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Spatial variability in degassing at Erebus volcano, Antarctica

Tehnuka Ilanko (1), Clive Oppenheimer (1), Philip Kyle (2), Alain Burgisser (3,4)

(1) Department of Geography, Cambridge University, United Kingdom (ti235@cam.ac.uk), (2) Department of Earth & Environmental Science, New Mexico Institute of Mining & Technology, USA, (3) CNRS, ISTerre, Le Bourget du Lac, France, (4) Université Savoie Mont Blanc, ISTerre, Le Bourget du Lac, France

Erebus volcano on Ross Island, Antarctica, hosts an active phonolitic lava lake, along with a number of persistently degassing vents in its summit crater. Flank degassing also occurs through ice caves and towers. The longevity of the lake, and its stable convection, have been the subject of numerous studies, including Fourier transform infrared (FTIR) spectroscopy of the lava lake. Two distinct gas compositions were previously identified in the main lava lake plume (Oppenheimer et al., 2009; 2011): a persistent 'conduit' gas with a more oxidised signature, ascribed to degassing through a permeable magma conduit; and a H_2O- and SO_2- enriched 'lake' composition that increases and decreases cyclically due to shallow degassing of incoming magma batches.

During the past decade of annual field seasons on Erebus, gas compositions have been measured through FTIR spectroscopy at multiple sites around Erebus volcano, including flank degassing through an ice cave (Warren Cave). We present measurements from four such vents, and compare their compositions to those emitted from the main lava lake. Summit degassing involves variable proportions of H_2O, CO_2, CO, SO_2, HF, HCl, OCS. Cyclicity is evident in some summit vents, but with signatures indicative of shallower magmatic degassing than that of the lava lake. By contrast, flank degassing at Warren Cave is dominated by H_2O, CO_2, and CH4.

The spatial variability in gas compositions within the summit crater suggests an alternative origin for 'conduit' and 'lake' degassing to previous models that assume permeability in the main conduit. Rather, the two compositions observed in main lake degassing may be a result of decoupled 'conduit' gas and pulses of magma rising through discrete fractures before combining in the lake floor or the main plume. Smaller vents around the crater thus emit isolated 'lake' or 'conduit' compositions while their combined signature is observed in the lava lake. We suggest that this separation between gas sources is enabled by a complex shallow fracture network, collapses of which also promote frequent changes to crater morphology. Flank degassing results from decoupling and ascent of CO_2-rich gas through deeper fractures, and re-equilibration to lower temperatures and pressures.