Magmatic plumbing of Ross Island, Antarctica uncovered by melt inclusions from CO_2-rich alkalic magmas

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Melt inclusions (MI) entrapped at variable depths and stages of magmatic evolution can provide a history of the physico-chemical states of a magma. Here we use MI to trace the histories of alkalic magmas from Ross Island to better understand their ascent paths, degassing, and crystallization at this hotspot volcanic center.

We report volatile, major, and trace element data on 92 olivine-hosted ($Fo_{78.2-88.3}$) MIs in 9 basanites (SiO_2 39.0-45.4 wt.%) from 3 volcanoes on Ross Island (Hut Point, Mt. Terror, and Mt. Bird). Incompatible element ratios suggest a similar garnet-bearing mantle source for all samples. FTIR data indicate pre-eruptive magmas are volatile-rich, containing 0.01-0.95 wt.% CO_2 and 0.02-1.98 wt.% H_2O. S, Cl, F, and Li are nearly invariant and are decoupled from variations in CO_2 and indices of crystallization. Trends in H_2O-CO_2 in Hut Point and Terror MI cannot be explained by simple open or closed system degassing scenarios and require H_2O depletion by diffusive re-equilibration or fluid flushing. We estimated vapor bubble vol.% and observe no clear link between vapor bubble vol.% (1-22%) and decrease of H_2O or CO_2 in all but one sample set. However, the number of vapor bubbles in a single MI is variable (1-4), a possible indication that some were present as an exsolved fluid phase during MI formation. Vapor saturation modeling shows MIs have a broad range of entrapment pressures but most are between 200 and 400 MPa. We suggest Hut Point and Terror magmas stall briefly at depths of ~7.5-15 km where they are likely buffered by a CO_2-rich fluid phase prior to eruption. Bird MIs can be explained by open system degassing.

We also revisit 54 olivine-hosted ($Fo_{53.0-82.8}$) MIs [1] in seven samples of basanite to phonolite from Mt. Erebus, the central volcano on Ross Island. Erebus MIs have lower water concentrations (~0.12 wt.% in all but one sample set) and lower entrapment pressures (most <100 MPa) compared to the surrounding volcanoes. These results suggest Erebus magmas ponded in shallow magma reservoirs and evolved under drier conditions.

[1] Oppenheimer *et al* (2011), *EPSL* **306**, 261-271.