Geophysical Research Abstracts,
Vol. 11, EGU2009-7377-1, 2009
EGU General Assembly 2009

Oscillatory degassing of a phonolite lava lake, Erebus volcano, Antarctica

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Lava lakes provide windows into the magma networks that feed active volcanoes. Their observation can provide important insights into magma transport and eruptive styles. A few lava lakes, like that at Erebus volcano, Antarctica, have been continuously active for decades. Such persistence suggests bidirectional magma flow in the feeder conduit, driven by density contrasts arising from degassing. However, few observations distinguish the manner in which gases separate from magmas, undermining efforts to evaluate physical models for rheology and eruptive behaviour. Using spectroscopic observations at Erebus, we show that the gas plume emitted from its lava lake consists of two components: a deep-sourced CO_2-rich gas that percolates through permeable conduit magma, and an H_2O-rich gas exsolved near the surface. Thermal observations reveal $\sim$10 min cycles in lava lake convection and heat output that are strikingly phase-locked with cycles in gas composition and flux, suggesting similarities with laboratory simulations. Our findings indicate unstable magma flow in the upper conduit due to viscosity stratification, and exemplify the relative roles of closed- and open-system degassing in persistently active volcanoes. Since this interplay between degassing styles can be associated with abrupt transitions in eruptive behaviour, the ability to discriminate gas sources in a volcanic plume can contribute more widely to volcanic hazard assessment.