological mapping, and expert knowledge. Some areas may still be missing information where it is unavailable or require slight adjustments to unit or contact locations. The resulting dataset transforms a collection of legacy geological maps into a modern geospatial resource. A web map version will be released initially for expert review and quality assurance, after which the dataset will be made openly available for download. Future work will expand the database beyond bedrock geology to include additional geological features preserved within the original map series.

References

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[HTTPS://GATT.GIS.IS/GEONETWORK/SRV/ICE/CATALOG.SEARCH#/METADATA/%7B424ED357-15AE-4C35-BDA1-DD679A586006%7D](https://gatt.gis.is/geonetwork/srv/ice/catalog.search#/metadata/%7B424ED357-15AE-4C35-BDA1-DD679A586006%7D)

Streitishvarf composite dyke: A field case study of mixing of mafic and silicic magmas in subvolcanic intrusions in Iceland

Robert Alexander Askew¹ Mickael Laumonier², Catherine Gallagher³, Thor Thordarson³, John Godfrey Fitton⁴ and Frankie Butler⁵

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The Streitishvarf composite dyke in eastern Iceland preserves a well-exposed record of progressive magma mixing between mafic and silicic magmas. Field, petrographic, and whole-rock geochemical data reveal a series of discrete zones, from basaltic margins through hybrid andesitic–dacitic zones to an enclave-bearing rhyolitic core, each representing a separate stage of magma mixing. These zones are sharply bounded and chemically distinct, indicating that mixing occurred in stages prior to emplacement.

Enclave morphologies, crystal textures, and crystal zoning patterns suggest variable degrees of mingling and thermal equilibration, with hybridization progressing over time. The structure of the dyke and its subsidiary branches records how magma propagated through the crust, exploiting early feeder pathways before stabilizing into a composite intrusion. Streitishvarf thus captures a record of the internal evolution of a magma mixing system: a series of partially mixed zones, preserving evidence of their origins, interactions, and timing, frozen mid-process.

This study demonstrates that magma mixing can occur as a series of episodic but discrete events and is a process that does not require a homogenized mixed magma body. Thus, the Streitishvarf dyke provides a cross-sectional snapshot of a hybridization process frozen mid-transition. As such, it offers a valuable case study for understanding hybrid dyke formation, evolution of crustally stored magma, and silicic melt mobilization in rift settings.

Torfufell Through Time: The Evolution of a Late Miocene Central Volcano in North Iceland

Sigurveig Árnadóttir¹, Thor Thordarson², Árni Hjartarson³ and Bjarni Gautason⁴

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2 Háskóli Islands (University of Iceland), Iceland

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4 University of Iceland Research Centre, Breiðdalsvík, Iceland

A recent study details the evolution of the Late Miocene Torfufell central volcano and the surrounding area in central North Iceland through geological mapping, paleomagnetic measurements, geochemistry, descriptions of key geological features, and integration with new and existing age data. These observations indicate that the edifice construction commenced at ~7.8-8.0 Ma, with the early stages featuring mafic effusive volcanism producing series of basaltic $\tilde{a}$ lavas and latter stages typified by a broader compositional range, including intermediate and silicic volcanic products. This volcanism was associated with intrusive activity on the form of mafic dykes and silicic plugs. The two volcanic sequences are separated by a peculiar tephra-, smectite and fossil-bearing sediment horizon in several outcrops. Results of U-Pb ages from six silicic units of the volcano range from 7.15 $\pm$ 0.12 Ma to 6.76 $\pm$ 0.02 Ma, taken here to represent a ~400 kyr time-span for silicic activity at the volcano.

The enigmatic Deep Conductive Layer in the Icelandic Crust

Knútur Árnason¹, Benoit Gibert², Claire Bouligand³ and Arnar Már Vilhjálmsson⁴

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Early Magneto-Telluric (MT) resistivity soundings in Iceland revealed a Deep Conductive Layer (DCL), a layer with anomalously high conductivity, at the depth of 10-15km (upper seismic layer 3) in the crust under most of Iceland. When first observed in the 1970s, the DCL was interpreted as partial melt below a thin and hot crust. Later seismic and gravity studies have showed that the crust is 20-40 thick, abnormally dense and cold. The DCL is an intra-crustal layer below the brittle/ductile transition and does not correlate with any currently known seismic features. The DCL domes up beneath central volcanoes with high temperature geothermal areas. Outside central volcanoes, it is found to be electrically anisotropic, being more conductive in the spreading direction than is the tectonic/fracture direction. We have reviewed several possible conduction mechanisms that could explain the high conductivity in the light of recent experimental work on electrical conductivity of minerals and rocks and possible prevailing conduction mechanisms in the light of existing geophysical and petrological observations in Iceland. These investigations show that seismic and electrical surveys are both compatible with the presence of melt in the DCL in the volcanic plumbing system associated to volcanoes. Outside active volcanoes, seismic properties of the DCL, inferred from local tomography, are not compatible with the presence of melt or even aqueous fluid in the DCL but confirm thick, cold and fluid-free lower crust, leaving only solid-state conduction as a viable conduction mechanism. Review of laboratory measurements on various type of minerals lead to the conclusion that Fe-Ti oxides or hydrated minerals, such as amphibole, could explain the DCL.

Modelling the progressive deformation of transfer zones, application to the Reykjanes Peninsula, Iceland

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Volcanic activity, whether submarine or subaerial, interacts with tectonic processes within highly segmented fault systems, such as transfer zones, which accommodate deformation between two offset rift or ridge segments. These volcano–tectonic systems pose significant hazards to populations living nearby through cascading events such as earthquakes and volcanic eruptions. In southwestern Iceland, after 781 years of quiescence, the Reykjanes Peninsula has experienced a series of sismo-volcanic events since 2019. A first sismo-volcanic episode occurred at Fagradalsfjall between 2021 and 2023, before the activity migrated westward to the Svartsengi-Grindavík area, threatening the town of Grindavík and leading to its evacuation. At the surface, lava erupts through a complex en-échelon system composed of five to six fissure swarms striking approximately N45°E and extending over nearly 50km, whose initiation, evolution, dynamics, and role in magma migration remain poorly understood. Using the Discrete Element Method (DEM) and the Bonded Particle Model (BPM), we investigated the influence of several parameters that potentially control the resulting fracture pattern. Our models show that opening oblique structures with a mean strike of N45°E distributed over a 50-km-long deformation zone are consistent with a transtensional regime applied to an average 17.5-km-thick crust. The deformation can be divided into two distinct phases. The first is a quasi-elastic phase, during which deformation propagates upward from the base of the model to the surface, following a helical pattern. The second corresponds to a plastic phase, characterized by the longitudinal development of the en-échelon structures, which can be grouped in fissure swarms. Our results also highlight the key role of both mechanical and geometrical parameters in the initiation and development of en-échelon structures, including crustal thickness, the cohesion-to-tensile strength ratio, grain interlocking, the transtensional loading angle, and the imposed boundary velocity profile.

The Sveinar Cone Rows Are Not a Single Eruption: New Tephrochronological Evidence Reveals a Multiphase Holocene History, NE Iceland

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The Rauðuborgir-Sveinar-Randarhólar-Rauðhólar (RSRR) lineament is among the most striking volcanic features of Iceland's Northern Volcanic Zone (NVZ). Extending ~75 km as a chain of ~22 cone rows, it has long been interpreted as the surface expression of a single fissure eruption at ~11ka BP, making it Iceland's longest volcanic fissure. Early structural work within the Sveinar grabens, part of RSRR, emphasised early- to mid-Holocene faulting but did not identify late-Holocene volcano-tectonic events. Similarly, other stratigraphic studies concluded that the Sveinar and related craters erupted >6-9ka BP. However, reconnaissance by Höskuldsson & Þórðarson (2020) and our 2025 field campaign reveal a more complex eruptive and tectonic history.

Here, we present new stratigraphical, field, and tephrochronological evidence for asynchronous formation of the Sveinar cone rows, including previously unrecognised late-Holocene volcanotectonic activity. The Sveinar graben system hosts cone rows with distinct eruptive ages. The main Sveinar cone rows (Vegasveinar, Sveinar and Ytri-Sveinar) were previously dated to ~6-8ka BP. Our observations reveal a ~6-7ka BP age for the Sveinar cone row since the ~7ka Hekla-5 is absent from soil profiles on top of the lava. However, the Ytri-Sveinar cone row, north of the former, is considerably younger, at ~2ka BP, an age verified by the presence of the 2.5ka Hverfjall tephra under the Ytri-Sveinar lavas and its scoria fall deposit. The Vegasveinar cone row, by High1 and south of Sveinar, is dated at ~11ka BP, because the ~10.8ka Askja-S (Skölli) tephra layer is present in the soil resting on top of scoria from the cone.

These results provide the first direct evidence that the Sveinar cone rows, and thus the RSRR lineament, are not a product of a single eruption but rather constructed by multiple discrete eruptive events spanning at least 9 millennia, from ~11ka until ~2ka yrs BP. Associated grabens and normal faults exhibit similarly prolonged development: faults cut the ~2ka Ytri-Sveinar lava and cones, confirming younger tectonic activity in this system than previously recognised. This study highlights the need to reconsider existing models of fissure eruption development and rift propagation in Iceland. By refining the eruptive chronology of the Sveinar cone rows, we demonstrate that activity persisted far longer than assumed, overturning the long-standing view of a single early Holocene fissure eruption and establishing instead a multiphase eruptive history that continued into the last two millennia. It also provides new constraints on magmatism-tectonism coupling and Holocene rifted volcanic-terrain evolution in the NVZ.

Incremental assembly of Iceland's largest granite pluton - new insights on structure and setting of the Slaufudalur pluton

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Thanks to advances in geochronology, numerical modelling, and mineral chemistry, and other disciplines, it is now generally accepted that km³-sized magmatic intrusions form by the amalgamation of numerous small magma batches over time. However, the consequences of this incremental assembly for the internal and external structure, as well as magma and fluid transport are still underexplored. The Slaufudalur pluton, Iceland's largest granite pluton, is a superbly exposed example of an incrementally assembled intrusion formed in the upper crust. We used a combination of field structural mapping, photogrammetry, magnetic fabric analysis, and 3D reconstruction to document: (1) the internal architecture, (2) alteration, and (3) deformation within and around the Slaufudalur pluton. We present a map of the pluton's lithological units that shows an upper, layered sequence underlain by more local unlayered units. Magnetic fabrics reflect overprinting of primary magma-flow related fabrics by alteration due to magmatic fluids from subsequent magma batches. Overall, our observations support a top-down construction of the pluton, which also explains deformation of earlier emplaced parts of the pluton during continuous addition of magma batches. The wall and roof contacts of the pluton comprise arrays of Riedel shear fractures that show signs of oblique slip during successive magma emplacement. This observation indicates that the pluton formed in a transtensional pull-apart structure, which explains the orientation and nature of the pluton contacts and the deformation within and around the pluton. This new conceptual model for the emplacement of the Slaufudalur pluton implies that magma accumulated outside a typical rift-zone volcanic system – either between volcanic systems in the rift zone, or in a different setting controlled by transtension outside the riftzone.

Should I stay or should I blow? Emplacement and eruption of a shallow-crustal granitic magma reservoir – the Reyðarártindur pluton, Southeast Iceland

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Even prior to the paradigm shift towards transcrustal, mush-dominated magmatic plumbing systems, it was recognised that silicic magmas have a hard time erupting without a specific trigger, simply because of the high magma viscosity. In Iceland, the frequent association of silicic eruptive products with mafic magmas, e.g. in the form of mafic enclaves, led to the hypothesis that mafic magma recharge is the main trigger for silicic magma eruption. Here, we present the first comprehensive study of the Reyðarártindur pluton, Southeast Iceland, an example of shallow silicic magma emplacement and eruption without the involvement of mafic magma.

The Reyðarártindur pluton is a Miocene granitic intrusion emplaced into mainly basaltic lavas at about 1-2 km depth. While the floor of the pluton is not exposed, glacial erosion produced natural sections through the uppermost 300 m of the pluton. These sections include spectacular exposures of the roof and wall contacts, as well as access to the pluton interior.

Our detailed geological and structural mapping, paired with photogrammetry, allowed us to reconstruct the original pluton shape with a total estimated volume of least 2.5 km³ contained in a complex rhomboid with steep walls and a flat roof at several levels. While the wall contacts truncate the basalt host rock at right angles, the roof is concordant but stepped. We interpret these observations to reflect initial magma emplacement at different depths, and pluton growth by piecemeal floor subsidence.

Systematic rock sampling, textural, petrological, and geochemical analyses demonstrate that the bulk of the pluton is composed of granitic magma. Only in the lowest exposures does this granite contain enclaves of quartz monzonite and another granite, all sourced from the same underlying plumbing system. All three types of magmatic rocks are also present in the base of volcanic conduits that extend from the pluton roof into the overlying rocks. These conduits are associated with pluton-roof subsidence and faulting dissimilar from the roof structures observed elsewhere. Based on these observations, we conclude that silicic magma recharge and mingling triggered eruptions from the Reyðarártindur magma reservoir.

Hence, Reyðarártindur is a striking example of the plutonic-volcanic connection and illustrates silicic magma emplacement and eruption without the involvement of mafic magma.

Mix or Mingle?: Investigating textural features of intrusive bimodal magmatic systems using case studies from the North Atlantic Igneous Province

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Bimodal magmatic systems exhibit the "Daly Gap," whereby intermediate compositions are notably scarce or absent (Daly, 1925). In settings with bimodal magmatism, e.g. in Iceland, explosive volcanism is often triggered by the interaction between the mafic and silicic endmember composition magmas (e.g., Sparks et al 1977; Nakamura, 1995; Snyder and Tait 1995; Murphy et al 1998; Jellinek and Kerr 1999; Leonard et al 2002).

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 and viscosity reversals in magmatic systems. A particular focus is the systems' physical and chemical behaviour where mafic and felsic magmas are brought into contact.

We study magma mixing and mingling in the shallow crust (<5 km) through investigations of intrusive bimodal magmatic systems and interpret the processes that lead to these structures, using case studies of Slieve Gullion - Sliabh Cuillinn (Northern Ireland), St Kilda - Hirta, (Northwest Scotland), Streitishvarf (East Iceland) and Eystrahorn – Austurhorn (Suð austurland).

This research will integrate observations from grain to regional scale. Remote sensing and outcrop-scale observations will be combined with qualitative and quantitative microstructural analysis, geochemistry, and viscosity modelling to elucidate the processes and controls on the extent of magma mixing and mingling in bimodal volcanic systems. This project will also involve using diffusion chronometry to understand the timescales of magma mixing and mingling using Streitishvarf as a constrained case study furthering the study of Askew et al., (2026). Ultimately, this work will advance our understanding of the structural controls on central layered complex emplacement, the textures produced during bimodal magma emplacement, and the effects of compositional bimodality on magmatic system evolution.

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Tectono-Volcanic Research in Iceland – the next 100 years framed by the last 5

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In the past 100 years since the birth of George Walker, considerable revolutions occurred in geology and our understanding of how the planet operates. Alfred Wegner's work on Continental Drift was forgotten then recalled as viable once Hess's seafloor spreading mechanism made it seem not so impossible. This led to Tuzo Wilson's plate tectonic theory of the Earth's outer shell being rigid and driven by transform faults, mantle hotspots, and the opening and closing of seas that we later call the Wilson Cycle. Recent revolutions in observations in the past several decades of near instantaneous events, eruptions, major earthquakes, and fault ruptures as well as long term plate motions provide new insights into these complex systems. Modern events like the reactivation of the Grindavík grabens, and associated tectonovolcanic unrest in Reykjanes Iceland shows us in nearly real-time, that the same faults keep slipping, but with hundreds to thousands of years of stability between ruptures and the same volcanic lineaments keep erupting, leading to the use of monogenetic eruptions in Iceland perhaps being pushed to extinction. Extension at the plate boundary is not correlated with magma volume (or vice versa) as we have seen in the Sundhnúkur cone row from 2023-2026. Strike slip faulting occurs before extension, showing that shearing from plate tectonics is the key that cracks open the system leading to extension that then provides the pathways for magma to rise to the surface. These ultra-modern observations can help us look back as well. How do they change how we look at the Iceland "Traps", or the Siberian, or Deccan, for that matter? How does the tectonics control the pathways and the timing and recurrence of these events? Where are all of the active faults in Iceland and what do we know about their hazards? Is the folding we see in the Tertiary lavas of Iceland only from flexure, or do faults play a larger role in forming these folds? The Icelandia theory has merit and requires more attention as well. These among other items will be outlined as we think about the next 100 years. Because we never know what is around the corner, I for one expect and look forward to lots of surprises, in particular as AI and machine learning yield new insights into older problems including many of those first outlined by George Walker.

Expanding the Hengill Resource: Deep and Step-Out Exploration Beyond the Known Reservoir

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This presentation outlines a new phase of geothermal exploration in the greater Hengill area for Reykjavik Energy. Building on decades of successful exploration, development, and operation of the Nesjavellir and Hellisheiði geothermal fields, current efforts are focused on expanding the resource base through exploration of both deeper reservoir targets and new prospects beyond established field boundaries. The planned IDDP-3 well at Nesjavellir will investigate deep and superhot conditions beneath the existing field, providing a unique opportunity to tap into a deeper superhot resource and evaluate its potential for future development. At the same time, greenfield exploration of Meitlar, Norðurhálsar, Þverárdalur, and Mosfellsheiði targets potentially productive geothermal systems stepping out of the conventional resource boundaries. Together, these initiatives seek to identify new opportunities for sustainable energy development and improve our understanding of the links between magmatism, rifting and hydrothermal fluids circulation which control the heat distribution throughout the Hengill volcanic system.

The Leiðólfsvell Rootless Cone Group Tephra: Insights into Sustained Rootless Eruptions

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In the summer of 1783, the Laki eruption produced vast lava emission, episodic explosive activity and tephra fallout along a 27 km long cone row, with volcanic gas creating pollution on a hemispheric scale. In the early days of the eruption, lava advanced towards Mt. Leiðólfsvell to the southwest of the cone row. Lava flowed into the channel of Hellisá river and its surrounding wetlands, resulting in a series of sustained “Rootless eruptions”, fuelled by explosive water-magma (i.e. fuel-coolant) interactions. Surface expressions of this activity remain preserved as a tephra sheet up to 7m thick and remains of the rootless cone group featuring spatter ramparts with large >200m wide vents and small explosion pits (~5m). The Leiðólfsvell Rootless Cone Group (LRCG) is now partly covered with later flows from the Laki eruption.

The LRCG tephra is layered with between 5- 7 identifiable fall units. Each unit is inversely graded, indicating intensifying eruption phases lasting hours to days. However, the entire fall unit sequence exhibits overall upward fining, suggesting decreasing eruption intensity over time. This occurrence provides a unique opportunity to explore eruption source parameters of these secondary eruptions, quantifying their intensities. Four field excursions were undertaken to map tephra dispersal and examine the nature of the eruption activity. This revealed a tephra dispersal over ~25km² in the 0.5cm isopach and volume of over 3.1x10⁶ km³. The eruption columns are estimated to have been between 1.6-5km tall, compatible with heights obtained from Rev. Jón Steingrímsson's report of a plume rising from Leiðólfsvell (seen from Prestsbakki) on 17th July 1783. This dates the occurrence of the activity. Mapping of the tephra fall reveals major dispersal to the southeast with minor sectors to the west and northwest. Each sector has its own internal stratigraphy, indicating two to three vent cluster sources, or temporally separated eruption pulses.

The tephra features slightly more evolved glass (=melt) than Laki primary tephra and lava, leading us to hypothesise that ponding of the lava in the Leiðólfsvell region, enabled sustained and tempered lava supply to the explosion centres. An overall stratigraphic up-fining of the tephra sequence is taken to indicate sequential deceleration (i.e. decreasing fragmentation energy) of intensities via changes to water-lava mass ratio. Despite progressive fining of the deposit, the fine ash fraction accounts for ~9% of total erupted mass per unit, raising questions about the importance of ash production during fuel-coolant like explosive activity.

Continental Crust under the Greenland-Iceland-Faroe Ridge

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A plethora of otherwise-paradoxical data are readily explained by widespread, substantial continental crust beneath the Greenland-Iceland-Faroe Ridge (GIFR) [Foulger et al., 2020]. These data include the following.

1. The GIFR decouples tectonics between the south and north oceans.
2. The Northeast Atlantic opened via the Ægir and Reykjanes Ridges, which never connected. They were offset laterally by 100 ± 50 km and propagation stalled whilst they were still ~ 300 km apart along strike. A continental block must thus have been incorporated in the new ocean.
3. Palinspastic reconstructions of Iceland require a ~ 100 km wide block of crust at depth, older than any reported surface lavas.
4. Magnetic anomalies across the GIFR are unlike seafloor spreading anomalies.
5. The GIFR was a continuous, ocean-spanning landbridge until the Northeast Atlantic was $\sim 1,000$ km wide.
6. Volcanism in Iceland occurs over ~ 350 km laterally and along dual unstable, migrating rift zones, unlike “normal” oceanic spreading. This persisted on the GIFR throughout ocean opening.
7. The GIFR crust is $\sim 30 \pm 10$ km thick. Its seismic structure everywhere resembles heavily magmatized continental crust, similar to the passive margins of East Greenland, Norway and Britain. It is clearly unlike oceanic crust.
8. At $\sim 900^\circ\text{C}$ the lower crust is unexpectedly cold, and devoid of pervasive melt.
9. Petrological temperatures suggest only a $50\text{--}100^\circ\text{C}$ mantle potential temperature anomaly under Iceland.
10. Amounts of felsic rock unparalleled for oceanic crust, EM2 geochemical signatures, peraluminous petrologies, and ancient zircons occur.

The GIFR runs along the frontal thrust of the Caledonian suture where it coalesces with the Proterozoic Nagssugtoqidian suture in Greenland. The Ægir and Reykjanes Ridges likely were unable to break through this strong, transverse structure which instead stretched to form hyper-extended continental crust overlain by basalts in the form of seaward-dipping reflectors [Geoffroy et al., 2020]. Other examples of such structures are the Vøring Plateau, Davis Strait, west Indian Ocean and offshore Brazil. State-of-the-art numerical modelling confirms this is feasible, including honouring mass-balance requirements. This model can naturally explain the above observations above without special pleading and needs to be further tested.

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Hvalfjordur Tertiary basalt succession, W-Iceland. One million year evolution of a fissure swarm

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Documenting the relation between a fissure swarm and the accompanying buildup of a lenticular lava succession is a major contribution made by Walker in Tertiary Iceland. Geological mapping was undertaken using his methodology of the 4-3 Ma Hvalfjörður fissure swarm and contemporary volcanic accumulation in West Iceland was undertaken about half a century ago (Franzson 1979). The succession can be traced more than 60 km along strike from Akranes to Hvítársíða in the northeast. This was the only rift system operating at that time in the Western Rift Zone and therefore captures localized magma evolution in the underlying mantle lasting one million years. The stratigraphic base in Skarðsheiði and Akrafjall consists of two monolithic olivine tholeiite lava shields succeeded by an approximately 200 m thick series of porphyritic basalt lavas, intercalated with a number of sedimentary horizons. This is overlain by a ~100 m sequence of moderately thick (6m) aphyric tholeiitic lavas followed by relatively thin tholeiite lavas (3m) totaling >100 m. The environment reflects a low effusion rate at the base with relatively voluminous lavas flowing within a graben shaped fissure depression. As eruption rate increased the depression changed gradually to topographic high with an absence of sediments and thinner lava flows. The phenocrysts in the lower part of the succession are dominantly plagioclases with less abundant olivine and augite. Occasional phenocrysts are found in the upper part. Forty-two samples were taken for geochemical analysis in Heiðarhorn in Skarðsheiði spanning the age range of the succession. These show the following progressive changes with time; the lower porphyritic lavas have both a narrow compositional range as well as high CaO and Al₂O₃ and low MgO reflecting plagioclase enrichment and olivine removal, a clear sign of fractional crystallization. Going up the succession evidence of higher effusion rate and aphyric lavas become more dispersed and heterogeneous. The clear fingerprints of fractional crystallization, evident in the porphyritic part, are not evident in the upper part which suggests that magma compositions are controlled more by another process, such as variable partial melting. The Tertiary succession in East Iceland mapped by Walker shows very similar evolution as described above and likely formed in a similar way.

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Stratigraphic mapping in a pre-modelled field by the grand master - a word of warning

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G.P.L. Walker (1964) believed the E-Iceland flexure zone was formed on the surface, and the abundant breccias and sediments were formed in lakes resulting on the downward side of the flexure and mentioned abundant major and minor intrusions within the flexure and called it tectono-volcanic flexure. Annels (1967), Walker's student, agreed that the flexure had a surface expression and suggested that it was gradually overlapped by younger volcanics from the west, and related all major and minor intrusions in the upper Hornafjörður region to this structural feature. Newman (1967) had a similar approach. I had to "prove" them all wrong (Friðleifsson, 1983), which took an effort and was a major ordeal in some respect – questioning the Britto-Tertiary school on their "home ground" in a double sense - as my intended PhD research was to focus on the high-temperature hydrothermal alteration history of a volcanic complex, but not the stratification and the volcano-tectonic history. However, Walker later (1974 and later papers) changed his opinion on the flexure zone. However, in order to deal with my Geitafell Central Volcano PhD study, my background data rested on Annels' (1967) stratigraphic mapping and his interpretation – which needed a serious reinterpretation. At that time, Torfason (1979) had rejected some of Walker's 1974 statements regarding the flexure zone. I had to remap the field, including recognizing all major climatic and structural events, putting them in chronological order, and sorting out the intrusive rock history, from the earliest feeder dyke systems to the latest superimposed flexure-related regional dyke system. Detailed stratigraphic mapping is the key to understanding, and pre-fixed modelling should be treated with reasonable care before such an effort.

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Temporal and Structural Interactions Between Silicic Volcanic Centers and the Slaufudalur Granitic Pluton, Southeast Iceland.

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The processes governing the generation of silicic magmas are fundamental to volcanic behaviour and continental crust formation. Exposed plutons provide key constraints on these processes; however, the geological context of silicic plutonic systems, particularly in oceanic rift environments, remains poorly resolved. Southeast Iceland hosts exceptionally exposed large plutonic complexes, due to a combination of higher erosion and crustal accretion rates, making it a prime natural laboratory for investigating silicic magma generation oceanic crust and Iceland's past geodynamics.

The aim of our research integrates is to constrain the processes that govern the petrogenesis and temporal evolution high-resolution field mapping, photogrammetry, structural analysis, petrography, geochemical and geochronological data on key stratigraphic units to examine how silicic volcanic formations relate to pluton emplacement and shallow (<5 km) crustal magma storage.

Recent geological mapping in Southeast Iceland (Askew et al. this conference) has revealed four previously unknown extensive silicic volcanic formations containing: caldera infill sequences, conduit facies, and intrusions. These formations bound, and appear structurally linked to the Slaufudalur granite pluton, the largest exposed granitic intrusion in Iceland (8–10 km³). Yet Slaufudalur's relationship with surrounding rocks, previously mapped as just basaltic lava flows, remains poorly constrained.

New U-Pb Zircon ages of both plutonic and the newly identified silicic caldera formations indicate that silicic magmatism in the area spans a near continuous 5-million-year period, from 9–4.4 Ma. Within the pluton, zircon crystallisation ages reveal a resolvable age difference between an older roof unit and younger units beneath it. This is consistent with previous studies that suggest a top-down magma batch emplacement (Carmody, 1991; Burchardt et al. 2012).

These findings offer new insights into possible geodynamic scenarios in Iceland during the Miocene-Pleistocene, also contributes to a broader understanding of crustal accretion and crustal recycling processes in long lived silicic volcanic centers with oceanic rift environments.

New geochronological evidence of over 8 Myr of persistent silicic volcanism in Southeast Iceland

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Silicic magmatism is rare in oceanic crustal settings which are predominantly basaltic. Yet Iceland hosts substantial volumes of evolved volcanic and intrusive rocks, providing an exceptional natural laboratory for investigating the generation, storage and evolution of silicic magma in an oceanic setting. The mechanisms governing prolonged silicic magmatism and their relationship to crustal development remain poorly understood.

Southeast Iceland preserves an extensive and deeply dissected record of older volcanic and intrusive systems which appear to stack on top of each other stratigraphically. These manifest as silicic volcanic sequences, caldera infill complexes, large granitic and gabbroic bodies, and abundant silicic intrusions. Many of these systems lack the regional dike swarms characteristic of established axial rifting suggesting a flank or off-rift setting. This setup provides an opportunity to investigate silicic magmatism within older basaltic stratigraphy beyond the main active rift zones.

We combine regional geological mapping (see Askew et al., this conference), geochronology, petrology and geochemistry to reconstruct the spatial, temporal and compositional evolution of silicic magmatism across Southeast Iceland. By establishing the longevity and architecture of exhumed magmatic systems, this work aims to constrain the processes responsible for silicic magma generation, storage and recycling in oceanic crust and develop a geodynamic framework for their persistence within this part of the Miocene-Pleistocene stratigraphy in Iceland.

Here, we present new U-Pb zircon ages and geochemical data from SE Iceland together with a systematic analysis of previously published data. The observed age distribution indicates persistent silicic magmatism in the area for >8 Myr (~1.2-9.2 Ma), with no clear hiatus.

This prolonged magmatic and volcanic record raises fundamental questions about how silicic magmatism can persist within older oceanic crust in the absence of an established axial rift. Lower magma flux, prolonged magma storage, interaction with hydrothermally altered basaltic crust, and recycling or remobilization of previously generated silicic material may all contribute to this persistence, but their relative importance remains unresolved.

The Drill Core Library of the Natural Science Institute of Iceland

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The Drill Core Library (DCL) of the Natural Science Institute of Iceland includes drill core and cuttings from over 4.000 boreholes. The combined length of these boreholes is over 600 km, thereof 100 km of cored boreholes. The purpose of the DCL is to preserve this material and make it accessible to researchers for measurement and sampling. The DCL has been housed in Breiðdalsvík, Iceland, since 2015, and has since 2021 been operated in close collaboration with the University of Iceland's Research Centre in Breiðdalsvík.

In recent years, efforts have been made to improve the DCL's physical and digital infrastructure. The development of lab facilities has laid the groundwork for systematic documentation of the collections and increasingly open data access. Information about the collections is now made available through a WFS service, as well as Iceland's National Spatial Data Infrastructure (SDI), www.kortagluggi.is and the European Plate Observing System's (EPOS) Data Portal, www.ics-c.epos-eu.org.

To further improve access to the collections for potential users, an effort is underway to photograph the drill core collection in its entirety and make the images publicly available. The photographs are stored in the DCL database and made available through the WFS system and National SDI. Of the 10.778 core boxes preserved in the library, 4.880 (45%) have been photographed thus far. The photography effort is scheduled for completion in 2027. By request to the curator, particular drill cores can be prioritized for photography.

Scientists are encouraged to use this infrastructure to familiarize themselves with the DCL collections and use them for their research. The DCL's sampling and loan policy and further information about the collections can be found online at <https://www.natt.is/en/research/scientific-collections/drill-core-library>. The curator and staff will assist applicants in finding appropriate material for their intended purpose and in filling out a sampling or loan application.

Erosion in East Iceland and continental shelf formation.

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Volcanism in East Iceland was active from about 14 to 10.3 Ma in the northern half (the region of Borgarfjörður eystri, Loðmundarfjörður and Reyðarfjörður) and from 6.5 to 4.2 Ma in the southern half (the region of Austurhorn and Vesturhorn). This volcanic formation has undergone substantial erosion. The part of the region above sea level shows intense glacial and fluvial erosion. The seaward part of this region has been poorly analysed geologically and in terms of its erosion history. During summer 2026, we conducted multi-channel seismic analysis in the waters east of Iceland. Four of these profiles extend into the continental shelf. Preliminary analysis of the profiles reveals continental-shelf structures linked to tectonic activity, erosion of the primary lava piles, and deposition of eroded material at the shelf edge. We also use bathymetry data from OLEX and from the 2026 cruise. Bathymetry data reveal that the shelf surface contains glacier troughs and substantial unglaciated areas between them. Further offshore, within 40 to 60 km of the current coast, the shelf shows eroded lava flows. The distance from bedrock observations to the active coast ranges from 70 to 60 km, suggesting the original extent of eastern Iceland. It also suggests an average erosion rate of 5 to 10 mm per year, with a higher rate in the south. We suggest that Quaternary sea-level fluctuations affected the erosion rate and created shelf landmasses during the lowest stand. The bathymetry data show active tectonics, as suggested by the preliminary MC data.

Magma flow durations in flood basalt dikes, and machine learning inference of genetic chemical relationships between adjacent members of the Columbia River Flood Basalts, USA

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Flood basalt events such as the North Atlantic Igneous Province represent an end-member in the spectrum of volcanic processes, exhibiting massive eruption sequences that dominate the regional geologic record and associated with large-scale release of volatiles that significantly impacted global climate. A lack of analogous historical events however means that eruption mechanics are challenging to quantify, and the relationship of flood basalt sequences to modern eruption cycles are generally poorly constrained. We will discuss recent progress towards understanding the emplacement mechanics of the Columbia River Flood Basalts (CRFB), USA, using a combination of low-temperature thermochronology, a magnetic geothermometer, and thermal modeling to constrain active transport durations. We conducted a detailed multi-modal study of a CRFB 9 m wide, ca. 16 Ma feeder dike segment that was shallowly emplaced into a ca. 130 Ma pluton in the Wallowa Mountains of northeastern Oregon, USA. We generated AHe, ZHe, apatite and zircon fission-track (AFT, ZFT), and biotite $^{40}\text{Ar}/^{39}\text{Ar}$ (BtAr) ages along a 215 m transect away from the dike-wallrock contact; along this transect we also used the distance to unreset paleomagnetic inclination as a magnetic geothermometer. These data were used along with an unsteady 1D conduction model to perform a Bayesian Markov Chain Monte Carlo inversion that constrains the duration of active magma transport in the dike to 2.2-11.3 yr. Application of this approach in separate transects along strike of the dike, combined with geochemical fingerprinting, suggests that multiple pulses of magma associated with two stratigraphically neighboring CRFB units (Wapshilla Ridge and Meyer Ridge) in the Grande Ronde formation passed through the dike nearly coevally in time. Independent unsupervised machine-learning classification of major and trace element patterns for the CRFB lavas support this genetic association and further suggests geochemical similarities with other nearby Grande Ronde members. This association would imply that a massive fraction of the CRFB, >100,000 km³ representing ~50% the entire CRFB, erupted in extremely close succession and perhaps re-used upper crustal feeder dike structures to ascend through the upper crust.

Beyond MFCI: Modelling Jet and Plume Dynamics in Wet Basaltic Eruptions

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Phreatomagmatic eruptions are among the most powerful explosive eruptions on Earth and have produced some of Iceland's largest basaltic explosive events, with tephra-fall deposits covering more than half the country. Unlike magmatic eruptions, whose fragmentation and plume dynamics are comparatively well understood, phreatomagmatic eruptions introduce additional interactions between the eruptive jet and external water that modify fragmentation, ash production and eruption columns dynamics that are incompletely understood. For decades, wet explosive activity has largely been interpreted through molten fuel–coolant interaction (MFCI): direct magma–water interaction results in explosive steam generation alongside thermal granulation during quenching. However, there is growing evidence that MFCI does not explain several key observations recorded in the deposits from phreatomagmatic eruptions in Iceland. Wet and dry eruptions of comparable magnitude and magma composition exhibit similar eruption intensities, plume heights, clast densities, vesicularities and pre-fragmentation vesicle-size distributions, implying the magma may already have formed a gas–pyroclast jet before encountering water. MFCI-like interactions are then difficult to initiate, while the ash-rich character of wet tephra is also poorly reconciled with natural MFCI analogues. An alternative process-based understanding is therefore needed. In this contribution I will introduce a recently funded Icelandic Research Fund 2026 PhD project at the University of Iceland that will develop a new process-based understanding of Plinian phreatomagmatic eruptions. Our hypothesis is that ambient water is turbulently entrained into a momentum-driven gas–pyroclast jet as it rises through a water column, before flashing to steam and quenching suspended pyroclasts, promoting thermal granulation and modifying jet density and plume development. I will illustrate the three essential questions considered in this project and our approach: (1) what controls water entrainment into gas–pyroclast jets, and how does this influence eruption dynamics and grain-size distribution (GSD)? (2) how can these processes be parameterised in a physical model coupling jet thermodynamics and turbulent fluid mechanics, and propagated into plume processes? (3) how do these near-surface processes influence tephra dispersal and deposition from proximal to distal regions? This will establish a new physics-based framework for predicting the dynamics of plumes from phreatomagmatic Plinian eruptions, tephra dispersal and associated hazards. The Walker Centennial meeting will be an excellent opportunity for early-engagement with the community as this project begins.

Iron Partitioning During Garnet Fractionation of Basaltic Magmas

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Garnet crystallization at deep continental arc conditions is expected to preferentially remove iron (Fe) and ferrous (Fe^{2+}) from primary arc melts, but the effect of this process on the oxidation state of arc magmas has not been well understood. We simulated garnet crystallization from basaltic magma using high-pressure experiments and determined Fe^{2+} and ferric iron (Fe^{3+}) partitioning between garnet and melt using electron microprobe analyses and synchrotron Mössbauer spectroscopy. Our measured partition coefficients for both Fe^{2+} and Fe^{3+} are well above unity, supporting garnet fractionation as an effective mechanism for Fe depletion in arc melts. Their indistinguishable values, however, suggest convergence of Fe-valence partitioning at high temperatures.

The timing of deformation associated with the emplacement of the Sandfell laccolith

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The 11.7 Ma Sandfell laccolith in Faskrudsfjörður, Eastern Iceland, is a 0.6 km³ rhyolite intrusion. Internally, the Sandfell laccolith exhibits structural domains with varying fabrics and deformation features, ranging from flow banding and layered fractures to brecciation.

To study the relationship between the structural domains and the emplacement of the Sandfell laccolith, samples were collected along transects across these domains. Combined microstructural, anisotropy of magnetic susceptibility, and palaeomagnetic investigations show that the formation of the Sandfell laccolith began with the emplacement of an initial 14 to 10 m thick, subhorizontal intrusion characterised by a relatively fine grain size and folded flow bands. Subsequent intrusion of new rhyolite magma grew the laccolith laterally, as indicated by subhorizontal flow bands, but also led to doming of the intrusion, accommodated by brecciation and shearing within the laccolith. When the total thickness of the intruded rhyolite reached approximately 100 metres, a trap-door fault began to form in the northern part of the laccolith, leading to intense brecciation within the laccolith below the overlying fault scarps. Flow bands and fabrics associated with this stage of growth are inclined to the southwest, indicating that laccolith growth shifted to dominantly vertical, accommodated by movement along the trap-door fault.

The Sandfell laccolith palaeomagnetic directions plot on an N-S girdle, with inclinations ranging from sub-vertical to shallow dipping, indicating that some directions have been rotated after locking in. We interpret that laccolith inflation resulted in an initial clockwise rotation, which shifted to anti-clockwise rotation of the palaeomagnetic vectors as a trap-door fault formed along the northern margin of the pluton. Finally, lateral bulldozing of the host rock and older, already emplaced magma to the SE by newly intruding magma resulted in clockwise rotation of the palaeomagnetic vectors. Our results from the Sandfell laccolith show that palaeomagnetism, together with fabric and microstructural analyses, can be used to reconstruct the relative timing of deformation events associated with magma emplacement.

Investigation of the origin of Unit 6 and associated lapilli train from the 937-940 CE Eldgjá eruption, Iceland

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The 937-940 CE Eldgjá eruption took place on a ~70 km long, discontinuous cone-row in southern Iceland. Although eruption was generally effusive, it also produced approximately 1.3 km³ DRE of tephra in at least 16 explosive phases, making it one of the most explosive basaltic eruptions in historical times. Distinct tephra units have been interpreted to represent the explosive phases occurring at different sections of the linear vent system.

This study is focused on Unit 6, as it indicates a change in the nature of the eruptive behavior compared to the other 15 phases, which may be a sign of an important event in this sustained eruption. Fall deposit of Unit 6 show systematic up-section fining from coarse ash to very fine ash in all measured sections. It is also unusually rich in juvenile lithics. Furthermore, the rate of change in its thickness with distance from source is much smaller than for tephra fall deposit from the other phases, which can indicate that its eruption intensity may have been significantly greater. These factors raise the need for understanding the condition and process that led to the formation of Unit 6. We aim to unravel its origin via systematic studies of its dispersal, reconstruction of key eruption parameters and characterization of deposit grain size and componentry. In addition, the upper part of Unit 6 contains 2-3 lapilli trains, nicknamed lindur, with clast up to 3 cm in diameter. We propose that these “lindur” indicate early, and overlapping, activity of the eruptive episode that produced the overlying magmatic lapilli tephra fall unit.

Understanding the origin of such an unusual tephra unit is important because explosive basaltic eruptions are hazardous not only for Iceland but also globally. Improved understanding of the processes responsible for driving such eruption may contribute to better volcanic hazard assessment and can decrease associated risk.

George Walker and the flood basalt stratigraphy of Eastern Iceland

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The geological mapping campaigns of George Walker in eastern Iceland—first as an independent researcher and later with students—delivered maps and articles with unprecedented information for volcanic studies, crucial for understanding Icelandic geological history. The work incorporated mapping techniques advanced in British territories and was perfected throughout his years in Iceland. Despite considerable progress in the field of volcanology, Walker's ideas and observations continue to be revisited and inspire new discoveries.

One important contribution was Walker's detailed documentation of eastern Iceland's flood basalt stratigraphy, later expanded into a general discussion about their nature, mode of emplacement, and occurrences worldwide. In Iceland, his studies demonstrated that the Miocene stratigraphy included true flood basalts from fissure eruptions that interdigitated with lava flows and tuffs from central volcanoes. The flood basalts comprised groups of lava flows with distinct petrography and architecture, often traced across numerous fjords to become important markers within the stratigraphy. The main types were tholeiites, olivine basalts, and porphyritic lava flows with conspicuous plagioclase phenocrysts. These groups were described as wedging out from their source areas and enveloping nearby volcanic centers.

Present mapping, along with volcanological studies on the flood basalt sequences of eastern Iceland, has brought new insights into the extent and volumes of some of the flood lava groups, along with constraints on the mode of emplacement of the flows. This work enables an evaluation of the nature and scale of the eruptions in comparison to modern examples, leading to a better understanding of Miocene magmatism in Iceland and with important implications for crustal accretion models.

Iceland as a field laboratory for understanding Vøring volcanic margin seismic and borehole data

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Continental breakup is commonly associated with massive magmatism, forming so-called volcanic rifted margins. The Vøring Margin offshore mid-Norway experienced prolonged continental breakup-related basaltic magmatism in the Paleogene and is a global type-example of volcanic rifted margins. Here, seismic reflection profiles reveal a series of well-defined seismic facies units, including Inner and Outer Seaward Dipping Reflectors (SDR), Outer High, Landward Flows, Lava Delta, and Inner Flows. Extensive sheet intrusions and numerous kilometer-sized hydrothermal vent complexes are present in the Cretaceous and Paleocene sedimentary sequences. Conventional and high-resolution three-dimensional seismic data reveal well-defined igneous seismic geomorphologies of top and base basalt reflections, including compressional ridges, flow lobes, pitted and faulted surfaces, and egg-box networks. Kilometer-thick high-velocity bodies ($V_p > 7$ km/s) are identified in the lower crust, and they are interpreted as dominantly gabbroic and ultramafic rocks. Scientific drilling has recovered igneous rocks from 16 sites during the DSDP Leg 38 (1974), ODP Leg 104 (1985), NPD (2014) and IODP Expedition 396 (2021), including flood basalts, pillow basalts, ignimbrites, hyaloclastites and tephra. Recently, a granite was discovered on the Kolga High near the Møre-Vøring margin transition. We have conducted field work in Iceland over the past decade to better understand and interpret the seismic facies units, geomorphologies and core data from the Vøring Margin. Lava flow fields in the south (e.g., Laki, Fagradalsfjall) and north (e.g., Krafla, Holuhraun) are important for documenting the three-part flow interiors (base, core, crust) of inflated lava flows. Also, the surface morphologies reveal compressional ridges, lava-rise pits, rootless cones and elongated tunnels that can be related to geomorphologies present on seismic data. In the eastern and western fjords we find stacks of Miocene-age subaerial basalt flows separated by red sediment horizons, comparable to recovered rocks from boreholes through SDR and Landward Flows. Well-exposed sub-glacial and sub-aqueous pillow basalts and hyaloclastite sequences in the Kverkfjöll and Reykjanes areas resemble cores and ROV images from Eldhø, an Outer High on the Vøring Margin. In conclusion, the pioneering research on basalt deposits on Iceland by Walker and others have been key to build a new understanding of the deposits and processes forming buried landscapes on volcanic rifted margins globally.

Deformation related to the emplacement of the Eystrahorn complex, East-Iceland

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Magma accumulation and magma movement within the crust are monitored through geophysical techniques, but interpretation is based on modelling and ultimately on our geological understanding of exhumed magmatic systems. Therefore, studying these exposed magmatic systems enhances our understanding and interpretation of geophysical signals, thus, improving modelling and hazard prediction. Plutons represent the subsurface expression of central volcano magma storage zones. Southeast Iceland hosts several such plutons in easily accessible and well exposed areas. This project focusses on the exposed pluton of Eystrahorn (previously referred to as Austurhorn) that intruded around 6.5 Ma (Padilla et al. 2016) in southeast Iceland. Eystrahorn is a granitic-gabbroic plutonic intrusion hosted by predominantly Neogene mafic lava pile. The well exposed contacts of the complex were recorded using high resolution drone imagery to construct photogrammetric models and combined with field measurements and petrographic analysis. We aim to reconstruct the mode of emplacement of the Eystrahorn pluton and quantify the associated deformation. Our work builds upon previous studies including detailed petrological and geochemical analysis as well as detailed geological maps (Blake 1966; Weidendorfer et al. 2014). Despite the depth of previous work, most of these studies can be improved with further investigation. Furthermore, no study has been conducted regarding the mechanisms of magma emplacement at Eystrahorn. The project, which started in August 2026, will investigate deformation within the host rock surrounding the pluton, as well as the 3D geometries of the intrusion itself. The investigation will use new high-resolution aerial images, along with new more detailed drone photogrammetric data collected by the authors.

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Húsavík–Flatey Fault: Strike-Slip Stuck Between Rifts

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Across Iceland, the Mid-Atlantic Ridge System is expressed through a complex sequence of interacting tectonically or volcanically dominated zones. Here we focus on northern Iceland, where the Tjörnes Fracture Zone (tectonically dominated), connects the onshore Northern Volcanic Zone (NVZ) to the offshore Kolbeinsey Ridge over a 100 km long zone. Tjörnes Fracture Zone comprises of three sub-systems: the Grímsey Oblique Lineament, Húsavík – Flatey Fault (HFF) and Dalvík Lineament. Specifically, we review the role of the Húsavík – Flatey Fault (HFF) as part of the plate boundary: Why does a dominantly strike-slip fault system develop between two spreading systems characterised primarily by extension? The development of the NVZ at ~8 – 8.5 Ma and the transfer of rifting from the paleo-rift eastward is the commonly cited reason for why the TFZ exists, to connect the then newly established NVZ and Kolbeinsey Ridge. However, our understanding of the entire TFZ is limited due to a majority of the system being marine-based. Additionally, the three sub-systems of the TFZ express different modes of faulting, with fault orientations (sometimes only roughly estimated from seismicity) and slip differing significantly. The HFF is the best understood system given its ~25 km onshore section while also being very poorly understood compared to other strike-slip faults of its size. New field and remote sensing mapping along the HFF provides new insights to the fault zone and how transform faults operate. Here, we summarise what is known of HFF through time, while presenting recently acquired field data that sheds light on the HFF fault development, including fault rocks that show fault deformation for the first time, and size of Holocene earthquakes. Lastly, we ponder questions that we should aim to answer to develop the understanding of the HFF and therefore the Icelandic plate boundary. In light of the 100 years since George Walker's birth, these new insights can help us then look back at the larger Iceland region.

The life and career of George Walker, volcanologist (1926 to 2006)

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George, an only child, was born in London in 1926. His father Leonard died when he was 6, of damage caused by wounds received in World War 1. His Mother, Evelyn, was a nurse and she returned to her home farm in Ulster (N Ireland) every summer with George. George did well at elementary school and then attended Willesden Secondary School where he liked Art, Geography, Science, and English. However, in summer 1939 while George and Evelyn were in Ulster, World War 2 broke out. They stayed there and he transferred to a high-school in Lisburn, just outside Belfast. By this time, George was already an accomplished observer and recorder of natural phenomena, which he had learned from books and with a little help from a high-school chemistry teacher. He studied geology at Queen's University, Belfast, and then moved in 1950 to Leeds University (England) to study zeolite minerals in the flood basalts of Ulster, for his PhD. Remarkably, 2 years after starting his PhD he was offered a teaching position at Imperial College, London, but he stayed with Leeds, completing his PhD in 1956. He then moved to Imperial College. His research interests focused on the geology of Iceland, working apace on basalt lava flows, their secondary minerals, and the structure of basalt volcanoes and the Icelandic crust. In 1957, George married Hazel Smith, they had two children, and she later became an important helper in his research and publications.

George made seminal contributions to the geology of Iceland, showing that the lavas and volcanoes could be correlated and put into age-order. In 1964, he and Bodvarson showed that they grew older to either side of an axis in the middle of the island, demonstrating how crustal spreading could explain the large-scale structure of Iceland. He met and was strongly influenced by the work of Sigurdur Thorarinsson on tephrochronology and explosive volcanism. The eruption of Surtsey in 1963 was a pivotal moment. Together with visits to Etna and other European sites, he began to concentrate on explosive volcanism and active volcanoes.

In the late 1960's into the 1970's, George focused much of his attention on explosive volcanism and the study of pyroclastic deposits to reconstruct past eruptions and gain insights into the dynamics of explosive eruptions. Together with trusted collaborators, such as Basil Booth, Ron Croasdale, and Lionel Wilson, and several research students he revolutionized volcanology, pioneering systematic characterization of pyroclastic deposits, underpinned by gathering of prodigious amounts of field data and laboratory studies of grain size distributions. From these data he made brilliant interpretations of how these characteristics were controlled by eruption dynamics and atmospheric dispersal. His work was stimulated by other outstanding researchers of that era, such as Hans Schmincke, Shigeo Aramaki, and Dick Fisher. His work included systematic classification of pyroclastic fall deposits and foundational studies of the facies of pyroclastic flow deposits interpreted in terms of emplacement dynamics. These studies paved the way for quantitative documentation and reconstruction of eruptions. He still had some time for research on other aspects of volcanology, notably showing how the length of lavas was strongly correlated with effusion rate. He moved to the University of Auckland, New Zealand in 1977-78, where he continued with ground-breaking work on New Zealand volcanism, ignimbrites, and caldera formation, notably with Colin Wilson, a remarkably productive 3 to

4year period. In 1981, George accepted the Macdonald Professorship of Volcanology at the University of Hawai'i, Mānoa (O'ahu), where he spent 15 years until his retirement in 1996. There he made many new studies of lavas at Kilauea with grad student Scott Rowland, on post-erosional volcanism on O'ahu, and on exposed extinct shield volcanoes on O'ahu and other Pacific islands, such as Samoa. Notable amongst these were documentation of dike-swarms and their role in the evolution and plumbing of shields, with grad students Mike Knight and Edgardo Cañon-Tapia, and paleomagnetist colleague Emilio Herrero-Bervera. He also found time to extend his work to flood basalts with Edgardo and others. George retired back to England in 1996, keeping a long-made bargain he had with Hazel, and lived in Gloucester until he died.

Our late friend and co-author Geoff Wadge summed up George's influence in an obituary in words that are hard to improve upon:

“Never happy with the world of project proposal management, finance, and public relations George Walker realised his strengths lay in fieldwork, identifying solvable problems and inspiring others, and he played to them. Today's students of volcanology will see George Walker's name on many of the key papers that mark the rapid evolution of the subject in the last few decades of the twentieth century. Those who had the good fortune to be with him in the field carry fond memories of a man in his element, sharing his acute observations and insights with a twinkle in his eye to an audience struggling to keep up with him physically and mentally.”

Petrology of Neogene intrusions and volcanoes in eastern Iceland

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We carried out six field seasons (2003-2010) in the Austurhorn and Vesturhorn intrusive complexes, the Thingmuli volcano, and briefly in the Breiddalur volcano and other intrusive complexes. In the Thingmuli volcano our results suggested that silicic magmas can be produced in multiple ways (Charreteur et al., 2013). A trend of relatively iron-rich intermediate and silicic rocks, characterised by iron-rich clinopyroxene and sodic plagioclase phenocrysts is best explained by fractional crystallisation of basaltic melt under reduced conditions, as originally suggested by Carmichael (1964). In contrast, a trend of relatively iron-poor intermediate and silicic rocks appears to result from mixing basalt, partial melts of hydrated basaltic crust, and rhyolite under higher redox conditions.

Similar dual geochemical trends were identified in Holocene tholeiitic volcanic systems in Iceland, and in the Austurhorn and Vesturhorn intrusive complexes. The Raudafell composite complex in the Breiddalur volcano provides exceptional exposure of mafic-felsic rocks including the transitions from a feeder dyke through a vent structure, to a lava flow. The rocks define well-constrained mixing trends. Samples from the vent complex display a rare basalt-rhyolite emulsion texture, best explained by micro-mingling of two miscible melts with significant viscosity contrasts (Charreteur and Tegner, 2013).

The layered gabbroic massifs in the intrusive complexes are up to 800 m thick and display numerous rhythmic units. Mineralogical and compositional variations are best explained by repeated replenishment of basaltic magma, commonly carrying a crystal cargo, into open, dynamic chambers (Thorarinsson and Tegner, 2009).

Our complete sample collection (n= 606) will be stored and made available at the Natural Science Institute of Iceland, and all associated geochemical data will be compiled and published for future research.

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The petrological architecture of Ingólfshöfði and its relationship to Öræfajökull (Iceland).

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This research aims to enhance our understanding of volcanic plumbing systems beneath central volcanoes in Iceland. This is achieved through petrological studies and detailed investigations of mineral and magma evolution, including the temperature, pressure, and chemistry of selected components within the igneous rock suite. Öræfajökull, a large central volcano with transitional alkalic compositions in southeast Iceland, was selected for this study to reconstruct its magma plumbing system using geochemical methods, focusing on key magma storage zones beneath the volcano and the magmatic processes that alter magmas at these levels.

Ingólfshöfði, located about 20 km south of the Öræfajökull summit, offers a unique opportunity to investigate the magma plumbing system in its simplest form, before it becomes more complex closer to the main volcano. This research involves a detailed examination of clinopyroxene thermobarometry and a textural analysis of phenocrysts and glomerocrysts, which have not previously been undertaken for the Ingólfshöfði volcanic formation.

Ingólfshöfði is an emerging volcanic formation that features both Surtseyan explosive phases and effusive lava-forming phases, with the former represented by a basal tuffaceous pyroclastic sequence and the latter by the capping lava flows. The erupted magma contains clinopyroxene, olivine, and plagioclase crystals. Petrological and textural analyses of volcanic products collected from Ingólfshöfði reveal two distinct compositional groups: a “primitive group” with higher Mg# for clinopyroxene, higher Fo% for olivine, and higher An% for plagioclase, and an “evolved group” with lower Mg#, Fo%, and An% values.

These compositional groups are linked to distinct pressure zones, indicating that the magma plumbing system beneath Ingólfshöfði comprises two prominent crystal mush zones. The lower mush zone, characterised by primitive magma, occurs at approximately 7.5- 11 km depth, whereas the upper mush zone, containing more evolved magmatic compositions, lies at around 1.5- 3 km depth. Melt inclusions and crystal zonation support magma mixing and mingling before the eruption of Ingólfshöfði. In conclusion, this study provides valuable insights into the magmatic processes at the periphery of the Öræfajökull volcano.

Emplacement of mafic lava flow fields

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Endogenous growth is the underpinning process governing the emplacement of pahoehoe sheet lobes, which exhibit a three-part structural division of vesicular basal crust, crystalline lava core, and vesicular upper crust, which correspond to the bottom crust, molten core and the surface crust of an actively inflating sheet lobe. Moreover, field evidence demonstrates that an upper crust of considerable thickness (range; 20-50% of final lobe thickness) is formed during lobe emplacement. This pahoehoe crust is coherent and stationary, supported by the viscous lower part of the crust. Beneath it the molten lava is transported from the vents to the active flow front in insulated internal pathways where the cooling rates are $\ll 1^\circ\text{C}/\text{km}$. Observations show that lava tubes and tumuli are formed as the result of the localisation of flow along preferred internal pathways and lobe inflation. Initially sheet lobes are emplaced as thin inflating flat-topped sheets onto an undulating substrate. The lava flux through the lobes is variable and highest above substrate depressions. Continued inflation results in gradual redirection of flow towards these regions of higher flux. Eventually, the flow of lava is restricted to a few preferred pathways that feed lava to the steadily advancing flow front. As the lava breaks out of the pathways it forms new lobes that immediately are sealed by crust and grow in thickness and length by inflation. In due course the flow of lava is confined to a new extension of the lava pathway and the process described above is repeated. It is by this step-wise mechanism of forming lobe after lobe, pahoehoe lavas gradually make their way across the landscape without much cooling of the flow interior and in doing so they have formed the longest and largest lava flows on Earth, with flow lengths up to 2000 km and aerial coverage 10s-100s thousand square km. Studies and observations on past as well as active flow fields in the three decades have demonstrated that endogenous growth and flow inflation is an important mechanism in other mafic lava flow types, aa and even 'a'a.

The 937-40 CE Eldgjá flood lava eruption, Iceland: Explosive activity and magma composition

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The 937-40 AD Eldgjá flood lava eruption in Iceland (21 km³) featured a ~70-km-long, northeast-trending vent system with a four distinct vent segments: Eldgjá South, Central, Chasm, and North. The South segment is partly beneath the Mýrdalsjökull glacier, but the remainder of the vent system was subaerial. The eruption produced >16 eruption episodes each featuring phreatomagmatic or magmatic explosive activity of sub-Plinian to Plinian intensities. The tephra fall from these explosive phases covers >20,000 km² and has a cumulative volume of >6 km³ (1.3 km³ DRE). The lava volume is ~19.6 km³. The eruption started on the South segment, ~10-15 km NE of the Katla caldera and for the first ~1.5 yrs the eruption shifted between vents just outside and beneath the glacier, i.e., either on or just outside the northeast flank of the volcano, producing stratified phreatomagmatic tephra fall sequence interspersed with sporadic magmatic tephra fall units. This part represents the Wet Phase of the eruption. In the final 1.5 yrs the activity propagated in a stepwise manner towards the northeast, away from the Katla volcano, producing magmatic tephra (and lava) representing the Dry Phase. Eldgjá magma is rather evolved (MgO: 4.9-5.7 wt.%), mildly alkalic FeTi-basalt. Geochemical data representing all eruption episodes show that the most primitive magma (MgO: 5.5-5.7 wt.%; Zr: 220-235 ppm) erupted during the initial Wet Phase. The erupted magma became more evolved (MgO: 4.9-5.5 wt.%; Zr: 240-280 ppm) during the Dry Phase, indicating extraction of magma from shallower levels within the crustal storage zone during the latter half of the eruption.

The magmatism of 2021-23 Fagradalsfjall Fires, Reykjanes Volcanic Belt, Iceland

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On the evening of 19 March 2021, after 781 years of quiescence, the Reykjanes Volcanic Belt (RVB), Iceland, entered into its 4th Eruption Period in the last 4000 yrs when an eruption began on a 180-m-long linear vent system at the Fagradalsfjall volcanic complex. This event also marked the onset of the 2021-23 Fagradalsfjall Fires, which featured three effusive eruptions: 19.03-18.09.2021 at Geldingadalir, 03-21.08.2022 at Meradalir, and 10.07-05.08.2023 at Litli-Hrútur. Collectively they erupted $135 \times 10^6 \text{ m}^3$ (DRE) of mostly enriched, olivine tholeiite (8-8.5 wt% MgO) magma. However, the 2021 Geldingadalir eruption initially expelled depleted olivine tholeiite magma. These magmas were extracted from a $\sim 100 \text{ km}^3$ crystal-mush-rich magma storage zone situated at 9-12 km depth beneath Fagradalsfjall (e.g., Troll et al 2024). Major element analyses of groundmass glass in tephra from the 2021 Geldingadalir eruption reveal that during the first 12 days, the melts were depleted olivine tholeiites ($8.02 \pm 0.12 \text{ wt. \% MgO}$, $n=85$) with a $\text{K}_2\text{O}/\text{TiO}_2$ value of ~ 0.15 , which is consistent with the highest $\text{K}_2\text{O}/\text{TiO}_2$ melts ($0.015\text{-}0.16$) erupted during the Holocene on the RVB. From day 13, the $\text{K}_2\text{O}/\text{TiO}_2$ value of the erupted melt at Geldingadalir ($8.19 \pm 0.18 \text{ wt \% MgO}$; $n=50$) steadily increased until day 39, when it plateaued at a value of ~ 0.25 . For the remaining 4 months (i.e., days 39-180) of the 2021 eruption ($8.43 \pm 0.25 \text{ wt \% MgO}$, $n=117$) and throughout the 2022 Meradalir ($7.59 \pm 0.26 \text{ wt \% MgO}$, $n=172$) and 2023 Litli-Hrútur events ($7.35 \pm 0.21 \text{ wt \% MgO}$, $n=72$), the erupted melt $\text{K}_2\text{O}/\text{TiO}_2$ value was remarkably steady at ~ 0.25 . This is a uniquely high $\text{K}_2\text{O}/\text{TiO}_2$ value for basaltic melts with these MgO contents, as melts with 6.5-8.5 wt% MgO within the axial rift in Iceland typically have $\text{K}_2\text{O}/\text{TiO}_2$ values of ~ 0.15 or lower and all values are < 0.20 . The same applies to the 6.5-8.5 wt% MgO alkalic basalt melts from Hekla and Vestmannaeyjar volcanic systems (i.e., $\text{K}_2\text{O}/\text{TiO}_2 < 0.20$). The only 6.5-8.5 wt% MgO melts with higher $\text{K}_2\text{O}/\text{TiO}_2$ values (average, 0.49 ± 0.29) are melt inclusions from an effusive basalt eruption in the Snæfellsnes Volcanic Belt (Kahl et al 2021). It is therefore unlikely that the enriched melt composition erupted during the 2021-23 Fagradalsfjall Fires was delivered to the surface by the Holocene volcanism in Iceland and is instead a new addition its magmatism.

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Lava flow architecture and vent distribution of the Dabbahu central volcano and Manda Hararo fissure swarm in Ethiopia

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Characterisation of individual lavas and the architecture of stacking multiple lavas within a province requires a unique identifying feature for each individual flow field. In the absence of a unique chemostratigraphic, palaeomagnetic, or petrologic fingerprint, field investigation and good exposure may be the only way of tracing a single lava flow from its source to the distal reaches of a flow field. Our understanding of the physical architecture of lava flows and flow fields, derived initially from Walker's observations of simple and compound lava flows, have been used to develop detailed geological maps to enhance interpretations of the evolution of central volcanoes and associated fissure swarms in Ethiopia.

High-resolution mapping in the Manda Hararo rift segment (Afar, Ethiopia), involved remote sensing and three-dimensional image analysis of topography and surface rock chemistry based on mineral maps generated from false colour composites of Landsat ETM+, ASTER and hyperspectral (Eagle and Hawk) imagery together with aerial photographs. We interpreted the combined the datasets with DEMs within an immersive visualisation suite (GeovisionaryTM software) to simulate a fieldwork-based investigation. Derived interpretations were ground-truthed by targeted field studies and samples were acquired for ⁴⁰Ar-³⁹Ar dating.

The spatial and temporal distribution of volcanism in the Manda-Hararo rift segment was identified as well as the interplay between tectonism and magmatism in this active extensional setting at the continental-oceanic crust transition. The ~120 km long Manda-Hararo rift segment consists of pāhoehoe flow fields, believed to result from low effusion and lava flow advance rates that promoted the development of thick crusts, and silicic central volcanoes (Dabbahu and Ado Ale). Flow confinement and utilisation of topographic depressions, including grabens, faulted blocks, and ephemeral channels, promoted the advancement of the flow fields despite the low topographic gradients. Whilst linear basaltic fissure vents dominate the topographic rift axis, point source basaltic vents with young volcanic ages (<10 ka) are located up to 7 km away from the rift axis. Recent volcanism (2005-2011) and dyke emplacement (modelled from high-resolution geophysics and satellite geodesy) reveal focused magmatic accretion in the rift axis during the most recent rifting episode. However, the abundant off-axis cinder cones and vents reveal oblique and off-axis magmatic plumbing systems and that crustal accretion may not be limited to the central spreading centre. This is similar to models of slow-spreading magmatic mid-ocean ridge (MOR) segments, and contrasts with repetitive eruptions from central fissure vents in fast-spreading MORs.

Role of Inherited Structures on Incremental Emplacement of Midcrustal Lopolith-Like plutons: Insights from Mesozoic plutonism in South China

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Modes of magma emplacement provide key information on the geodynamic-tectonic settings of magmatism, brittle/ductile crustal deformation behavior, and the volumes and rates of magma transfer in the crust, particularly when magma volume and emplacement duration thresholds are crossed. Most upper-crustal granitic intrusions are incrementally emplaced as laccoliths or sills, whereas mid-crustal or deeper-level granitic intrusions appear to be predominantly emplaced as sills or lopoliths, yet relatively few examples have been studied. We present two case studies from the Mesozoic plutonism in the South China Block: the Jurassic Qitianling pluton and the Late Jurassic Shibei pluton. The Qitianling pluton was constructed in the upper part of the middle crust (at a depth of ~10–15 km), and is characterized by (1) generally undeformed granite–country rock contacts with a narrow thermal aureole, (2) irregularly wavy and gradational contacts between the main granite facies, (3) dominant sub-horizontal magnetic fabrics with scattered magnetic foliation, (4) rare dykes, and (5) a subcircular surface and lopolith-like geometry. It forms an ~25-km-wide and ~5-km-thick lopolith that was incrementally emplaced during a period of tectonic quiescence, most likely by under-accretion of multiple magma sheets deflected from magma pulses that ascended through pipe-like channels.

The Shibei pluton, a Late Jurassic granitic body in Fujian province, is featured by macroscopically isotropic granite and undeformed margins. Field observations, fabric investigations, and gravity modelling reveal two distinct magnetic fabric groups: high-angle to sub-vertical (54°–90°) NE–SW-striking magnetic foliations with variably plunging lineation in the southern-central part, and variably dipping (22°–88°) magnetic foliation generally striking subparallel to pluton–country rock contacts with irregularly oriented lineation in the northern part. Bouguer gravity modelling demonstrates a tabular geometry with a N–S-striking long axis, a length–width–thickness ratio of ~32:8:1, and intrusion thickness decreasing from ca. 2.5 km in the southwest to ca. 0.5 km in the northeast, with an undulating bottom and one or more convex intruding roots. Integrating published geochronological and regional tectonic data, we propose that the Shibei pluton was constructed by successive NE–SW-striking magma injections. Early magma batches were emplaced in the SW part, guided by inherited structures produced by pre-emplacement tectonic events. Continuous magma injections were laterally accreted to earlier intrusions and/or injected along lithological and/or structural discontinuities within the country rocks at upper crustal levels, without producing ductile deformation in the pluton–country rock contact zone.

Together, these two mid-crustal lopolith-like plutons highlight the role of inherited structures in controlling incremental emplacement, and our structural and fabric investigations indicate that the SE South China Block was not subjected to major tectonic deformation during the Late Jurassic period.

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Hydrothermally Altered Sheeted Dikes Recovered From IDDP-2 Drill Hole, Reykjanes, Iceland

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The 4.5 kilometer deep IDDP-2 drill hole was targeted to the active hydrothermal up-flow zone of the Reykjanes Geothermal Field which is developed in the on-land extension of the Mid Atlantic Ridge seafloor spreading center. Spot coring recovered sheeted dikes starting at a depth of 3068.7 m. The dikes show prograde hydrothermal alteration with amphibolite facies alteration overprinting epidote-actinolite alteration, similar to the deep hydrothermal reservoir that feeds the Reykjanes power plant. Spot cores recovered from 3865.5 to 4311.2 m are diabasic dikes pervasively altered under static hydrothermal conditions to hornblende-labradorite. Igneous textures are well preserved, but no primary minerals remain. Hydrothermal veining is limited to sparse mm scale hornblende veins. The bottom of the hole was continuously cored from 4634 to 4657 m with excellent recovery. Four half dikes separated by 3 chilled margins were recovered. Igneous textures are well preserved, but the rocks are pervasively altered to hornblende-plagioclase-clinopyroxene-orthopyroxene-ilmenite-magnetite-isocubanite $\pm$ biotite and hydrothermal olivine. Geothermometry coupled with paragenesis records retrograde hydrothermal alteration from a seawater derived supercritical fluid from near magmatic temperatures with peak alteration occurring at $\sim 800^\circ\text{C}$. Retrograde alteration records cooling down to the present day *in situ* temperature of $550\text{--}600^\circ\text{C}$. Open fractures lined with euhedral biotite and quartz record the latest stage of alteration at 600°C from phase separated seawater brine + vapor. Geophysical logging at the bottom of the hole prior to the final coring confirmed active fluid flow into the bore at 4.5 km depth. The measured temperature (426°C) and pressure (340 bars) lie on the seawater phase separation curve consistent with active phase separation of a seawater-derived fluid at the *in situ* temperature of $550\text{--}600^\circ\text{C}$. IDDP established the presence of active high-temperature fluid flow in high permeability open fractures in the sheeted dike complex that underlies the Reykjanes Geothermal field and verifies the potential for exploitation of efficient, super-hot geothermal energy. The drilling also constrains the physical, chemical, and mineralogical controls on the production of black smoker hydrothermal fluids that play a significant role in the cooling of the oceanic crust, the composition of seawater and the formation of important metallic mineral resources. A comparison with alteration in the deeply eroded sheeted dike complexes in E- and SE-Iceland offers the opportunity to extend our studies in space and time.

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