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Secular trends in plume composition of 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

Long-lived active lava lakes, such as that in the summit crater of Erebus volcano, Antarctica, provide a rare insight into sustained magma convection and degassing over long timescales. Erebus lava lake has been persistently active since 1972, and potentially for several decades or more previously (Ross, 1847). Since the 1970s, regular scientific expeditions, lasting a few weeks in the austral summers, have made observations of the lake activity. Annual Fourier transform infrared (FTIR) spectroscopic gas measurements began in 2004 (Oppenheimer and Kyle, 2008; Oppenheimer et al., 2009), yielding an extensive, if discontinuous, time series of infrared absorption spectra. These data, once processed, provide insights into temporal evolution of the gas geochemistry in terms of seven molecular species: H_2O, CO_2, CO, SO_2, HCl, HF, and OCS.

FTIR spectroscopic data are now available over ten field seasons, totalling roughly 1.8 million spectra and increasing each year. This period spans changes to crater morphology, fluctuations in lava lake surface area (Jones et al., 2014), and two episodes of increased explosive activity (2005-06 and 2013). The dataset captures both long-term degassing trends and short-lived features, such as cyclicity in gas emissions during passive degassing (Ilanko et al., 2015) and compositions released by explosive bubble-burst eruptions. We consider the longer-term changes to gas ratios occurring within (i.e. over days to weeks) and between annual field seasons, their potential causes, and their relationship to observations of eruptive behaviour and crater morphology.