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From Source to Surface: Magmatic Timescales and Processes Leading to Eruptions from Red Crater (Tongariro, New Zealand)

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Volcanic eruptions at subduction zones are ultimately driven and sustained by magma recharge from the mantle. However, primitive compositions are mostly overprinted by interactions with the overlying crust and magma evolution before eruption, especially in complex trans-crustal magmatic systems in continental subduction zone settings. Knowledge of how these systems manifest and evolve through time in response to magma recharge is vital for understanding and predicting volcanic behaviour. This study uses detailed geochemical analysis of mafic minerals (olivine, pyroxene) of recent (<1.8 ka) eruptions from Red Crater to gain insights into the magmatic system of Tongariro, a large composite andesite volcano located in one of New Zealand's most volcanically active areas at the southern end of the Taupō Volcanic Zone (TVZ). We have used mineral chemistry, crystal compositional zoning and melt inclusions to identify and characterize components in the magmatic system and to reconstruct pre-eruptive storage conditions and magmatic timescales. Our investigation reveals four olivine populations with core compositions from Fo_{70} to Fo_{91} and thin Fe-rich rims (~Fo_{78}). Pyroxene crystals are often complexly zoned and record up to three distinct magmatic environments within one crystal. Olivine-hosted melt inclusions represent some of the most primitive melts reported in the southern TVZ to date, while melt compositions found in pyroxenes vary from primitive to evolved. Overall, we find abundant chemical and textural evidence for open-system processes and our interpretation supports the influx of primitive Mg-rich magma from a deep mantle source, variable interaction with at least one mid-lower crustal, more evolved magma reservoir, followed by rapid ascent and eruption. This information improves our knowledge of magmatic processes leading to eruptions in this area and contributes to the general understanding of andesite petrogenesis at continental subduction zones.