Origin of high-Mg andesites at White Island

*AU: * Turner, S*
EM: sturner@els.mq.edu.au
AF: Department of Earth and Planetary Sciences, Macquarie University, Sydney, NSW 2109, Australia
AU: Wood, B
EM: bwood@els.mq.edu.au
AF: Department of Earth and Planetary Sciences, Macquarie University, Sydney, NSW 2109, Australia

On White Island, New Zealand, the intensified period of strombolian-volcanian and phreatomagmatic explosive activity that commenced in March 1977 led to eruption of unusually primitive, high-Mg andesites. These are Fo80- 93 olivine-saturated rocks that have MgO contents up to 10 percent (Mg# = 65-71) and SiO_2 of 56-58 percent. They have incompatible trace element characteristics that are typical of arc rocks. $^{87}Sr/^{86}Sr$, $^{143}Nd/^{144}Nd$ and $^{176}Hf/^{177}Hf$ ratios (0.7049-0.7053, 0.51282-0.51266 and 0.28301-0.28298, respectively) are consistent with subducted sediment addition and/or crustal input but there is no clear correlation of either isotope ratio with MgO. The rocks have modest (3-10 percent) ^{238}U excesses at low ($^{230}Th/^{232}Th$) ratios (0.697 to 0.722). ^{226}Ra- ^{230}Th disequilibria is also restricted but, unusually, includes both ^{226}Ra excesses and deficits with ($^{226}Ra/^{230}Th$) = 0.94-1.07. ($^{210}Pb/^{226}Ra$)o ranges from 0.98 to 1.52 requiring gas accumulation that may increase over time and with decreasing MgO. Sr/Y and Tb/Yb ratios are both low and relatively invariant at 8 and 0.3, respectively, and along with the ^{238}U excesses preclude an origin in which residual garnet was involved. The occurrence of some ^{226}Ra deficits suggests the presence of residual amphibole during partial melting for some samples. Rapid magma ascent (to preserve the ^{226}Ra disequilibria) limits the amount of possible melt - wall rock interaction that might reduce source-derived Tb/Yb ratios and in the mantle or raise $^{87}Sr/^{86}Sr$ in the crust. The White Island high-Mg andesites did not form by partial melting of eclogite in the subducting Pacific plate. Their primitive, olivine-saturated compositions suggest that their source was peridotitic and experimental data suggest that melting at low temperatures at 0.5-1.5 GPa and in the presence of elevated alkalis can reconcile the high SiO_2 and MgO of the rocks. These conditions appear to be favoured by the location beneath continental, rather than oceanic lithosphere.