Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.25581

Gabbro Nodules: Windows into Icelandic Crystal Mush

MR. RAHUL SUBBARAMAN[1], LEWIS HUGHES[1], MARGARET E. HARTLEY[1], JONATHAN FELLOWES[1], MARGHERITA POLACCI[1], MS. BARBARA BONECHI, PHD[1], LUCIA PAPPALARDO[2], GIANMARCO BUONO[2] AND DAVID A. NEAVE[1]

[1]University of Manchester
[2]Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Napoli - Osservatorio Vesuviano

Cohesive yet porous frameworks of solid crystals with interstitial melts—crystal mushes—form geometrically complex plumbing systems beneath many active volcanoes [1]. Percolating melts and exsolved fluids create small, potentially eruptible melt lenses [2]. In oceanic setting like Iceland, these systems likely form localised mushy magma reservoirs that are stacked and separated by melt-free country rock [3]. Understanding the pre- and syn-eruptive textures of these mushes is critical for refining models of magma behaviour [4], as their properties ultimately determine whether magma remains trapped in the crust or erupts at the surface. We collected gabbro nodules from Gígöldur in Central Iceland that likely represent fragments of these mushes and offer unique windows into the petrology of mush-rich magma reservoirs.

We investigated the microtextural and chemical variability of our gabbroic nodule samples using electron backscatter diffraction (EBSD), SEM-EDS, EPMA, and LA-ICP-MS to address the following key questions: (1) What is their chemical variability at the micro- to decimetre scale, and how does this relate to regional-scale heterogeneity? (2) Does crystal mush assembly involve in situ crystallisation, or are xenocrysts/antecrysts incorporated? (3) Do these nodules preserve the preferred mineral orientations that have been observed in the oceanic crust, and is there evidence of deformation indicative of compaction or tectonic processes?

The nodules are plagioclase-rich, with interstitial olivine, and occasionally clinopyroxene. Vesicles occur in varying sizes and degrees of coalescence, often rimmed by glass of variable thickness. Point-counting shows compositions range from nearly anorthositic to leuco-troctolitic and leuco-gabbroic. Our calculations suggest that the mushes beneath Gígöldur likely contained low exsolved volatile-rich vapours. Olivine-Plagioclase-Augite-Melt (OPAM) thermobarometry [5] suggests final storage at mid to upper-crustal levels. Multiple generations of rims enclosing both individual plagioclase crystals and entire clusters reflects the complexity of the magma plumbing system beneath Gígöldur.

References:

[1] Edmonds, Cashman, Holness & Jackson (2019), *Phil Trans R Soc A* 377(2139): 20180298.
[2] Holness, Anderson, Martin, Maclennan, Passmore & Schwindinger (2007), *J Petrol* 48(7): 1243–1264.
[3] Maclennan (2019), *Phil Trans R Soc A* 377(2139): 20180021.
[4] Sparks & Cashman (2017), *Elements* 13(1), 35-40.
[5] Higgins & Stock (2024), *J Petrol* 65(5): egae043.