Reviewed research article

Geochemistry and petrology of Holocene lavas in the Bárðardalur region, N-Iceland. Part I: Geochemical constraints on source provenance

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Abstract — *Because of extensive volcanic production in Iceland during the Holocene, many of the early postglacial large-volume fissure lavas cannot be unambiguously traced to their eruptive craters solely by observations in the field. For example, the Bárðarbunga volcanic system has been suggested as a likely source of the large Holocene lava flows found in Bárðardalur valley, but this idea mainly relies on petrographic observations. We conducted a chemical and isotopic study of the lavas in Bárðardalur. For comparative purposes, we also targeted basement rocks of the Bárðarbunga central volcano, as well as several eruptive units in the region north of Vatnajökull. Based on a comparison of chemical and radiogenic isotope data of lavas from the Bárðardalur region and the eruptive units north of Vatnajökull and the Bárðarbunga central volcano, it appears most likely that the lavas of Bárðardalur valley belong to the Bárðarbunga volcanic system. These new data, and a compiled dataset for other selected volcanic systems of the NRZ, shed light on possible limitations when assigning erupted material to its source volcano by means of chemical composition. Furthermore, this study demonstrates that our understanding of the relative importance of the different processes at play during the petrogenesis of Icelandic basalts is likely to be greatly improved by multi-parameter datasets for geologically well-characterized eruptive units.*

INTRODUCTION

Field observations indicate that eruption rates within the neovolcanic zones in Iceland may have been up to 30 times greater during periods of rapid deglaciation in early postglacial times relative to the current ones (e.g., Maclennan *et al.*, 2002; Sinton *et al.*, 2005; Sims *et al.*, 2013). This enhanced magmatic activity has been explained by (1) increased decompression melting in the mantle associated with the disappearance of the ice load (Sigvaldason *et al.*, 1992; Jull and McKenzie, 1996) (2) extensive tapping of crustally-stored magma due to changes in the stress field as a result of rapid uplift (Guðmundsson, 1986). Early postglacial lavas are volumetrically dominant features in many volcanic regions of Iceland, particularly within the Bárðarbunga volcanic system and the Northern Rift Zone (NRZ) (Vilmundardóttir, 1977; Jakobsson, 1979; Hjartarson, 2006; Thordarson and Larsen, 2007). During the period between ∼9000–6000 years BP, eruption rates in the region of the Bárðarbunga-Veiðivötn fissure swarm were exceptionally high, resulting in the production of some of the largest Holocene lava flows in Iceland (Figure 1), including the ∼8600 years BP Þjórsárhraun lava (see box 2 in Figure 1) (e.g., Hansen and Grönvold, 2000; Hjartarson, 2006; Halldórsson *et al.*, 2008), with an estimated minimum volume of 25 km^3 (Hjartarson, 2011). Another large lava field, which might represent an early postglacial volcanic pulse from the Bárðarbunga volcanic system, can be found in Bárðardalur valley in North Iceland (see box 1 in Figure 1) (Sigbjarnarson, 1988; Vilmundardóttir and Kaldal, 1991; Hjartarson and Kaldal, 2004; Hjartarson, 2004).