



Overview of the mineralogy and geochemistry of pillow lavas and dikes exposed at Vatnsskarth, Iceland: insights on physical and chemical processes at tindar ridges

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A quarry at Vatnsskarth, which is part of the Krisuvik fissure system in southwestern Iceland, provides exceptional exposures of the stratigraphy and insights into the formation processes of a glaciovolcanic, pillow-dominated tindar. The active part of the quarry is ~0.5 km wide, and 0.7 km long, while the overall width of the ridge at this location is ~1.2 km. The Vatnsskarth sections comprise a variety of extrusive and intrusive lithofacies, including packages of the two predominant units, pillow lava and vitric tuff-breccia. Locally tuff and lapilli tuff lenses are also present. Intrusions vary from conformable with existing contacts to cross-cutting. Dikes are exposed immediately south of the quarry and are subparallel to the overall ridge orientation. Gabbroic inclusions are also present in multiple units, although they are most abundant within the intrusions. The upper sections of the ridge are covered by multiple packages of glaciogenic diamictons, comprising predominantly rounded and locally striated basaltic cobbles.

All of the coherent units at Vatnsskarth appear to have the same phenocryst assemblage of $Pl > Ol > Cpx$, with a similar mineralogy in the groundmass. Preliminary mineral compositions (SEM-EDS) show a limited range of compositions for Pl (An68-89; average ~An80) and Ol (Fo64-83). Locally Pl phenocrysts show oscillatory zoning, and Ol has small inclusions of Cr-spinel. Major element geochemistry (n=40) shows only small variations between the units (average MG# (with Fe²⁺ set at QFM) = 58 +/- 1.2; average Ca/Al (molar) = 1.39 +/- 0.03). For sample VAT13-14, which has the highest Mg#, MELTS predicts an anhydrous, 0.1 MPa liquidus temperature of 1214 C, a liquidus Ol composition of Fo84, and a Pl saturation composition of An79; the predicted mineral compositions are in good agreement with observed compositions.

Comparison to the geochemistry of samples from another quarry along the same ridge but ~2 km north, at Undirlithur, show that samples on the north side of Vatnsskarth have compositions similar to the second (younger) compositional group at Undirlithur. The occurrence of the same magma composition in both quarries is consistent with the fissure segment having been active at multiple points over length scales of km during ridge construction. Furthermore, because this particular magma batch was identified in dikes at Undirlithur, it may also indicate that dikes distributed magma along-axis during the formation of the ridge. This geochemical information is consistent with ridge-parallel orientations of dikes, as well as orientations of magma distributary channels.