

Processes and timescales of magma genesis and differentiation at Lopevi Volcano, Vanuatu, SW Pacific

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Recently erupted basaltic and andesitic lavas of Lopevi Volcano, one of the most active in Vanuatu, were analysed for whole rock major and trace element abundances, Sr and Nd isotopic ratios and U, Th and Ra isotopic compositions; forming the first detailed U-series study of an individual volcanic centre within the Vanuatu (New Hebrides) arc. The data are used to constrain the processes and timescales of magma genesis and evolution beneath the volcano, leading towards a better understanding of the relationship between magma supply and eruption, which is invaluable for volcanic hazard assessment.

MgO contents of lavas erupted throughout 2000-2003 cluster at around 4-5 wt%, whereas those from earlier eruptions (during the 1930's and 1960's) exhibit a wider range, extending to more primitive MgO contents (up to 8.5 wt%). Fractional crystallisation is an important mechanism of differentiation at Lopevi, exerting strong control on major and trace element variations. Increases in SiO₂, Na₂O, Al₂O₃, TiO₂ (and to a lesser extent K₂O and P₂O₅) and decreases of CaO and Fe₂O₃ with decreasing MgO are consistent with the removal of a mineral assemblage dominated by olivine and pyroxene. Unlike volcanic rock suites of many other arc volcanoes, Dy/Yb ratios at Lopevi do not systematically decrease with increasing SiO₂, demonstrating that amphibole cannot be an important fractionating mineral during magmatic differentiation at mid-lower crustal depths beneath the volcano.

Enrichment of LREE relative to HFSE and HREE, high Ba/La ratios relative to MORB, uniform HFSE/HFSE ratios (e.g. Ta/Nb) along with ²³⁸U excesses (1.250-1.400) in Lopevi lavas identify the contribution of a fluid component to a relatively homogeneous, slightly depleted mantle source. Furthermore, the sub horizontal array displayed by the data on a U-Th equiline diagram indicates this addition occurred significantly recently. ²²⁶Ra excesses in the lavas suggest that crustal residence times of magmas at Lopevi are <8000 years. ⁸⁷Sr/⁸⁶Sr ratios lie between 0.703992 and 0.704078 and are characteristic of volcanoes similarly located in the central Vanuatu arc, above where the D'Entrecasteaux Ridge is being subducted and accreted (cf. northern and southern sections of the Vanuatu arc).