

Timescales and magma ascent rates using 3D-CSD in the Mangawhero Formation lava flows, Mount Ruapehu, New Zealand.

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The Tongariro Volcanic Centre is a highly active volcanic region in the central North Island, New Zealand. Comprised of three andesite cone volcanoes – Ruapehu, Tongariro, and Ngauruhoe, their eruptions span a wide range of eruption styles and sizes, from Plinian to Strombolian. Previous studies on demonstrably explosive phases (<10 kyr) have shown that pre-eruption magma residence times are short (~2 to 4 days) with ascent rates up to 9 cm/s. Here we compare magmatic timescales in the lead-up to effusive phases from Ruapehu's Mangawhero Formation, which is a lava flow unit composed mainly of plagioclase and two pyroxene andesites, emplaced between 50 and 15 kyr. We analysed the crystal size distributions (CSD) of orthopyroxenes from 9 lavas of the Mangawhero Formation and calculated the residence times using the slope of the CSDs, using a known growth rate. Our results indicate that magma residence times prior to effusive eruptions are between 2 and 9 days i.e., very similar to those preceding explosive eruptions. Further, plagioclase and pyroxene crystals were analysed using EPMA to obtain their compositions and determine the P - T - H_2O conditions using a combination of thermobarometry, hygrometry and MELTS modelling. We find that the magmas had water contents up to 3 wt.% and resided at ~ 220 MPa and temperatures up to 1075 °C. These data are used to derive a maximum magma ascent rate of between ~2 and 10 cm/s. Our results show that pre-eruption unrest is largely indistinguishable between explosive and effusive magma ascent, complicating monitoring efforts. More work is needed to explore shallow conduit controls on eruption style and size variations at this volcanic centre.