INSIGHT INTO MAGMA CHAMBERS: DYNAMICS OF THE ACTIVE MAGMA SYSTEM AT EREBUS VOLCANO

Background: Magma chambers are the heart of all volcanoes, and they control the nature and size of volcanic eruptions. However, magma chambers are out of sight and their nature and behavior can only be determined indirectly from seismic and geodetic measurements and examination of periodic eruptive products. Very rarely, volcanoes have lava lakes with magma convecting up from an underlying magma chamber. As such lava lakes are a surface manifestation of the unseen underlying magma chamber. Most lava lakes are transient and usually exist for less than 20 years. Erebus has a lava lake of an extremely rare phonolite magma which was first observed in 1973 and satellite images show the lake is still present today.

Objective: The fundamental objective is to make the first in depth examination of the mineralogy and geochemistry of a time series of volcanic bombs to examine changes in the Erebus magma chamber. In recent years there have been major refinements in using mineral chemistry to determine pressure and temperature of crystallization and other properties like oxygen fugacity. The Erebus bombs have a suite of minerals including olivine, clinopyroxene, anorthoclase, magnetite, sulfides phases, and apatite. The bombs are mostly composed of glass, which represents a rapidly chilled sample of the phonolite magma in the magma chamber.

Questions: Possible questions that can be addressed include:
1. Is the magma system being recharged with volatiles such as H_2O, CO_2, S, F, and Cl?
2. Is there crystal growth? What are the conditions of crystallization?
3. What are the physical conditions in the magma chamber?
4. Is there evidence of assimilation of the material surrounding the magma chamber?

Suggested studies:
1. Complete major and trace element and volatile analysis of the glass from a suite of bombs including duplicates and triplicates from a single year.
2. Detail major and trace element analyses of all mineral phases.
3. Crystal size distributions of the anorthoclase crystals to search for evidence of crystal growth.
4. Detailed analysis of the physical conditions of the magma system.

Samples: A suite of bomb samples erupted from the lava lake between 1973 and 2014 are archived at the Polar Rock Repository at Ohio State University and available for analysis. (prr.osu.edu)

Background references:
Zreda-Gostynska, G., Kyle, P.R., Finnegan, D., Prestbo, K.M., 1997. Volcanic gas emissions from Mount Erebus and their environmental impact on the Antarctic environment. Journal of Geophysical Research 102 (B7), 15039-15055.

Kelly, P.J., Kyle, P.R., Dunbar, N.W., Sims, K.W.W., 2008. Geochemistry and mineralogy of the phonolite lava lake, Erebus, Antarctica:1972-2004 and comparison with older lavas. Journal of Volcanology and Geothermal Research 177, 589-605.

Sims, K.W.W., Blichert-Toft, J., Kyle, P.R., Pichat, S., Bluzstajn, J., Kelly, P., Ball, L., Layne, G., 2008. A Sr, Nd, Hf, and Pb isotope perspective on the genesis and long-term evolution of alkaline magmas from Erebus volcano, Antarctica. Journal of Volcanology and Geothermal Research 177, 606-618.

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