Timescales of crustal assimilation at intra-oceanic arcs: U-series and geochemical constraints from Lopevi Volcano, Vanuatu, SW Pacific

H.K. HANDLEY[1]*, S.P. TURNER[1], I.E.M. SMITH[2] AND R.B. STEWART[3]

[1]GEMOC, Dept. of Earth and Planetary Sciences, Macquarie University, Sydney, NSW 2109, Australia (*correspondence: hhandley@els.mq.edu.au) (sturner@els.mq.edu.au)

[2]Department of Geology, University of Auckland, Private Bag 92019, Auckland, New Zealand (ie.smith@auckland.ac.nz)

[3]Institute of Natural Resources, Massey University, Palmerston North, New Zealand

The extent and geochemical impact of crustal contamination during magmatic evolution in intra-oceanic subduction zone settings is assumed to be of minimal significance and is poorly constrained. However, acquiring such information is a first-order priority before meaningful timescales of magma generation and crustal residence beneath volcanoes can be determined.

Despite relatively homogeneous Sr-Nd isotopic compositions (compared to other Vanuatu arc lavas) of high-MgO basalts and differentiates erupted over the last 100 years at Lopevi volcano, the rock suite displays a strong negative correlation between $^{87}Sr/^{86}Sr$ isotope ratio and indices of differentiation (e.g. SiO_2). This presents compelling evidence for the interaction of rising mafic magmas with 'primitive' sub-arc crust and provides an excellent framework within which to investigate and ascertain timescales of crustal interaction using U-series data.

Quantative geochemical modelling of whole-rock trace element ratios, $^{87}Sr/^{86}Sr$ isotope compositions and U-series data shows that assimilation of a relatively small-degree partial melt of >380kyr-old mafic oceanic crust (similar to Pacific- or Indian-MORB in $^{87}Sr/^{86}Sr$ isotopic composition) during fractional crystallisation of magma exerts major control on ($^{230}Th/^{232}Th$) and ($^{226}Ra/^{230}Th$) activity ratios of the lavas. The incorporation of higher ($^{230}Th/^{232}Th$) and lower ($^{226}Ra/^{230}Th$) assimilated material draws the samples much closer towards secular equilibrium than that of simple closed-system differentiation, reducing calculated apparent timescales of closed-system differentiation from Th isotope composition (10^4-10^5) by orders of magnitude. Modelling suggests that assimilation occurs extremely rapidly at Lopevi with maximum timescales for magma generation, differentiation and eruption in the order of 10^2 years.