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Silicic magma generation at Askja volcano, Iceland

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Rate of magma differentiation is an important parameter for hazard assessment at active volcanoes. However, estimates of these rates depend on proper understanding of the underlying magmatic processes and magma generation. Differences in isotope ratios of O, Th and B between silicic and in contemporaneous basaltic magmas have been used to emphasize their origin by partial melting of hydrothermally altered metabasaltic crust in the rift-zones favoured by a strong geothermal gradient. An alternative model for the origin of silicic magmas in the Iceland has been proposed based on U-series results. Young mantle-derived mafic protolith is thought to be metasomatized and partially melted to form the silicic end-member. However, this model underestimates the compositional variations of the hydrothermally-altered basaltic crust.
New data on U-Th disequilibria and O-isotopes in basalts and dacites from Askja volcano reveal a strong correlation between (230Th/232Th) and delta 18O. The 1875 AD dacite has the lowest Th- and O isotope ratios (0.94 and -0.24 per mille, respectively) whereas tephra of evolved basaltic composition, erupted 2 months earlier, has significantly higher values (1.03 and 2.8 per mille, respectively). Highest values are observed in the most recent basalts (erupted in 1920 and 1961) inside the Askja caldera complex and out on the associated fissure swarm (Sveinagja basalt). This correlation also holds for older magma such as an early Holocene dacites, which eruption may have been provoked by rapid glacier thinning. Silicic magmas at Askja volcano thus bear geochemical signatures that are best explained by partial melting of extensively hydrothermally altered crust and that the silicic magma source has remained constant during the Holocene at least. Once these silicic magmas are formed they appear to erupt rapidly rather than mixing and mingling with the incoming basalt heat-source that explains lack of icelandites and the bi-modal volcanism at Askja volcano.