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In-situ isotope study of Icelandic tephra: new petrogenetic constrains from comparison of three isotope systems B-O-Th

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We report new boron isotope compositions and concentrations measured by ion microprobe on Holocene tephra samples from 6 Icelandic volcanoes. These new results are compared with O and Th isotopes measured on the same samples.

The B concentrations range over almost a factor of 10, from 1.50±0.10 to 13.10±0.10 ppm in basalt and obsidian, respectively. The variations of boron isotope compositions in the Icelandic tephra and their negative correlations with both δ^{18}O and (^{230}Th/^{232}Th) strongly support the crustal melting model for most silicic magma in Iceland. The co-variation is interpreted in terms of a mixing between mantle derived basalts and crustal melts produced from anatexis of hydrothermally altered basaltic crust. The highest δ^{11}B (+16.9±2.2 and +6.1±1.6 per mill) measured in dacites from the rift-related Askja and Krafla volcanoes. In contrast, the lowest δ^{11}B values (–5.3±2.0 per mill) are observed in a trachyte from Snæfellsjökull volcano located at the extreme W of the island. This sample also have normal δ^{18}O and (^{230}Th/^{232}Th) (+5.10 per mill and 1.067, respectively) and consistent with an origin through fractional crystallization of mantle derived basalts. The twofold origin of the silicic magma most likely reflect contrasting geothermal gradient: low at the periphery where a cold crust will cause abundant crystal fractionation of rare basalts and high in the rift-zones where magmatism is abundant and crustal melting hydrothermally altered basalts is

frequent. The combination of the O and B isotope systems allows for the first time the identification of the alteration agent. It is a hydrothermal fluid not solely of meteoric origin but significantly influenced by seawater.