Fieldwork in Iceland - Microtextural and Microstructural investigation of active Icelandic mushes.

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The Mineralogical Society postgraduate student bursary helped me partially support the start of a new PhD project, 'Microtextural and Microstructural investigation of active Icelandic mushes'. To carry out this project as successfully as possible, I needed access to an extensive suite of samples encompassing a broad range of textures and an opportunity to conduct detailed field investigations of the study area and record their geological context in great detail. The bursary partially supported my field work in Iceland in August 2023, guided by my supervisors Dr David A Neave (Senior Lecturer (research), University of Manchester) and Dr Margaret E Hartley (Reader, University of Manchester). This fieldwork was a part of a combined University of Manchester and University of Cambridge expedition. During this period, I was also able to understand the context of the laboratory data I have generated during my first year of PhD and formed a vital role in training and development towards scientific independence.

Project Background:

Active volcanoes are increasingly understood to be fed by vertically extensive magma plumbing systems that extend through much of the crust [1,2] and are dominated by cohesive frameworks of solid crystals – crystal mushes – through which melts percolate and coalesce to form small, ephemeral but eruptible magma bodies [2]. Studying the properties of crystal mushes is crucial to improving models of magma behaviour and eruption forecasts, since the mush plays a central role in mediating volcanic behaviour and determining the resulting hazards [3]. Studying the pre- and syn-eruptive textures of crystal mushes is extremely challenging, because mush-derived clots of crystals will disaggregate during magma ascent [4], while the mushes preserved in fossil magma reservoirs are overprinted by post-emplacement physical and chemical processes [5]. The aim of this project is to develop a better understanding of how the physicochemical properties of the mushes evolve with time and how melt-rich and crystal-rich environments control the evolution and behaviour of deep magma plumbing systems. To do this, we have identified fragments of erupted mushes (gabbro nodules; also referred to as cognate xenoliths or crystalline enclaves in literature [6]) that preserve mush textures and provide ideal windows into the petrology of an actively evolving mush system. Microstructural and microtextural proxies for determining sources of mush fragments are based on textures from layered intrusions [7] and the oceanic crust [8]. Analogous studies on the nodules from Gigöldur are required to characterise the properties of mush fragments from active magmatic systems like those present beneath Iceland. The goal is to apply EBSD to extract the microscopic features that can provide insights into mush formation (preferred orientation), evolution (deformation structures) and pre-eruptive mobilisation (dissolution). EBSD provides us with direct orientation information of individual grains from a large statistical ensemble of grains in the investigated cross-section.

References:

[1] Paulatto M et al. (2019). *J Geophys Res: Solid Earth* 124: 11170-11191, [2] Cashman KV et al. (2017). *Science* 355(6331), [3] Sparks RJS et al. (2019). *Phil Trans R Soc A* 377, 20180019, [4] Neave DA et al. (2014). *J Petrol* 55(12), 2311-2346, [5] Holness MB et al. (2017). *J Petrol* 58(4), 643-673, [6] Holness MB et al. (2019). *Phil Trans R Soc A* 377, 20180006, [7] Holness MB et al. (2007). *J Petrol* 48(7), 1243–1264, [8] Mock D et al. (2021). *J Geophys Res: Solid Earth* 126, e2020JB019573.

Figure captions:

(a) On the top of a hyaloclastite ridge in South Gígöldur. Holuhraun fields and Kverkfjöll visible in the background, (b) series of broad ridges striking NNE-SSW consisting of interfingering hyaloclastites and postglacial craters at Gígöldur, (c) caught in action - bagging the samples and taking field notes, mid-way to the ridge-top at Central Gígöldur, (d) gabbro nodules containing plagioclase feldspar (white), olivine and pyroxenes (black) and volcanic glass (dark green) in various proportions, (e) caught in action – sampling on a steep slope of a ridge in South Gígöldur, (f) range of samples – nodules of various modality of minerals (pale-white with black spots), plagioclase-phyric scoracious agglutinates (black), oxidised/altered scoracious aggutinates (red), hyaloclastite (pale yellow-brown).