ABSTRACT

An abstract of the thesis of Cindy A. Broderick for the Master of Science in Geology presented May 9, 2008.

Title: The Origin of Sulfur-rich Apatites in Silicic Magmas

We investigated apatite from the Fish Canyon Tuff and from tuffs and lavas of the San Luis Caldera Complex, Colorado to determine the origin of sulfur-rich (> 0.7 wt% SO₃) apatite in silicic, calc-alkaline magmas. This study found sulfur in apatite to range from 0.2 and 2.0 wt.% SO₃. Low-S, medium-S and high-S apatites occur in all units that range in composition from andesite to rhyolite. Based on experimental studies, high-S apatites with sulfur concentrations > 0.7 wt.% SO₃ could not have grown in rhyolitic melts under magmatic conditions as documented for the Fish Canyon Tuff and inferred for the other investigated units. The objective of this study is to determine if high-S apatites found in silicic magmas are the result of inheritance from mafic magmas or if other factors contributing to high sulfur concentrations in apatite must be involved.

Laser-ablation ICP-MS analyses were performed on apatite in order to correlate variations observed in sulfur with trace elements (e.g. REE) to make inferences about the melt environment from which apatites grew. Apatites from the Cebolla Creek Tuff, Fish Canyon Tuff and Eagle Mountain andesite have distinct apatite populations, based on their trace elements, whereas apatite from the Rat Creek Tuff and Nelson Mountain Tuff show variations in their trace elements consistent with several apatite populations each with distinctive compositions. Apatites among units are most distinct in La, Th, Sr,
and Eu/Eu*. Apatites, regardless if they were low-S or high-S, have similar REE patterns and concentrations characteristic for the unit from which they crystallized. This provides no evidence that apatites grew from melts that strongly varied in composition. Furthermore, the inferred Sr concentrations in the melt, based on Sr concentrations in apatite, indicate all apatites grew in melts of rhyodacitic to rhyolitic composition. Both REEs and Sr concentrations in apatite argue against inheritance of high-S apatites from mafic magmas. Therefore, high-S apatites require an alternative source to explain the upper end of the sulfur range observed in apatite. One possibility is that apatites during crystallization interacted with sulfur-rich fluids which could be derived from an underplated, degassing mafic magma.