Petrogenesis of recent trachytic eruptions from Sete Cidades volcano, São Miguel, Azores (Portugal)

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Sete Cidades has produced 12 intracaldera, trachytic eruptions (Sete A-L) within the last ~4-5 ka [1,2]. We have completed detailed petrographic, major and trace element, Sr, Nd and Pb isotope and U-series disequilibria studies of whole rock samples from the Sete A-L deposits to constrain petrogenetic processes, eruptive ages and repose intervals associated with the Sete Cidades magmatic system [3]. Major and trace element analyses were performed on a suite of 16 samples representing all of the deposits from Sete A-L. The data show limited major element variation (~63% SiO_2) but highly variable trace element abundances (e.g. >1.6-fold variations in Zr and ~4-fold variations in Sr). Trace element abundances show a complex relationship with stratigraphy that we interpret to reflect a 3-stage evolutionary process. Stage 1 (Sete A-B), characterized by an increase in Zr concentration with stratigraphic height, reflects evolution of a trachytic magma via 35% fractionation of the observed mineral assemblage including sanidine>biotite>clinopyroxene>Fe-Ti oxides>apatite. Stage 2 (Sete B-F) is characterized by decreasing Zr concentrations with stratigraphic height, suggesting injection of a less evolved trachytic magma into the Sete Cidades magma chamber. Stage 3 (Sete F-L) is recorded by an increase in Zr with stratigraphic height, and is consistent with 54% crystallization of the observed mineral assemblage. Sr isotopic variation in leached whole rock samples ($^{87}Sr/^{86}Sr$=0.70375-0.70439) further requires assimilation of hydrothermally altered syenite wall-rock [4,5]. Nd and Pb isotopic compositions are essentially invariant ($^{143}Nd/^{144}Nd$=0.51287; $^{206}Pb/^{204}Pb$=19.52-19.56) and within the range of local basalts, consistent with trachytic magma evolution from parental basalts derived from a single mantle source over the past ~4-5 ka. Six samples have also been analyzed for U-series disequilibria, and all are Th-enriched and Ra-depleted. With one exception, $^{238}U/^{232}Th$ and $^{230}Th/^{232}Th$ activity ratios are constant with ($^{238}U/^{232}Th$)≈0.88 and ($^{230}Th/^{232}Th$)≈0.96, similar to basalts from the Sete Cidades region, and consistent with the trachytes deriving from parental basalts that evolved rapidly (within ~10 ka) to produce the Sete A-L trachytic magmas. Present-day $^{226}Ra/^{230}Th$ activity ratios range from 0.32-0.75, consistent with recent and extensive sanidine fractionation during trachyte magma evolution, and further allowing constraints on the maximum eruptive ages. Preliminary data indicate a maximum eruptive age of 912 years B.P. for Sete B, which suggests that the recent recurrence interval of Sete Cidades may be only ~42 years, much shorter than the recurrence intervals of 200 and 1200 years at neighboring Furnas and Fogo volcanoes [6].

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