The Potential Impact of Rhyolitic Mega-Eruptions, Exemplified by the 9.5 ka Rotoma Event

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The Earth's most violent and explosive eruptions originate from rhyolitic calderas. The most productive rhyolitic centres include Toba, Yellowstone, Long Valley and the Taupo Volcanic Zone (TVZ). The TVZ is the most active, having erupted at a millennial-scale frequency. Within the TVZ there are two active calderas, Okataina and Taupo, the most recent rhyolitic eruption occurred from Okataina at c. AD1305. Large rhyolitic eruptions will inevitably occur in the future, these eruptions are capable of causing major disruptions to climate and civilisations.

TVZ rhyolitic eruptions are large magnitude, with intracaldera events commonly >4-5 km3 d.r.e., while >100 km3 of magma is ejected in large caldera-forming eruptions. High (>30 km) plinian plumes from all these events extend into the stratosphere, dispersing ash both into the Tasman Sea west of New Zealand via trade winds, as well as to the east into the Pacific Ocean under the prevailing westerlies. Coarse ash (>60 microns) has been carried >1400 km during some TVZ events. Eruptions of this magnitude are therefore capable of hemispheric scale disruptions.

This study investigates the 8 km3 Rotoma eruptive episode (~9.5 ka) at Okataina, from the generation and storage of the rhyolite magma, through to the eruption processes, and aftermath. Simultaneous or sequential eruptions occurred from an 11 km linear chain of vents that parallel the dominant tectonic fabric of the TVZ, producing a diverse range of eruption styles and products. The plinian phases were both magmatic and phreatomagmatic, and deposited ash over much of the North Island. Areas within 20 km of the vents were blanketed by >1 m of tephra, while 43 mm of tephra fell 160 km upwind at Auckland, now the site of New Zealand's largest city (population ~1.3 million). Pyroclastic density currents swept areas radially to 20 km from vent, while lava flows filled depressions to 100 m depths, forming new topography and radically changing fluvial drainage systems. The extrusion of large volumes of lava during the episode implies that

activity was prolonged for several years.

An eruption of this magnitude today would catastrophically change landscape and ecosystems within the central North Island, and prevent most economic activity such as tourism, farming, forestry, and hydroelectric power generation over a wider area. Local urban centres would be uninhabitable for many years after the eruption ceased. Widespread disruption to international aviation routes in the South Pacific would also occur. Such eruptions would compromise the economic viability of New Zealand and have knock-on effects for the rest of the Pacific region.