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The Crust Cracks Up: lateral magma transport in NE Iceland

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The processes that affect the compositional range of basaltic magmas erupted along fissures include mantle melting, crustal storage and eruption. Holocene fissure swarm eruptions in NE Iceland provide a unique opportunity to investigate the interaction of magmatic and tectonic processes and their impact on the compositional variability. The ~11 ka Sveinar-Randarhólar Fissure, located in the Northern Rift Zone (NRZ) of Central East Iceland is the longest Holocene eruptive fissure system in Iceland. The ~75 km long fissure system is composed of generally north-south trending scoria craters and basaltic lava flows. We present here glass, whole rock and mineral geochemical results of scoria and lavas sampled along the Sveinar-Randarhólar Fissure. The petrographic and geochemical compositions, including olivine oxygen isotope data display little geochemical variability along the entirety of the fissure. Combined with new thermobarometric estimates, this homogeneity implies that the magmas originated from a homogenous reservoir at ~8-10 km depth and that they were transported laterally along the entirety of the fissure with little to no fractionation or cooling. Our new geochemical data indicate that the Sveinar-Randarhólar Fissure magmas are comparable to those erupted from the Askja central volcano to the south of the fissure and some 135 km distant from the northernmost fissure eruptions. A 60 km crater-free gap between the Askja caldera and the first Sveinar-Randarhólar Fissure crater may be explained by glacial coverage of the region during the early Holocene, suppressing eruptive activity. We propose a model in which a caldera collapse event, associated with coeval eruptive activity at Askja, caused over-pressurisation of the underlying magma chamber (‘French Press’ model), resulting in magma being laterally injected into the crust and transported relatively fast northwards along structural weak zones in the crust.