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Volatiles in basaltic magmas from Ōkataina, Aotearoa New Zealand

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The Ōkataina Volcanic Centre (OVC) is the highest threat volcano in Aotearoa New Zealand and the most recently active caldera system in the Taupō Volcanic Zone (TVZ). The OVC has dominantly erupted rhyolitic magmas with subordinate basalt, such as in the most recent basaltic Plinian eruption from Tarawera in 1886. We analysed melt inclusions from basaltic eruptions at Ōkataina to constrain the volatile content of the basaltic magmas feeding this dominantly rhyolitic caldera. Ōkataina basaltic magmas are rich in water (up to 5 wt%) and sulfur (up to 3000 ppm), and the high sulfur contents of the melts requires relatively oxidised (ΔFMQ<+1) magma, otherwise sulfur would be sequestered into a sulfide melt. The oxidised, volatile-rich nature of these magmas reflects their subduction zone setting. To understand how the gases released from Ōkataina basalts would evolve during ascent to the surface (especially given their oxidised and water-rich nature), we use a multi-volatile (C-O-H-S) thermodynamic model. Although the initial CO_2 content of the melt is poorly constrained, we find that sulfur preferentially degasses deep due to the high-water contents, in contrast to water-poor systems such as MORBs. For instance, a magma with 1000 ppm CO_2, 1000 ppm S, and 1 wt% H_2O degasses 50 % of its sulfur by ~250 bar, whereas for 5 wt% H_2O it degasses 50 % of its sulfur by ~1700 bar. Current gas emissions are CO_2 diffusively degassing from the volcano (as measured via soil CO_2 survey data) and from fumaroles that are very water-rich. The fumarole chemistry is consistent with magmatic degassing at shallow depths (<1500 bar) but are also heavily influenced by interaction with the hydrothermal system. Using the petrologic method for assessing sulfur emissions, the Tarawera eruption released up to 4 Mt of SO_2 into the stratosphere over five hours, which supports studies indicating up to two years of cooling in the southern hemisphere followed this eruption.