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Making Earth's earliest continental crust - an analogue from voluminous Neogene silicic volcanism in NE-Iceland

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Borgarfjörður Eystri in NE-Iceland represents the second-most voluminous exposure of silicic eruptive rocks in Iceland and is a superb example of bimodal volcanism (Bunsen-Daly gap), which represents a long-standing controversy that touches on the problem of crustal growth in early Earth. The silicic rocks in NE-Iceland approach 25 % of the exposed rock mass in the region (Gústafsson et al., 1989), thus they significantly exceed the usual $\leq$ 12 % in Iceland as a whole (e.g. Walker, 1966; Jonasson, 2007). The origin, significance, and duration of the voluminous (> 300 km3) and dominantly explosive silicic activity in Borgarfjörður Eystri is not yet constrained (c.f. Gústafsson, 1992), leaving us unclear as to what causes silicic volcanism in otherwise basaltic provinces. Here we report SIMS zircon U-Pb ages and δ18O values from the region, which record the commencement of silicic igneous activity with rhyolite lavas at 13.5 to 12.8 Ma, closely followed by large caldera-forming ignimbrite eruptions from the Breiðavik and Dyrfjöll central volcanoes (12.4 Ma). Silicic activity ended abruptly with dacite lava at 12.1 Ma, defining a $\leq$ 1 Myr long window of silicic volcanism. Magma δ18O values estimated from zircon range from 3.1 to 5.5 ($\pm$ 0.3; n = 170) and indicate up to 45 % assimilation of a low-δ18O component (e.g. typically δ18O = 0 ‰ Bindeman et al., 2012). A Neogene rift relocation (Martin et al., 2011) or the birth of an off-rift zone to the east of the mature rift associated with a thermal/chemical pulse in the Iceland plume (Óskarsson & Riishuus, 2013), likely brought mantle-derived magma into contact with fertile hydrothermally-altered basaltic crust. The resulting interaction triggered large-scale crustal melting and generated mixed-origin silicic melts. Such rapid formation of silicic magmas from sustained basaltic volcanism may serve as an analogue for generating continental crust in a subduction–free early Earth (e.g. $\geq$ 3 Ga, Kamber et al., 2005).

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