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# Evolution of a peralkaline rhyolite magmatic system: Tūhua (Mayor Island), New Zealand

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Tūhua (Mayor Island) is an isolated peralkaline (molar $(Na_2O+K_2O)/Al_2O_3>1$) rhyolite volcano situated ~80 km behind the active calc-alkaline arc volcanism of the Taupō Volcanic Zone (TVZ), New Zealand. The ~4 km diameter island represents the topmost extent of a larger ~10 km submerged edifice and consists of a series of lava-dominated shields cut by a composite caldera structure. The oldest exposed rocks date back to ≥135 ka and the youngest are late Holocene in age. The largest known eruption is the caldera-forming event at ~7.2 ka, since which there has been only effusive and minor explosive activity within the caldera. Eruption products are dominated by mildly peralkaline (9–11 wt% total alkalis) rhyolite (71–75 wt% $SiO_2$) with minor amounts of co−eruptive trachy-basalt to trachy-andesite (‘mafics’:50–58 wt% $SiO_2$). They are chemically evolved and cannot be considered primitive. Rare plutonic lithics range from calc−alkaline to peralkaline compositions. Compared with the better-known TVZ products, Tūhua rhyolites are somewhat richer in silica, alkalis and iron. More notably they show enrichment of REE, HFSE and halogens but depletion of Sr and Ba.

New geochemical and Sr-Pb-Nd isotope whole-rock data have been placed within a refined temporal context utilising new $^{40}Ar/^{39}Ar$ ages and the presence of well-dated mainland tephra beds. This has revealed a systematic evolution through time. Prior to ~40 ka, rhyolite $^{206}Pb/^{204}Pb$ ratios range between 18.884–18.889 and transition to more radiogenic values of 18.891–18.895 in younger eruptions. $^{143}Nd/^{144}Nd$ ratios show a similar increase to more radiogenic values. The change in Pb and Nd isotope ratios mirrors changes in the bulk chemistry from comendites ($Fe/Al^* = 1.33 \cdot FeOT/ (Al_2O_3–4.4) < 1$) to pantellerites ($Fe/Al^* > 1$). The co-eruptive mafics show less systematic variation in isotope composition over time but in some cases overlap with the rhyolite values.

These geochemical trends are thought to reveal a discernible shift in the domains where rhyolite genesis occurred that may provide insight into the current state of the volcano.