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Magma types and mantle sources of the Bárðarbunga volcanic system, Iceland

Sæmundur Halldórsson (1), Ken Rubin (2), Guðrún Sverrisdóttir (1), and Gylfi Sigurðsson (1)

(1) Nordic Volcanological Center, Institute of Earth Sciences, University of Iceland, 101 Reykjavík, Iceland, (2) Department of Geology and Geophysics, SOEST, University of Hawaii, Honolulu, Hawaii 96822, USA

The Bárðarbunga volcanic system (BVS) represents one of the largest volcanic systems in Iceland, extending ∼190 km from the northern boundary of Torfajökull in the south to Dyngjufjöll Ytri in the north, and intersecting the largely ice-covered Bárðarbunga volcano. The extensive length of the BVS thus allows sampling of an unusually large section of the mantle underlying Iceland's Eastern rift zone. Perhaps surprisingly, the degree of mantle source heterogeneity beneath the BVS remains poorly known. We have recently undertaken a detailed study of the BVS because such data are fundamental for understanding the magmatic history and magma delivery system beneath of the BVS, including those that led to recent volcanism north of Dyngjujökull. Here, we present major and trace element analyses, as well as high-precision Pb isotope analyses, of several Holocene lava flows from the Dyngjuháls area and from rocks representing the basement, flanks and nunataks of the ice-free part of the Bárðarbunga volcano. We compare these data to those on a suite of recently collected fissure basalts from the Veiðivötn fissure swarm in the south and the new lava north of Dyngjujökull in order to study the geochemical characteristics of the BVS as a whole.

The BVS has generated fairly primitive tholeiites (MgO ∼6-9 wt.%) throughout the Holocene. Evolved basaltic compositions (MgO ≤6 wt.%) that are often associated with large and mature caldera systems in Iceland (e.g., Krafla and Askja), appear to be notably absent in the BVS within our current sample set (although might still exist in the largely ice-covered Bárðarbunga volcano). Significantly, no highly evolved rocks (dacite, rhyolite) have been associated with the BVS. It is therefore unlikely that a long-lived and relatively shallow (<5 km) magma chamber has existed beneath Bárðarbunga throughout the Holocene, and possibly longer.

In Pb-Pb isotope plots, the three sections of the BVS form distinct trends. Notably, Holocene lavas from the Veiðivötn fissure swarm lie on two parallel trends, with 206Pb/204Pb ratios >18.40. In contrast, subglacial formations in the Dyngjuháls region, form a single trend with 206Pb/204Pb always <18.39. Significantly, another group of young lavas fall right in-between the three trends: those from the new fissure lava north of Dyngjujökull, historical Veiðivötn fissure swarm lavas, and Holocene Dyngjuháls lavas. In sharp contrast, samples of unknown age from the ice-free part of the Bárðarbunga volcano display significant heterogeneity and overlap all of these data/trends.

We propose that at least three mantle components contribute melts to the BVS, in different proportions in space and time. However, recent eruptions, regardless of location appear to be fed from the same or at least a more uniform magma source. Finally, we note that removal of ∼2500 m. of glacial ice that overlaid the BVS during the last deglaciation, could have strongly influenced the melting regime in addition to magma delivery and/or storage under central Iceland – much more so than along the Northern rift zone (e.g., Theistareykir; Slater et al. 1998).

Slater, L., Jull, M., McKenzie, D., Grönvold, K., 1998. Deglaciation effects on mantle melting beneath Iceland: Results from the northern volcanic zone. Earth Planet. Sci. Lett. 164, 151–164.