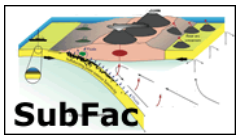
Magmatic degassing histories from apatite volatile stratigraphy



Award: 05-49082 (March 2006)

J. Boyce[1,2], R. Hervig[1]

[1] *Arizona State University;* [2] *University of California, Los Angeles*

We have evaluated the ability of apatite to record magmatic volatiles by measuring H, F, and Cl in apatite phenocrysts using secondary ion mass spectrometry (SIMS or "ion probe"). Core to rim traverses in polished crystal sections in apatite phenocrysts from the Cerro Galan ignimbrite (Argentina) reveal a complex record of pre-eruptive magmatic processes (Boyce and Hervig, 2008a). While all five crystals analyzed are different, the patterns are broadly similar: Apatite core regions are homogenous and enriched in OH relative to Cl and F, suggesting equilibrium with an H2O-rich magma prior to eruption (Figure). Outside of homogeneous core regions, we observe oscillatory but generally decreasing OH towards c-axis terminations, with OH and Cl concentrations anticorrelated in several crystals. Using previously determined diffusivities for halogens in apatite (Brenan, 1993*), we can constrain the maximum timescale over which the observed variations in volatile chemistry could have survived at magmatic temperatures to be less than ~400 days. If core to rim relationships in apatite are accurately tracking temporal changes in volatile activity in the magma with time, then these measurements provide a record of the processes – such as degassing and recharge – taking place in the magma chamber in the year prior to eruption. NSF MARGINS support for this project has laid the foundation for greater understanding of magmatic processes and will likely lead to new hazards assessment tools. Utilizing experimentally determined relationships between apatite and melt volatiles should permit apatite to function as a quantitative hygrometer, fluorimeter, and chlorimeter for magmatic systems. These analyses of apatite, and the timescales they imply can be correlated with surface monitoring of pre-eruptive volcanic activity providing an essential link between magmatic processes and surface indications.

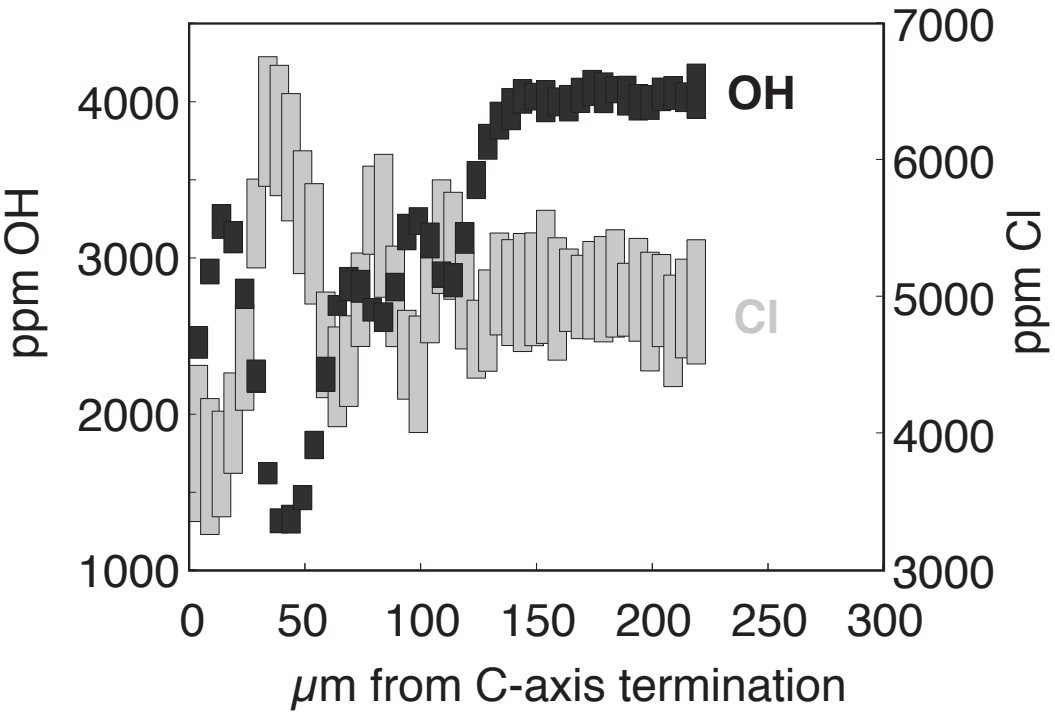


Figure: Core to rim (c-axis direction) profile of H (dark gray) and Cl (light gray) in an apatite phenocryst from the Cerro Galan ignimbrite (Argentina). Bars are ~8μm wide (approximately the size of the analyzed region) and 2SE high.

Boyce, J., and Hervig, R., 2008a, Magmatic degassing histories from apatite volatile stratigraphy: Geology, v. 36, p. 63.

 *References listed in appendix A.