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Crustal thermal state and origin of silicic magma in Iceland: the case of Torfajökull, Ljósufjöll and Snæfellsjökull volcanoes

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Pleistocene and Holocene peralkaline rhyolites from Torfajökull (South Iceland Volcanic Zone) and Ljósufjöll central volcanoes and trachytes from Snæfellsjökull (Snæfellsnes Volcanic Zone) allow the assessment of the mechanism for silicic magmas genesis as a function of geographical location and crustal geothermal gradient. The low δ^{18}O (2.4‰) and low Sr concentration (12.2 ppm) measured in Torfajökull rhyolites are best explained by partial melting of hydrated metabasaltic crust followed by major fractionation of feldspar. In contrast, very high ^{87}Sr/^{86}Sr (0.70473) and low Ba (8.7 ppm) and Sr (1.2 ppm) concentrations measured in Ljósufjöll silicic lavas are best explained by fractional crystallisation and subsequent ^{87}Rb decay. Snæfellsjökull trachytes are also generated by fractional crystallisation, with less than 10% crustal assimilation, as inferred from their δ^{18}O.

The fact that silicic magmas within, or close to, the rift zone are principally generated by crustal melting whereas those from off-rift zones are better explained by fractional crystallisation clearly illustrates the controlling influence of the thermal state of the crust on silicic magma genesis in Iceland.