Petrogenesis of high-Mg# andesite lavas from Ruapehu volcano, New Zealand

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The eruption of high-magnesium andesites (HMA) with Mg# values >60 at continental arc volcanoes conflicts with the expectation that mantle-equilibrated primitive magmas produced at subduction zones are basaltic. Studies of the origins of HMA lavas provide details on how primitive magmas transit through arc lithosphere, which has implications for constraints on crust-mantle connections as well as volcanic hazards.

Here we report on the occurrence and origin of a sequence of HMA lavas erupted at ~45 ka from Ruapehu volcano, which is a frequently active andesite-dacite stratovolcano in the Taupo Volcanic Zone (TVZ). The suite of lavas forms linear trends on bivariate whole-rock major and trace element plots that are distinctly elevated for MgO, Ni and Cr compared with all other lavas of Ruapehu and most other calk-alkaline andesites of the TVZ. The relatively primitive whole-rock geochemical characteristics are attributed to the involvement of mafic sources during magma genesis, as revealed by the presence of sharply reverse-zoned pyroxene phenocrysts with rims of $Mg\#_{85-89}$ and olivine xenocrysts with cores of Fo_{88-93} and Cr-spinel inclusions. The contribution of felsic end-members to the genesis of Ruapehu HMA magmas is recorded by the presence of rhyolitic glass within partially fused metasedimentary xenoliths and the low Mg# cores for pyroxenes within crystal clots that also preserve rhyolitic interstitial glass and melt inclusions.

The petrological and geochemical features of the samples indicate that the assembly of HMA magmas involved influxes of mafic magmas from the mantle that entrained olivine xenocrysts into mush zones of bulk (rhyo-) dacitic composition, which had evolved via preceding assimilation, fractionation and mixing processes in the crust. Timescale results from Fe-Mg interdiffusion modelling of orthopyroxene indicate that eruptions occurred within days to weeks of magma mixing events. Ruapehu HMA lavas are valuable samples of high-Mg# magmas collected from the global subduction zone system that were formed by crustal level magma hybridization processes (cf. Streck and Leeman, 2018) rather than directly by mantle melting processes (cf. Mitchell and Grove et al. 2016).

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