

Chemical composition of the evaporative degassing plume at Te Wai a Moe crater lake (Ruapehu, New Zealand)

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In this study, we present the chemical composition (CO_2/SO_2 , $\text{CO}_2/\text{H}_2\text{S}$ ratios) of the gas plume originating from Te Wai a Moe crater lake surface, Ruapehu Volcano, New Zealand, by the first MicroGAS measurements (i.e. a “mini” MultiGAS without pump and with diffusion-sensible sensors) in March 2019, a period of volcanic quiescence for Ruapehu volcano. The detection method did not require physically touching the lake, in respect of the Maori rules considering Te Wai a Moe as sacred. The March 2019 lake plume CO_2/SO_2 molar ratios are lower than the most magmatic end member in the Taupo Volcanic Zone, represented by high-T fumaroles of White Island, suggesting a formation process of SO_2 inside the lake. In fact, with respect to the parental gas rising from the magmatic-hydrothermal system beneath the crater lake (i.e. 1994-1995 fumarole composition during the last complete lake dry out), $\text{CO}_2/\text{H}_2\text{S}$ molar ratios increased 3-fold (from ~ 8 in the fumaroles to ~ 24 in the lake plume), whereas CO_2/SO_2 decreased from ~ 3.7 to ~ 2.9 . Assuming the parental gas did not change significantly, this observation suggests, as expected, efficient scrubbing of H_2S in the lake water, but also a conversion of H_2S to SO_2 through oxidation during gas rise through the lake. Time-framing of this gas flushing, from bottom to top towards the atmosphere, is still poorly constrained, though crucial for forecasting purposes. These first findings will have a direct impact on how to monitor Ruapehu’s Te Wai a Moe, and other crater lake systems worldwide, in the line with recent studies on tracking temporal variations in degassing plumes coming off crater lakes to provide clues on the source mechanisms of phreatic eruptions.