Role of fluids in melt generation in the Cascade arc: Constraints from U-Series data from Central Oregon

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We report new U-Th-Ra-Sr-Nd isotope data for late Holocene lavas from the Three Sisters region of the Oregon Cascades to investigate the processes responsible for melt generation. Our samples span the compositional range from basalt to rhyolite. The Sr and Nd data define fairly restricted ranges of ~ 0.7032-0.7036 and +4 to +5.6 ε_{Nd} units. Evidence for the involvement of fluids in the petrogenesis of Cascade arc lavas is ambiguous, with previous $^{230}Th/^{238}U$ data suggestive of dry melting [1-3], contrary to inferred high water contents of primitive lavas [4]. All our samples show ^{230}Th over ^{238}U enrichment, with three basaltic andesite samples showing marked ^{230}Th enrichment (($^{230}Th/^{238}U$) = 1.21 – 1.42), more than previously reported for other Cascade volcanoes [1, 2, 3]. The corresponding *K*-values for these samples are 2.75 – 3.25. In contrast, the remainder of the less evolved samples, with ($^{230}Th/^{238}U$) ~ 1, have *K*-values closer to the MORB value of ~ 2.5. The two rhyolitic samples have ($^{230}Th/^{238}U$) ~ 1, but higher *K*-values of ~ 2.9. Ra-Th disequilibrium measured in a sub-set of samples provides further constraints on fluid sources and melting processes. Most samples are close to secular equilibrium or show modest ^{226}Ra enrichment, with ($^{226}Ra/^{230}Th$) ~ 1.2. These values are in the range reported for other Cascade lavas [1, 2]. The most enriched sample is a rhyolite, with ($^{226}Ra/^{230}Th$) of 1.6.

The $^{230}Th/^{238}U$ data are consistent with decompression melting and variable addition of a high *K* component, likely mafic lower crust. The high-*K* values for the rhyolites were most likely generated by assimilation of this component, consistent with them having the highest $^{87}Sr/^{86}Sr$ and lowest $^{143}Nd/^{144}Nd$ ratios. Lack of U enrichment may be due to reducing conditions in the mantle wedge, but the lack of Ra enrichment argues against it, consistent with limited oxidation state data [6]. The high ($^{226}Ra/^{230}Th$) value measured in the rhyolite is likely not related to fluid-based addition of Ra from the slab but crystal fractionation and mixing processes.

[1] Volpe & Hammond (1991) *EPSL* **107**, 475-486. [2] Volpe (1992) *JVGR* **53**, 227-238. [3] Reagan *et al*. (2003) *J. Petrology* **44**, 1703-1726. [4] Grove *et al*. (2005) *Cont. Min. Pet.* **148**, 542-565. [5] Brandon & Draper (1996) *GCA* **60**, 1739-1749.

Trace element geochemistry of nyerereite and gregoryite phenocrysts from Oldoinyo Lengai natrocarbonatite lava

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Natrocarbonatite lavas erupted by the active volcano Oldoinyo Lengai (Tanzania) are characterized by high modal abundances of phenocrystal nyerereite [$(Na,K)_2Ca(CO_3)_2$] and gregoryite [$(Na,Ca,K)_2CO_3$] set in very fine-grained matrix consisting of halite, sylvite, fluorite, K-neighborite, Sr-REE-bearing apatite, Ba-nyerereite, a gregoryite-like phase and a Ba-Sr-Na-Ce carbonate related to khannesite. Although bulk rock geochemical studies have established that natrocarbonatites are highly enriched in light REE there is a paucity of data on the trace element contents of the constituent minerals. We have in this study determined by high resolution laser ablation ICP-MS the abundances of Li, P, V, Mn, Rb, Sr, Y, Cs, Ba, and REE within and between nyerereite and gregoryite phenocrysts.

Our data show that nyerereite is enriched in Rb (118-256 ppm), Sr (12800-33624 ppm), Y (1.3-7.3 ppm), Cs (1.8-5.9 ppm), Ba (4261-17228 ppm), and REE but poorer in Li (22-52 ppm), P (823-1906 ppm) and V (6.3-37 ppm) relative to gregoryite (Rb = 58-98; Sr = 5071-7009; Y = 0.3- 09; Cs = 1.1 - 4.8; Ba = 1793-3231; Li 151-391; P = 6790-15861; V=38-97 ppm). Nyerereite is highly enriched in REE (La = 262-1010 ppm) relative to gregoryite (La = 64-177 ppm). Chondrite normalized REE distribution patterns for both minerals are parallel and linear with no Eu anomalies, and show extreme enrichment in light REE (La/Sm_{CN} = 74-89) relative to bulk rock compositions (La/Sm_{CN} = ~43). Individual coexisting nyerereite and gregoryite phenocrysts are zoned with respect to all trace elements determined. Significant differences in the abundances of trace elements between coexisting crystals suggest that the phenocryst assemblage is derived by mixing of different batches of natrocarbonatite magma.